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Glyphosate-Tolerant H7-1 Sugar Beet: Request for Nonregulated Status

Final Environmental Impact Statement—May 2012

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Glyphosate-Tolerant[1] H7-1 Sugar Beet: Request for Nonregulated Status

Final Environmental Impact Statement – May 2012

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[1] The applicant has described H7-1sugar beet as "herbicide-tolerant" and historically APHIS has also referred to GE plants with diminished herbicide sensitivity as "herbicide-tolerant". However, the phenotype would fall under the Weed Science Society of America's (WSSA) definition of "herbicide-resistant" since H7-1 has an inherited ability to survive and reproduce following exposure to a dose of herbicide normally lethal to the wild type variety WSSA, Resistance and Tolerance Definitions, 2008, Available: http://www.wssa.net/Weeds/Resistance/definitions.htm. By the WSSA definition, "resistance [to an herbicide] may be naturally occurring or induced by such techniques as genetic engineering or selection of variants produced by tissue culture or mutagenesis." Herbicide tolerance, by the WSSA definition, only applies to plant species with an "inherent ability" to survive and reproduce after herbicide treatment.

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Executive Summary

The U.S. Department of Agriculture (USDA), Animal and Plant Health Inspection Service (APHIS) is considering alternatives in response to a petition from Monsanto/KWS SAAT AG seeking a determination of non-regulated status of its event H7-1 sugar beet. This sugar beet cultivar is genetically engineered (GE) to be resistant to the herbicide glyphosate and is marketed as a tool for managing weeds in sugar beet production. APHIS regulations at 7 Code of Federal Regulations (CFR) part 340, which were promulgated pursuant to authority granted by the Plant Protection Act, as amended (7 United States Code (U.S.C.) 7701–7772), regulate the introduction (importation, interstate movement, or release into the environment) of certain GE organisms and products. A GE organism is considered a regulated article if the donor organism, recipient organism, vector, or vector agent used in engineering the organism belongs to one of the taxa listed in the regulation (7 CFR 340.2) and is also considered a plant pest. A GE organism is also regulated under Part 340 when APHIS has reason to believe that the GE organism may be a plant pest, or APHIS does not have information to determine if the GE organism is unlikely to pose a plant pest risk. Under Part 340.6, any person may submit to the APHIS administrator a petition to seek a determination that the article should be deregulated. A GE organism is no longer subject to the plant pest provisions of the Plant Protection Act or to the regulatory requirements of 7 CFR part 340 when APHIS determines that it is unlikely to pose a plant pest risk.

APHIS received a petition in 2003 from the Monsanto Company of St. Louis, Missouri, and KWS SAAT AG of Einbeck, Germany (hereinafter referred to as Monsanto/KWS SAAT AG) seeking a determination of nonregulated status of H7-1 sugar beet. APHIS completed a Plant Pest Risk Assessment as well as an environmental assessment (EA) and announced a Finding of No Significant Impact (FONSI) that all supported a determination of nonregulated status on March 4, 2005. The Center for Food Safety et al. (CFS) filed a complaint in January 2008, challenging APHIS' determination of nonregulated status of H7-1 sugar beet. The U.S. District Court for the Northern District of California in September 2009, found in favor of CFS et al. holding that APHIS should have prepared an environmental impact statement (EIS) before making a determination of the regulated status of H7-1 sugar beet. On August 13, 2010, the Court vacated the APHIS decision to fully deregulate event H7-1 sugar beet varieties, once again making them subject to the Plant Protection Act of 2000 (PPA) and 7 CFR Part 340. The purpose of this Final EIS is to present to the agency decisionmaker and the public the analysis of reasonable alternative responses to the 2003 petition for full deregulation in a manner that comprehensively informs the decisionmaker and the public of the potential environmental impacts to the human environment. The regulatory decision for this petition must be consistent with, among other laws, the requirements in 7 CFR part 340.

The United States has a well-established sugar beet and sugar cane industry. Since the mid-1990s, approximately 50 to 60 percent of the U.S. refined sugar has been produced from sugar beet (USDA-ERS, 2010b). The acreage for sugar beet cultivation has not changed substantially over the past 50 years. Sugar beet are planted on about 1.1 million acres in the States of California, Colorado, Idaho, Michigan, Minnesota, Montana, Nebraska, North Dakota, Oregon, South Dakota, Washington, and Wyoming. Sugar beet are grown for root and seed production. The largest root production of sugar beet occurs in Minnesota and North Dakota, accounting for about 55 percent of production. The majority of the seed production occurs in the Willamette Valley of Oregon (just over 50 percent) and Eastern Washington (just under 50 percent). H7-1 sugar beet was planted in 2010 in all the above States except California. No H7-1 sugar beet was planted in California or South Dakota in 2011. The primary use of sugar beet is for production of sugar. Therefore, its production is closely coordinated with the factories that process the sugar. Most sugar beet are grown within 60 miles and up to 100 miles, in some cases, of the processing facilities. Other products derived from sugar beet include certain food additives, dietary supplements, and livestock feed. In the United States, other economically important species (*Beta* spp.) related to sugar beet include red table beet and Swiss chard/leaf beet.

A. Alternatives Analyzed

The three alternatives considered in detail by APHIS in this Final EIS were determined based on their ability to be realistic and appropriate alternatives to address the petition's proposed action, that is, determine whether or not H7-1 sugar beet should have nonregulated status, and thereby meet, comply with, and fulfill the agency regulatory requirements and their ability to be implemented by APHIS in a reasonable and realistic manner. Alternative 1 involves denial of the petition seeking a determination of nonregulated status of H7-1 sugar beet. Alternative 2 involves making a determination of non-regulated status. Alternative 3 involves various levels of regulation that would allow large-scale cultivation of H7-1 sugar beet. The specific alternatives are as follows:

Alternative 1, No Action – Sugar Beet Regulated and Planted by Notification or Permit. APHIS would deny the petition seeking a determination of nonregulated status of H7-1 sugar beet. APHIS would continue to regulate the environmental release and movement of H7-1 sugar beet under 7 CFR part 340. Notifications or permits with conditions specified by APHIS would be required for planting or movement of any H7-1 sugar beet. No partial deregulation of H7-1 sugar beet would be allowed under this alternative.

Alternative 2, Full deregulation of H7-1 sugar beet (Preferred Alternative) – H7-1 sugar beet would no longer be regulated articles under the regulations at 7 CFR part 340. Permits and notifications from APHIS would no longer be required for commercial planting of H7-1 sugar beet seed and roots. APHIS would no longer regulate the environmental release and movement of H7-1 sugar beet. H7-1 sugar beet would be expected to be planted in all sugar beet root production areas, including Imperial Valley, California, and the seed production areas of the Willamette Valley and Eastern Washington.

Alternative 3, Partial Deregulation – APHIS would adopt the partial deregulation of H7-1 sugar beet for the root crop, with mandatory conditions and restrictions. APHIS would continue permitting the seed crop via APHIS permits or notifications in accordance with 7 CFR part 340. The importation and interstate movements of the seed crop would be subject to measures specified in permits, notifications, or compliance agreements. This regulatory approach is currently being applied during the preparation of this EIS as an interim measure. The partial deregulation conditions would not allow the planting of H7-1 sugar beet in California and Western Washington.

B. Environmental Consequences of Alternatives

The environmental consequences of the three selected alternatives are broadly summarized by the potential impacts resulting from herbicide usage, from cultivation of H7-1 sugar beet, from socioeconomic effects on agricultural producers, and from effects on potential options for consumers. The impacts from some alternatives are similar based upon the degree of regulation, but the magnitude of effect may vary. Based on similar impacts, the description of potential consequences of each alternative are compared and contrasted. This summary of potential impacts and findings is designed to address specific court, regulatory, and scoping issues for the alternatives.

1. Production and Management Issues in Sugar Beet and Related Crops

Under Alternative 1, H7-1 sugar beet use would be limited to Research and Development activities estimated to not exceed 1000 acres/year. Alternative 1 is expected to increase herbicide usage of 12 herbicides on the conventional sugar beet root crop, many of which the EPA has determined are more toxic than glyphosate, and decrease glyphosate use. Alternatives 2 and 3 are expected to decrease the use of the 12 herbicides and increase the use of glyphosate. Some of the twelve herbicides, particularly ethofumesate and clopyralid, are likely to be used in conjunction with glyphosate to help manage glyphosate-resistant weeds.

Alternative 1 is expected to result in usage of herbicides that could have more environmental impacts than glyphosate, which is the predominant herbicide applied under Alternatives 2 and 3. This includes impacts to animals, micro-organisms, non-target plants, human health, and environmental quality of the physical environment.

Because, many weeds that are present in sugar beet fields are resistant to the non-glyphosate herbicides, Alternative 1 is expected to decrease the effectiveness of chemical weed control. Weed resistance to non-glyphosate herbicides under Alternative 1 is expected to further increase as the spectrum of available herbicide mechanisms of action is decreased when glyphosate is no longer available for post-emergent weed control in sugar beet. In some areas where weed control is poor with non-glyphosate herbicides, growers may abandon growing sugar beet under Alternative 1.

Alternatives 2 and 3 are expected to maintain the improved weed control sugar beet growers currently experience using glyphosate. Production practices for sugar beet frequently include a 3- to 4-year crop rotation, which is expected to delay the selection of glyphosate-resistant weeds. Glyphosate-resistant weeds could become a problem for sugar beet growers under Alternatives 2 and 3 especially if glyphosate-resistant weeds in rotation crops become prevalent in sugar beet fields. Industry and growers are aware of this situation and will likely take proactive measures aimed to reduce and delay the development and spread of glyphosate-resistant weeds. In addition to crop rotation, these measures include use of additional herbicide chemistries, use of mechanical and biological management practices, monitoring of crops for weeds, and management of weeds to prevent the buildup of the weed seed bank.

Cultivation of conventional sugar beet under Alternative 1 is expected to result in increased conventional tillage in the Northwest and Great Plains. Alternatives 2 and 3 are expected to result in a reduction of tillage, except in areas like California where conventional tillage is required for fallow irrigation. As increased tillage leads to more soil erosion, it is expected that more soil erosion and associated impacts on water quality will result from Alternative 1 than from the other alternatives.

Alternative 1 could result in limited availability of non-glyphosate herbicides and limited availability of conventional sugar beet seeds needed for planting the root crop until at least 2014. Six of the non-glyphosate herbicides are used almost exclusively on conventional beet crops. With the widescale adoption of H7-1 sugar beet, there has been very little demand for these herbicides and consequently their manufacture was curtailed. Similarly, with the widescale adoption of H7-1 sugar beet, there has been very little demand for conventional sugar beet seeds and production of conventional varieties has been limited. Seed and herbicide shortages would not be an issue for Alternatives 2 and 3.

In the United States, sugar beet can cross pollinate to vegetable beet (Swiss chard and table beet) and wild beet. Movement of genes between sugar beet and other related species requires flowering. Sugar beet roots and table beet and Swiss chard vegetables are harvested before flowering. Therefore, no gene flow can occur to the vegetable crop under any of the alternatives.

For about half the vegetable beet seed produced in the U.S., no gene flow from sugar beet seed production is expected under any of the three alternatives because the production fields are geographically isolated. For the other half of the vegetable beet seed, grown in the Willamette Valley, sugar beet seed is grown in proximity but separated by isolation distances established to ensure varietal purity and to reduce the likelihood of gene flow. There have been instances where vegetable beet seed has cross pollinated into sugar beet seed production fields and vice versa.

The potential gene flow of H7-1 traits to conventional sugar beet, organic beet, and other *Beta* spp. in the Willamette Valley would be reduced under Alternative 1. However, gene flow of H7-1 traits would also be minimized under Alternative 2, where H7-1 sugar beet is grown in compliance with voluntary industry practices, and in Alternative 3, where industry practices are mandatory. Gene flow of the H7-1 trait into vegetable beet under Alternatives 2 and 3 would be greater than under Alternative 1, but would be expected to be below the level of detection of 1 seed in 10,000. Among the voluntary industry practices are the use of 3- to 4-mile isolation distances between different *Beta* seed crops and infrequent use of male fertile lines containing the H7-1 trait for seed production in areas where other *Beta* seed crops are grown. In 2011, only 15 percent of the sugar beet seed production acreage in Oregon used male fertile plants containing the H7-1 trait. The average and median distance between male fertile H7-1 sugar beet and vegetable beet seed production fields in 2011 is at least 8.7 and 7 miles, respectively. The range is from 4–19 miles (Table 4-2).

Under Alternatives 1 and 3, no gene flow is expected to occur from H7-1 sugar beet to wild beet because H7-1 sugar beet would not be grown in the

Imperial Valley of California, the only known place where sugar beet and wild beet coincide. But even under Alternative 2, where H7-1 sugar beet would be grown in proximity to wild beet, no cross pollination is expected for the following reasons. First, in the Imperial Valley, only sugar beet root production, not seed production, occurs. In the root crop, individual plants may flower on occasion. This situation is very different than seed production fields where essentially every plant in the field flowers resulting in a vastly greater pollen cloud. Second, the only confirmed species of wild beet in Imperial Valley is *Beta macrocarpa*. This wild beet is a different species than sugar beet and does not readily cross hybridize. Furthermore, it flowers earlier than sugar beet and is self fertile. Therefore, it is much more likely to self hybridize than to cross pollinate with sugar beet.

2. Biological Resources

Under Alternative 1, use of non-glyphosate herbicides, , including cycloate, quizalofop-p-ethyl, sethoxydim, and trifluralin, would increase. There could be a risk of sublethal or chronic effects on mammals from the application of cycloate or quizalofop-p-ethyl. Chronic effects could occur on birds/reptiles from the use of sethoxydim, or trifluralin. Trifluralin is the herbicide of most concern for fish and aquatic amphibians because it is very highly toxic to these organisms. None of the herbicides are expected to pose risks of population-level effects when used within label limits. Potential impacts on aquatic species from tillage include impaired habitat conditions from soil erosion, which can result in harm to individual species, including individual mortality.

Under Alternatives 2 and 3, glyphosate use would increase. Glyphosate is not expected to pose an acute or chronic risk to birds, reptiles, mammals, terrestrial and aquatic invertebrates, fish, amphibians, and micro-organisms when used within label limits.

Under Alternatives 2 and 3, potential impacts on aquatic species from tillage are expected to be less than Alternative 1 due to the expected adoption of conservation tillage practices such as reduced and strip-tillage.

The increased usage of glyphosate under Alternatives 2 and 3 and non-glyphosate herbicides under Alternative 1 might adversely affect exposed non-target plants from herbicide drift. Herbicide drift is expected to be greater under Alternative 1 because non-glyphosate herbicides are applied more frequently and are more likely to be applied through aerial applications. As a result, the impacts to non-target plants from herbicide drift are expected to be greater under Alternative 1.

Several agronomic traits were evaluated and no biological differences between H7-1 sugar beet and conventional sugar beet were found.

Therefore,H7-1 sugar beet are not expected to become more invasive in natural environments or have any different effect on critical habitat than conventional sugar beet, which do not establish or persist in the environment. In addition, the nutritional profiles of H7-1 sugar beet is similar to conventional sugar beet. Therefore, any nutritional effects of H7-1 sugar beet on any animals that feed upon them would not be different than the nutritional effects associated with conventional sugar beet. H7-1 sugar beet are not expected to be toxic to animals or allergenic to humans. The 5-enolpyruvylshikimate-3-phosphate synthase (EPSPS) protein from plants and from the CP4 *Agrobacterium* strain is not known to have pathogenic or toxic effects on humans, animals, or plants based on numerous laboratory and field studies with these purified proteins or plants expressing these proteins. H7-1 sugar beet are not sexually compatible with any threatened and endangered species. Therefore, the H7-1 trait is not expected to adversely affect plants and animals, including threatened and endangered species.

APHIS has determined that the importation, interstate movement, and environmental release of H7-1 sugar beet, within and into the United States, would have no effect on listed threatened and endangered species or species proposed for listing and would have no effect on designated critical habitat or habitat proposed for designation.

3. Socioeconomic Effects on Agricultural Producers

In 2011, adoption of GE sugar beet varieties exceeded 90 percent of U.S. sugar beet production and, therefore, Alternative 1 would require large-scale conversion to conventional practices. If Alternative 1 were selected, limited availability of conventional seed and more costly non-glyphosate herbicides needed for sugar beet production in 2013 would be expected to result in temporary reduction in income for sugar beet growers as a group and reduced payrolls for the sugar beet processing industry when compared to Alternatives 2 and 3. Alternative 1 is expected to reduce overall sugar beet yields when compared to Alternatives 2 and 3, especially in areas where conventional herbicides do not give good weed control. Some processing plants could be forced to close, resulting in longer term reductions in processing capacity and job loss.

There is evidence that H7-1 sugar beet can lower producton costs of weed control in sugar beet. Sugar beet producers under Alternative 1 would no longer benefit from the reduced herbicide, weeding, and tillage costs associated with the H7-1 sugar beet varieties. However, they would not be subject to the technology fee costs for H7-1 sugar beet seed by using conventional varieties. Seasonal farm workers would have more employment opportunities under alternative 1 because field work is expected to be more frequent under this alternative.

Domestic sales and exports of sugar beet or beet sugar were not negatively impacted during the years when H7-1 sugar beet varieties were commercialized. There is, likewise, no evidence that selection of Alternatives 2 and 3 would affect commercial sales relative to Alternative 1.

Under Alternatives 2 and 3, production costs for vegetable beet producers in the Willamette Valley may increase as a result of testing costs for low level presence (LLP) of the H7-1 trait. Even if no cross pollination between H7-1 sugar beet and vegetable beet seed is ever detected, market perception, by the GE-sensitive market, may disadvantage Willamette Valley vegetable beet seed producers compared to their competitors in western Washington, California, and Arizona. If so, some vegetable beet seed production may relocate outside the Willamette Valley under Alternatives 2 and 3, though most have not relocated since commercial-scale H7-1 sugar beet seed production began in 2007. Only a fraction of the vegetable beet seed market is expected to be sensitive to this perceived potential LLP, so the bulk of vegetable beet seed production in the Willamette Valley should continue.

4. Consumer Options

Under Alternatives 2 and 3, consumers with a preference for non-GE products are not expected to be impacted by the availability of H7-1 sugar beet, given that half of the U.S supply of sugar is derived from non-GE sources. Sugar beet sugar that would be derived under Alternative 1 would be chemically identical to the sugar derived from H7-1 sugar beet under Alternatives 2 and 3.

Shortages of supply and increases in the cost of sugar would be anticipated for Alternative 1 until an adequate supply of conventional seed is produced, but sales of conventional sugar beet and their products would be expected to increase.

No impacts are expected to the supply or sales of organic sugar under any of the alternatives because organic sugar is not derived from sugar beet.

No impacts are expected to the supply or sales of conventional or organic vegetable beet under any of the alternatives as vegetable beet production is unaffected by sugar beet production.

No impacts are expected to the supply of conventional and organic vegetable beet seed under any of the alternatives as *Beta* seed production is largely concentrated, segregated, and isolated under all the alternatives.

Although Alternatives 1–3 vary in the degree of segregation between H7-1 sugar beet and vegetable beet where Alternative 1 has the most segregation and Alternative 2 has the least, this variation in segregation practices is not expected to result in an impact to supply

5. Human Health

The toxicological and nutritional profile of H7-1 sugar beet and the sugar produced from them indicates no substantive differences compared with non-transgenic sugar beet and sugar derived from them; therefore, no difference is expected between Alternatives 1-3 on the toxicological and nutritional profile of sugar beet.

H7-1 sugar beet have been found to have no adverse effects on human health and worker safety beyond those of non-transgenic sugar beet. APHIS estimated that about 95 non-fatal injuries would occur each year to sugar beet growers from tillage and herbicide applications under Alternative 1. Production of H7-1 sugar beet reduces the equipment use for both by about 70 percent and consequently a proportional decrease in non-fatal worker injuries is expected under Alternatives 2 and 3.

EPA has determined that the use in accordance with the labeling of currently registered pesticide products containing glyphosate and other herbicides will not pose unreasonable risks or adverse effects to humans or the environment, including its use on sugar beet. Under Alternative 1, workers will be exposed to more non-glyphosate herbicides which are more toxic to humans than is glyphosate. For example, clethodim is a much more toxic skin irritant than glyphosate, clopyralid and desmedipham are much more toxic eye irritants, and EPTC, ethofumesate, and triflusulfuron-methyl are much more toxic by inhalation than is glyphosate. Worker exposure to herbicides will be greater under Alternative 1 because more field work is expected to be needed and herbicide applications are expected to be more frequent. Under Alternative 1, risks to Human Health are expected to be greater than under Alternatives 2 and 3.

I. Purpose and Need

A. Purpose of H7-1 Sugar Beet

The sugar beet (*Beta vulgaris* ssp. *vulgaris*) cultivars, designated as H7-1 sugar beet by developers Monsanto/KWS SAAT AG, are genetically engineered to be resistant to the herbicide glyphosate. H7-1 sugar beet are marketed to benefit sugar beet growers by providing a tool for managing weeds in sugar beet production. H7-1 sugar beet are genetically engineered to be resistant to gyphosate through the insertion of a gene (from *Agrobacterium* sp. strain CP4) that encodes the enzyme 5-enolpyruvylshikimate-3-phosphate synthase protein (EPSPS) into the sugar beet genome.

Weed management has been one of the largest concerns and challenges in sugar beet production. Herbicide programs based on non-glyphosate herbicides injure sugar beet, decrease yields, and are often ineffective. With the insertion of the CP4 gene, H7-1 sugar beet farmers are able to apply glyphosate to weeds in the field without the concern for ancillary damage to the sugar beet crop.

B. Production History of H7-1 Sugar Beet

The United States is among the largest producers of sugar beet, and about half of the sugar refined in this country is produced from sugar beet (USDA-NASS, 2010d). The roughly 1.1 million acres of sugar beet grown in the United States includes seed production and root production (sugar production). Sugar beet root production is primarily localized in the Red River Valley area of Minnesota and North Dakota (57 percent of U.S. production), with smaller production areas in the Upper and Central Great Plains, and portions of Idaho, Michigan, Nebraska, Montana, Colorado, Wyoming, California, and Oregon (USDA-ERS, 2010c). Sugar beet seed production occurs primarily in Oregon and Washington and in 2011 H7-1 seed production was evenly divided between those two states. In Oregon, production is concentrated in the Willamette Valley in Oregon, located between the Coast Range and the Cascade Range (Stankiewicz Gabel, 2010).

In the United States, beet sugar is processed in most cases in local, farmer-owned processing cooperatives. Sugar beet producers and their cooperatives rapidly adopted H7-1 sugar beet varieties following the determination of the U.S. Department of Agriculture (USDA) Animal and Plant Health Inspection Service (APHIS) of nonregulated status of H7-1 sugar beet in 2005. Widespread cultivation began in 2008, with H7-1 sugar beet varieties being grown in 10 states. USDA's Economic Research Service (ERS) estimates that adoption of the genetically engineered (GE) sugar beet varieties exceeded 95 percent of U.S. sugar beet production in 2010 (USDA-NASS, 2010d).

C. Regulatory History of H7-1 Sugar Beet

On November 19, 2003, USDA–APHIS received a petition request from Monsanto Company of St. Louis, Missouri, and KWS SAAT AG of Einbeck, Germany (hereinafter referred to as Monsanto/KWS SAAT AG) seeking a determination of nonregulated status of a GE variety of sugar beet designated as event H7-1 (hereinafter referred to as H7-1 sugar beet). H7-1 sugar beet and cultivars derived from it are genetically engineered to be resistant to the herbicide glyphosate. On October 19, 2004, APHIS published a notice in the *Federal Register* (see 69 *Federal Register* (FR) 61466–61467, Docket No. 04–075–1) announcing receipt of the petition from Monsanto/KWS SAAT AG requesting a determination of nonregulated status under 7 U.S. Code of Federal Regulations (CFR) part 340. The petition stated that APHIS should no longer regulate H7-1 sugar beet because they do not present a plant pest risk.

APHIS also announced in the 2004 *Federal Register* notice the availability of a draft environmental assessment (EA) for sugar beet (USDA-APHIS, 2005) for the proposed determination of nonregulated status. APHIS received 44 comments on the petition and the draft EA during a 60-day comment period, which ended December 20, 2004. Following review of public comments, completion of the final EA, and the subsequent finding of no significant impact (FONSI), APHIS published another notice in the *Federal Register* on March 17, 2005 (see 70 FR 13007–13008, Docket No. 04–075–2), advising the public of the agency's determination decision, effective March 4, 2005, that H7-1 sugar beet posed no plant pest risk and would no longer be considered a regulated article under APHIS regulations codified at 7 CFR part 340. Pursuant to this regulatory determination decision, H7-1 sugar beet seed and root crops were fully deregulated, and could be grown without any APHIS-imposed conditions.

Before receiving the 2003 petition from Monsanto/KWS SAAT AG, APHIS had authorized approximately 35 notifications on 98 sites for H7-1 sugar beet in all sugar beet producing States (USDA-APHIS, 2011b). A USDA notification is an administratively streamlined alternative to a permit that is used if a GE plant meets specified eligibility criteria and the introduction meets predefined performance standards (7 CFR 340.3). APHIS had also authorized approximately 100 confined releases (i.e., planting outside in a field) for the field planting of all sugar beet varieties from 1998 to 2005. As part of the authorization process, the releases require seed developers to describe to USDA "the methods used to ensure that the regulated materials and any possible offspring remain confined to the release site and do not persist in the environment." Additionally, the seed developers must provide, among other data, descriptions of isolation distances, use of border rows or fallow zones, use of temporal isolation, cages, flower removal or bagging, and male sterility (USDA-APHIS, 2011b). The 100 authorizations for confined releases involved multiple planting locations with up to 270 acres being authorized under single notifications.

In 2009 a federal district court order held that APHIS was required to complete an EIS. On July 29, 2010, Monsanto/KWS SAAT AG submitted a supplemental request to APHIS (Monsanto and KWS SAAT AG, 2010) to amend the original petition for nonregulated status that was submitted in 2003 (Monsanto and KWS SAAT AG, 2004) pursuant to the regulatory scheme of 7 CFR part 340. The 2010 Monsanto/KWS SAAT AG petition requested that APHIS approve their petition seeking a partial deregulation or similar administrative action to authorize the continued cultivation of H7-1 sugar beet subject to conditions proposed by APHIS pending completion of the EIS. In November 2010, APHIS prepared a draft EA to evaluate the environmental impacts of the 2010 Monsanto/KWS SAAT AG petition seeking partial deregulation or similar administrative action for the continued cultivation of H7-1 sugar beet. The draft EA notice of availability (NOA) was published in the *Federal Register* on November 4, 2010 (see 75 FR 67945–67946, Docket No. APHIS-2010–0047) and indicated that the draft EA was available to the public for review and comment through December 6, 2010. The draft EA of the 2010 Monsanto/KWS SAAT AG petition evaluated several alternatives for responding to the request for partial deregulation or similar administrative action for the continued cultivation of H7-1 sugar beet, and those alternatives included specific production and management conditions proposed by APHIS.

APHIS received, reviewed, and considered public comments on the draft EA for partial deregulation of H7-1 sugar beet. APHIS then prepared a plant pest risk assessment (PPRA) for the root crop (USDA–APHIS 2011c), the final EA for partial deregulation of H7-1 sugar beet (USDA-APHIS, 2011a), and an accompanying FONSI. The FONSI includes a summary of the public comments received (see section I.H.2 of the FONSI). APHIS then issued the accompanying determination decision document on February 3, 2011, approving the petition for partial deregulation of H7-1 sugar beet with conditions for root crop production and to allow seed production under 7 CFR part 340 (USDA-APHIS, 2011a). The final EA, FONSI, PPRA, and determination decision were published in the *Federal Register* on February 8, 2011 (see 76 FR 6759-6761). The outcome of the EA process for the 2010 Monsanto/KWS SAAT AG petition is an interim measure set to expire at the end of December 2012 and which will be superseded by the determination made in reliance on this environmental impact statement (EIS).

For the 2011 plant pest risk assessment, prepared in conjunction with the EA for the interim decision for a partial deregulation of the H7-1 sugar beet root crop, APHIS concluded that H7-1 sugar beet grown under conditions are unlikely to pose a plant pest risk (USDA-APHIS, 2010b) based on the information provided by the applicant and the lack of any of the following—

- plant pest risk from the inserted genetic material,
- weedy characteristics,
- atypical responses to disease or plant pests in the field,
- effects on non-target or beneficial organisms in the agro-ecosystem, and
- horizontal gene transfer (HGT).

D. Litigation History

1. First Lawsuit: Sugar Beet I

In March of 2005, APHIS approved a petition requesting a determination of nonregulated status for H7-1 sugar beet after completing a PPRA and an EA pursuant to the National Environmental Policy Act of 1969 (NEPA) and issuing a FONSI.

On January 23, 2008, the Center for Food Safety, Sierra Club, Organic Seed Alliance, and High Mowing Organic Seeds filed a lawsuit in the U.S. District Court for the Northern District of California, which challenged the the USDA determination of nonregulated status of H7-1 sugar beet (see *Center for Food Safety, et al. v. Vilsack, et. al., No3: 08-cv-00484*). The plaintiffs argued that pollen from H7-1 sugar beet would contaminate conventional sugar beet and other closely related crops, such as Swiss chard and table beet, and that such gene flow from the H7-1 sugar beet to non-H7-1 sugar beet and other related crops could be economically detrimental to farmers and consumers of conventional and organic varieties. This was the first H7-1 sugar beet lawsuit and is referred to in this document as Sugar Beet I.

On September 21, 2009, the U.S. District Court for the Northern District of California ruled that the APHIS EA for H7-1 sugar beet failed to consider certain environmental and interrelated economic impacts. As a result, the court ordered APHIS to prepare an EIS (see *Center for Food Safety, et al. v. Vilsack, et al. No.3:08-cv-00484 Document139*). Specific findings of the court in its September 21, 2009 decision include:

(1) The Court found that the APHIS FONSI was "not supported by a convincing statement of reasons," and that, therefore, APHIS is required to prepare an EIS.

(2) In particular, the court agreed with an earlier ruling (see *Geertson Seed Farms v. Johanns*, 2007 WL 518624, *7 (N.D. Cal. Feb. 13,

2007) that "potential elimination of a farmer's choice to grow non-genetically engineered crops, or a consumer's choice to eat non-genetically [sic] engineered food, and an action that potentially eliminates or reduces the availability of a particular plant has a significant effect on the human environment" and therefore requires analysis in an EIS.

(3) The court noted that economic effects of "transmission of the genetically engineered gene into organic and conventional" crops should be considered by APHIS in its environmental reviews when determining whether nonregulated status would cause significant environmental impacts.

(4) The court was critical of the APHIS analysis of existing coexistence measures used in Oregon seed production areas, noting that APHIS did not adequately consider that recommended isolation distances were voluntary, might not be followed, and might not be sufficient.

(5) The court concluded that APHIS did not provide support for the contention that non-transgenic seed would continue to be available for growers or that growers would discern that seed varieties derived from H7-1 sugar beet are transgenic because it is labeled as glyphosate-tolerant.

On August 13, 2010, the court vacated the APHIS decision to fully deregulate event H7-1 sugar beet varieties, making them subject to the Plant Protection Act of 2000 (PPA) and 7 CFR part 340 once again. In doing so, the court remanded the matter back to the agency to determine what regulatory actions, if any, should be imposed upon event H7-1 sugar beet prior to the completion of the EIS and a new determination decision could be made. The plaintiffs' request for a permanent injunction against the planting of H7-1 sugar beet pending completion of the court-ordered EIS was denied. Consistent with the court order, APHIS *did not* treat H7-1 sugar beet planted *before* August 13, 2010, as regulated articles and those plants *were not* subject to the PPA of 2000 or 7 CFR part 340 for the duration of those plantings. Thus, H7-1 sugar beet planted for root production before August 13, 2010, was allowed to remain in the ground, be harvested, transported, processed, and sold as sugar. Based on the court order, H7-1 sugar beet planted for seed production before August 13, 2010, was allowed to be grown until the seeds or seed stecklings were harvested, transported, and stored; and sugar beet seed producers that used direct seeding (seed plants that were not transplanted during the steckling stage of seed production) before August 13, 2010 were allowed to let their H7-1 sugar beet seed plants to flower and set seed with no restriction under 7 CFR part 340.

2. Second Lawsuit: Sugar Beet II

Shortly after the Court's August 13, 2010 ruling in *Sugar Beet I*, four sugar beet seed companies applied for permits pursuant to APHIS' Part 340 biotechnology regulations to plant H7-1 sugar beet seed crops. The requested permit applications sought to allow the immediate planting of H7-1 sugar beet seeds for nonflowering steckling production on up to 526 total acres in Arizona and Oregon.

On September 3, 2010, APHIS issued four "nonflowering" permits allowing the planting of the first phase of the 2010–2011 H7-1 sugar beet seed (steckling) crop. The permits expressly prohibited the flowering of the H7-1 sugar beet plants. The permits were set to expire on February 28, 2011.

In response to APHIS' issuance of the four nonflowering steckling permits, on September 9, 2010, Center for Food Safety filed a new lawsuit alleging that APHIS violated NEPA. This is the second H7-1 sugar beet lawsuit and is referred to in this document as *Sugar Beet II* (see *Center for Food Safety, et al. v. Vilsack et al. No.: 4:10-cv-04038*).

On September 28, 2010, the court found that plaintiffs were likely to succeed on the merits because APHIS violated NEPA in permitting steckling crops. On November 30, 2010, the court ordered that the stecklings planted under permit shall be removed from the ground (see *Center for Food Safety, et al. v. Vilsack, et al. No.: 4:10-cv-04038 document 221*).

On December 3, 2010, the court issued a preliminary injunction ordering APHIS to issue an Emergency Action Notification to each of the four permittees directing them to plow under (i.e., "destroy") the stecklings by December 14, 2010. The Ninth Circuit Court granted a stay of the District Court's order on December 6, 2010 and on February 25, 2011, the Ninth Circuit issued an opinion reversing and vacating the District Court's preliminary injunction of December 3, 2010. The four permits expired on February 28, 2011, and the District Court dismissed the case as moot. Plaintiffs have appealed the decision.

3. Lawsuits: Sugar Beet III and IV

On February 4, 2011, after preparing an EA and PPRA, APHIS announced its new interim decision to partially deregulate H7-1 sugar beet. The decision was made in response to a petition for partial deregulation submitted July 29, 2010 by Monsanto/KWS SAAT AG. APHIS approved the petition to partially deregulate H7-1 sugar beet root crop subject to mandatory conditions contained in APHIS-issued compliance agreements. APHIS further announced that H7-1 sugar beet seed crop planting would only be allowed through permits with mandatory conditions issued pursuant to the agency's 7 CFR part 340 regulations.

Immediately after this announcement, two new legal challenges were filed against APHIS. The first challenge was a new lawsuit filed by growers and other members of the sugar beet industry. This lawsuit, referred to in this document as *Sugar Beet III*, was filed in the U.S. District Court for the District of Columbia (see *Grant, et al. v. Vilsack, et. al. No.*11-cv-308). The complaint alleged that APHIS exceeded its authority under the PPA by mandating certain conditions for the planting of H7-1 sugar beet. Plaintiffs also seek a declaratory judgment that APHIS' February 4, 2011 interim decision complied with NEPA.

The Center for Food Safety filed a new complaint on February 23, 2011, in the Northern District of California. This February 23, 2010 action is referred to in this document as *Sugar Beet IV* (see *Center for Food Safety, et al. v. Vilsack, et. al.* Nos. 11-cv—831; 11-cv-586; 11-cv-308). Sugar Beet IV was subsequently transferred to the U.S. District Court for the District of Columbia and consolidated with the *Sugar Beet III* case. Thus, *Sugar Beet III and IV* are proceeding in the District of Columbia.

E. Regulatory Authority

"Protecting American agriculture" is the basic charge of USDA–APHIS. APHIS provides leadership in ensuring the health and care of plants and animals. The agency improves agricultural productivity and competitiveness and contributes to the national economy and the public health. USDA asserts that all methods of agricultural production (conventional, organic, or the use of genetically engineered varieties) can provide benefits to the environment, consumers, and farm income.

Since 1986, the U.S Government has regulated GE organisms pursuant to a regulatory framework known as the Coordinated Framework for the Regulation of Biotechnology (Coordinated Framework) (51 FR 23302, 57 FR 22984). The Coordinated Framework, published by the Office of Science and Technology Policy, describes the comprehensive Federal regulatory policy for ensuring the safety of biotechnology research and products and explains how Federal agencies will use existing Federal statutes in a manner to ensure public health and environmental safety while maintaining regulatory flexibility to avoid impeding the growth of the biotechnology industry. The Coordinated Framework is based on several important guiding principles: (1) agencies should define those transgenic organisms subject to review to the extent permitted by their respective statutory authorities; (2) agencies are required to focus on the characteristics and risks of the biotechnology product, not the process by which it is created; (3) agencies are mandated to exercise oversight of GE organisms only when there is evidence of "unreasonable" risk.

The Coordinated Framework explains the regulatory roles and authorities for the three major agencies involved in regulating GE plants: USDA–APHIS, the Food and Drug Administration (FDA), and the Environmental Protection Agency (EPA). In the case of H7-1 sugar beet, under the Coordinated Framework review, USDA reviews the plant. FDA considers the safety and regulatory status of food and feed derived from the plant. EPA did not review the H7-1 sugar beet plant, but does register the use of the glyphosate and other herbicides by farmers in H7-1 sugar beet production. EPA also established a tolerance for allowable glyphosate and other herbicide residues on harvested H7-1 sugar beet.

1. USDA–APHIS

The USDA–APHIS Biotechnology Regulatory Service (BRS) mission is to protect U.S. agriculture and the environment using a dynamic and science-based regulatory framework that allows for the safe development and use of GE organisms. APHIS regulations at 7 CFR part 340, which were promulgated pursuant to authority granted by the Plant Protection Act, as amended, regulate the introduction (importation, interstate movement, or release into the environment) of certain GE organisms and products. A GE organism is considered a regulated article if the donor organism, recipient organism, vector, or vector agent used in engineering the organism belongs to one of the taxa listed in the regulation (7 CFR 340.2) and is also considered a plant pest. A GE organism is also regulated under Part 340 when APHIS has reason to believe that the GE organism may be a plant pest or APHIS does not have information to determine if the GE organism is unlikely to pose a plant pest risk.

A person may petition the agency that a particular regulated article is unlikely to pose a plant pest risk and, therefore, is no longer regulated under the plant pest provisions of the Plant Protection Act or the regulations at 7 CFR 340. The petitioner is required to provide information under § 340.6(c)(4) related to plant pest risk that the agency may use to determine whether the regulated article is unlikely to present a greater plant pest risk than the unmodified organism. A GE organism is no longer subject to the regulatory requirements of 7 CFR part 340 or the plant pest provisions of the Plant Protection Act when APHIS determines that it is unlikely to pose a plant pest risk. In such a case, APHIS authorizations (i.e., permits and notifications) would no longer be required for environmental release, importation, or interstate movement of the nonregulated article or its progeny.

It was pursuant to these APHIS regulations that Monsanto/KWS SAAT AG submitted a petition for a determination of nonregulated status of H7-1 sugar beet in 2003 (Monsanto and KWS SAAT AG, 2004). H7-1 sugar beet were initially considered a regulated article because they contain noncoding DNA segments derived from plant pathogens and the vector agent used to deliver the transforming DNA is a plant pathogen (Monsanto and KWS SAAT AG, 2004; USDA-APHIS, 2005; Monsanto and KWS SAAT AG, 2010)

2. FDA

FDA regulates GE organisms under the authority of the Federal Food, Drug, and Cosmetic Act. FDA is responsible for ensuring the safety and proper labeling of all plant-derived foods and feeds, including those that are genetically engineered. To help developers of food and feed derived from GE crops comply with their obligations under Federal food safety laws, FDA encourages them to participate in a voluntary consultation process. In 1992, FDA, which has primary regulatory authority over food and feed safety, published a policy statement in the *Federal Register* concerning regulation of food derived from new plant varieties, including those produced through biotechnology (U.S. FDA, 1992).

FDA also operates a voluntary, pre-market consultation process and encourages developers to consult with FDA to ensure that human food and animal feed safety questions are resolved before food from bioengineered crops is commercially distributed. The voluntary consultation process provides a way for developers to receive assistance from FDA when making a judgment about the regulatory status of a food prior to marketing. Monsanto/KWS SAAT AG participated in FDA's consultation program by submitting a food and feed safety and nutritional assessment summary for H7-1 sugar beet to FDA in April 2003. The consultation process was completed in August 2004 (Tarantino, 2004; U.S. FDA, 2004).

3. EPA

EPA regulates plant-incorporated protectants under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) and certain biological control organisms under the Toxic Substances Control Act (TSCA). EPA is responsible for regulating the sale, distribution and use of pesticides, including pesticides that are produced by an organism through techniques of modern biotechnology. EPA is also responsible for regulating pesticides (including herbicides such as glyphosate) under FIFRA (7 United States Code (U.S.C.) § 136 et seq.). FIFRA requires all pesticides to be registered before distribution, sale, and use, unless they are exempted by EPA regulation. Before a product is registered as a pesticide under FIFRA, the product must be shown to not result in unreasonable adverse effects on the environment when used in accordance with the label. EPA granted the registration of glyphosate for use over the top of sugar beet on March 31, 1999.

Under the Federal Food, Drug, and Cosmetic Act (FFDCA), as amended (see 21 U.S.C. § 301 et seq.), pesticides added to (or contained in) raw agricultural commodities generally are considered to be unsafe unless a tolerance or exemption from tolerance has been established. EPA establishes residue tolerances for pesticides under the authority of the FFDCA. Before establishing pesticide tolerance, EPA must reach a safety determination based on a finding of reasonable certainty of no harm under the FFDCA, as amended by the Food Quality Protection Act of 1996 (FQPA). FDA enforces the pesticide tolerances set by EPA. EPA established a tolerance for glyphosate residue found on beet, including sugar, roots, tops, and dried pulp on April 14, 1999 (64 FR 18360).

4. StatutoryBasis for Documentation

APHIS has prepared this EIS in compliance with the requirements of NEPA (42 U.S.C. § 4321 et seq.), the Council on Environmental Quality's (CEQ's) regulations implementing NEPA (40 CFR parts 1500–1508), and the USDA and APHIS NEPA implementing regulations and procedures (see 7 CFR part 1b and 7 CFR part 372). This EIS and a subsequent Record of Decision (ROD) are part of an independent NEPA process to make an informed decision on the petition request from Monsanto/KWS SAAT AG seeking a determination of non-regulated status of their H7-1 sugar beet.

F. Purpose and Need for APHIS Action

Under the authority of the plant pest provisions of the Plant Protection Act and 7 CFR part 340, APHIS has issued regulations for the safe development and use of genetically engineered organisms. As required by 7 CFR 340.6, APHIS must respond to petitioners that request a determination of the regulated status of genetically engineered organisms, including genetically engineered plants such as H7-1 sugar beet. When a petition for nonregulated status is submitted, APHIS must make a determination of whether the genetically engineered organism is unlikely to pose a plant pest risk. If APHIS determines, based on its Plant Pest Risk Assessment (PPRA), that the GE organism is unlikely to pose a plant pest risk, the GE organism is no longer subject to the plant pest provisions of the Plant Protection Act and 7 CFR part 340.

Any party can petition APHIS to deregulate an organism that is regulated under 7 CFR part 340. A petition must document the evidence that the GE organism is unlikely to pose a greater plant pest risk than the unmodified organism from which it was derived.

APHIS must respond to the November 2003 petition from Monsanto/KWS SAAT AG requesting a determination of nonregulated status of H7-1 sugar beet. APHIS prepared an EA and FONSI in February 2005 (USDA-

APHIS, 2005) and subsequently approved the petition in March 2005. On September 21, 2009, the U.S. District Court for Northern California ruled that the APHIS EA failed to consider certain environmental and interrelated economic impacts and ordered APHIS to prepare an EIS before making a determination on the regulated status of H7-1 sugar beet. This EIS has been prepared in order to specifically evaluate the effects on the quality of the human environment that could result from a decision on the regulated status of H7-1 sugar beet and to comply with Judge White's ruling on September 21, 2009 that APHIS is required to prepare an EIS.

G. Decisions to be Made

Based on the scoping process for the Draft EIS and the issuance of the Draft EIS, the specific decisions to be made by this Final EIS are:

- Should APHIS deny the petition seeking a determination of nonregulated status of H7-1 sugar beet, allowing for no full or partial deregulation of H7-1 sugar beet seed and root, and continue to fully regulate the environmental release and movement of H7-1 sugar beet under 7 CFR part 340 (the No Action Alternative)?

- Should APHIS approve the petition seeking a determination of nonregulated status (the Full Deregulation Alternative) of H7-1 sugar beet, allowing for the full and complete unregulated planting of H7-1 sugar beet seed and root in the United States, and thereby no longer regulate in any manner the environmental release and movement of H7-1 sugar beet under 7 CFR part 340?

- Should APHIS continue and adopt the interim decision for the partial deregulation of H7-1 sugar beet for root crop, with mandatory conditions and restrictions, and continue permitting seed crop via APHIS permits or notifications in accordance with 7 CFR part 340 (the Partial Deregulation Alternative)?

H. Scoping and Public Involvement

APHIS' determination of nonregulated status of H7-1 sugar beet raises several issues that are addressed in this Final EIS. APHIS identified these issues through an earlier scoping process in advance of the Draft EIS (DEIS).

1. Scoping: Notice of Intent (NOI) to Issue an EIS

Scoping for the DEIS for the petition for a determination of nonregulated staus for H7-1 sugar beet began on May 28, 2010, when APHIS issued its NOI in the *Federal Register* (see 75 FR 29969–29972) informing the public of its intent to prepare an EIS to evaluate and analyze the potential environmental effects resulting from APHIS' Determination of the petition. The NOI listed several topics and questions that were addressed in the DEIS and to the extent necessary and appropriate, also are addressed in this Final EIS:

(1) *Management practices for organic sugar beet, conventional sugar beet, and glyphosate-tolerant sugar beet.* What are the management practices and associated costs of establishing, growing, harvesting, and marketing sugar beet, including selling prices and premiums for the various types of sugar beet? What crop rotation regimes are used with sugar beet?

(2) *Production levels of organic and conventional sugar beet, Swiss chard, and table beet by region, State, and county.* What is the acreage of cultivated, volunteer, or feral sugar beet? What is the acreage of Swiss chard and table beet? Which regions of the country may be affected as a result of a determination of nonregulated status for glyphosate-tolerant sugar beet? What are the potential impacts on adjacent, nonagricultural lands such as natural areas, forested lands, or transportation routes that may result from the use of glyphosate-tolerant sugar beet?

(3) *Potential impacts of glyphosate-tolerant sugar beet cultivation on livestock production systems.* What are the potential impacts of glyphosate-tolerant sugar beet cultivation on conventional and organic livestock production systems?

(4) *Potential impacts on food and feed.* Does glyphosate affect the socioeconomic value of food or feed or its nutritional quality? What are the impacts, if any, on food or feed socioeconomic value or its nutritional quality from the use of glyphosate?

(5) *Differences in weediness traits of conventional sugar beet versus glyphosate-tolerant sugar beet.* What are the differences, if any, in weediness traits of conventional sugar beet versus glyphosate-tolerant sugar beet under managed crop production systems, as well as in unmanaged ecosystems?

(6) *Occurrence of common and serious weeds found in organic sugar beet systems, in conventional sugar beet systems, and in glyphosate-tolerant sugar beet systems.* What are the impacts of weeds, herbicide-tolerant weeds, weed management practices, and unmet weed management needs for organic and conventional sugar beet

cultivation? How may the weed impacts change with the use of glyphosate-tolerant sugar beet?

(7) *Management practices for controlling weeds in organic sugar beet systems, in conventional sugar beet systems, and in glyphosate-tolerant sugar beet systems.* What are the potential changes in crop rotation practices and weed management practices for control of volunteer sugar beet or herbicide-tolerant weeds in rotational crops that may occur with the use of glyphosate-tolerant sugar beet? What are the potential effects on sugar beet stand termination and renovation practices that may occur with the use of glyphosate-tolerant sugar beet?

(8) *Cumulative impact on the development of glyphosate-resistant weeds.* What glyphosate-resistant weeds have been identified and what is their occurrence in crops and in non-crop ecosystems? How would the addition of glyphosate-tolerant sugar beet impact the occurrence of glyphosate-resistant weeds in sugar beet, in other crops, and in the environment? Which are the most likely weeds, if any, to gain glyphosate resistance and why would they gain such resistance with the use of glyphosate-tolerant sugar beet? What are the current and potentially effective strategies for management of glyphosate-tolerant or other herbicide-tolerant weeds in glyphosate-tolerant sugar beet stands or in subsequent crops? What are the potential changes that may occur in glyphosate-tolerant sugar beet as to susceptibility or tolerance to other herbicides?

(9) *Current or prospective herbicide-tolerant weed mitigation options.* What are the potential impacts of current or prospective herbicide-tolerant weed mitigation options, including those addressed by the EPA-approved label for glyphosate herbicides?

(10) *Potential for gene flow from glyphosate-tolerant sugar beet to other Beta species, including gene flow between seed fields, root crops, and feral plants.* To what extent will deregulation change hybridization between cultivated and feral sugar beet, sugar beet introgression or establishment outside of cultivated lands, and sugar beet persistence or weediness in situations where it is unwanted, unintended, or unexpected? What are the potential impacts associated with feral glyphosate-tolerant sugar beet plants? Will the removal of glyphosate-tolerant sugar beet, in situations where it is unwanted, unintended, or unexpected, result in adverse impacts? In such situations, how will glyphosate-tolerant sugar beet be controlled or managed differently from other unwanted, unintended, or unexpected sugar beet?

(11) *Economic and social impacts on organic and conventional sugar beet, Swiss chard, and table beet farmers.* What are the economics of growing organic sugar beet, conventional sugar beet, or glyphosate-tolerant sugar beet as well as the economics of growing organic or conventional Swiss chard and table beet? What are the potential impacts of the presence of glyphosate sugar beet caused by pollen movement or seed admixtures? What are the potential impacts of commingling sugar beet seed with glyphosate-tolerant sugar beet seed? What are the potential changes in the economics of growing and marketing organic and conventional sugar beet that may occur with the growing of glyphosate-tolerant sugar beet? What are the potential changes in production levels of other crops that may occur with the growing of glyphosate-tolerant sugar beet? Will the cultivation of glyphosate-tolerant sugar beet result in more or fewer acres of other crops? What are the potential changes in growing practices, management practices, and crop rotational practices in the production of sugar beet seed for planting purposes that may occur with the use of glyphosate-tolerant sugar beet? What are the potential changes in the choice of seeds available for organic and conventional sugar beet farmers that may occur with the use of glyphosate-tolerant sugar beet?

(12) *Cumulative impact of potential increased glyphosate usage with the cultivation of glyphosate-tolerant crops.* What are the past, present, and future impacts of glyphosate usage on soil quality, water quality, air quality, weed populations, crop rotations, soil micro-organisms, diseases, insects, soil fertility, food or feed quality, crop acreages, and crop yields as a result of the introduction of glyphosate-tolerant crops? Does the level of glyphosate tolerance within glyphosate-tolerant sugar beet plants have an impact on the amount of glyphosate applied on the glyphosate sugar beet crop on a routine basis?

(13) *Impacts on threatened or endangered species.* What are the potential impacts of glyphosate-tolerant sugar beet cultivation on listed threatened or endangered species or on species proposed for listing? What are the potential impacts of glyphosate use on listed threatened or endangered species or species proposed for listing, including glyphosate used on glyphosate-tolerant sugar beet? What impacts does the addition of glyphosate tolerance in sugar beet cultivation have on threatened and endangered species as a result of displacing other herbicides?

(14) *Potential health impacts.* What are the potential health impacts to farmers or others who would be exposed to glyphosate-tolerant sugar beet?

(15) *Can any potential negative environmental impacts of the action be mitigated and what is the likelihood that such mitigation measures will be successfully implemented and effective?* What is the likely effectiveness of the stewardship measures, outlined in the petition, which are designed to reduce inadvertent gene flow to negligible levels as well as to monitor and minimize the potential development of glyphosate-tolerant weeds? Are there reasonable alternative stewardship or monitoring measures that may avoid or minimize reasonably foreseeable environmental impacts of a deregulation decision?

(16) *Impacts of the mitigation measures on coexistence with organic and conventional sugar beet production and on export markets.* What are the potential impacts of mitigation measures on coexistence with organic and conventional sugar beet production and on export markets? Are there reasonable alternative measures that may avoid or minimize reasonably foreseeable impacts on organic and conventional sugar beet production and on export markets that may be associated with a deregulation decision?

(17) *Consideration of reasonable alternatives.* The EIS will consider a range of reasonable alternatives. These could include continued regulation of H7-1 sugar beet, deregulating H7-1 sugar beet, or deregulating H7-1 sugar beet in part with geographic restrictions and required separation distances from sexually compatible crops.[2]

The NOI solicited public involvement in the form of written comments regarding the above issues and alternatives for regulatory action. Written comments were accepted from the public during a 30-day comment period, which lasted until June 28, 2010.

2. Scoping Analysis and Documentation

[2] The alternatives included in the May 28, 2010, *Federal Register* listing have since been revised and currently include: Alternative 1 – deny the petition seeking a determination of nonregulated status and continued regulation of H7-1 sugar beet by permits or notification (no action), Alternative 2 – full deregulation of H7-1 sugar beet, Alternative 3 – partial deregulation of H7-1 sugar beet for root crop and continued permitting of seed crop.

In total, APHIS received 70 comments from 64 respondents during the NOI comment period commenced on May 28, 2010, including multiple comments from the same individual or organization. There were 46 respondents opposed to deregulating H7-1 sugar beet, of which 3 were nongovernmental organizations. Two of those organizations sought to extend the comment period, while not providing substantive input on the scope of the EIS. The Center for Food Safety submitted a comment germane and in opposition to APHIS' positions on the specific issues previously identified for scoping. There were 18 respondents supporting deregulating H7-1 sugar beet, of which 17 were from industry or trade groups seeking an expeditious EIS and approval process.

An analysis of the comments received did not identify any additional broad issues outside of those enumerated in the NOI, but highlighted important issues within the present list of issues that were analyzed by the agency in the DEIS.

The following is a general summary of the comments received after issuance of the NOI.

In opposing the deregulation of H7-1 sugar beet, Center for Food Safety (CFS) suggested promoting cover crops as an alternate weed control strategy and provided a source for that approach. CFS further suggested that APHIS break out crop rotation regimes by region as a means of assessing the rate at which glyphosate-resistant (GR) weeds will emerge. CFS stated that the use of glyphosate may make plants more susceptible to disease and mineral deficiencies, adversely impact soil bacteria, and reduce yield. CFS provided references supporting their position. In addition to reducing feed quality due to glyphosate-induced lower mineral content, CFS suggested that glyphosate residues may render GR crops toxic to livestock and increase the presence of mycotoxins and other disease-related toxins due to increased susceptibility to fungal diseases such as *Fusarium* yellows (also called *Fusarium* wilt). CFS suggested H7-1 sugar beet and the associated use of glyphosate to control weeds will contribute to the development of GR weeds which may spread to neighboring crops, as well as development of weeds resistant to multiple herbicides. CFS also suggested that mandatory weed resistance requirements may be necessary if H7-1 sugar beet are deregulated. One such weed CFS cited is kochia, which according to CFS "has the ability to propagate long distances to infest other fields." CFS also urged APHIS to consider the negative effect "inert" ingredients present in glyphosate formulations may have on wildlife, such as the California red-legged frog.

Forty-five other commenters, including the Sierra Club and the Organic Seed Growers and Trade Association, submitted generally anti-GE comments opposing deregulation of H7-1 sugar beet and requesting additional time to respond to the scoping of the EIS. A citizen in opposition of H7-1 sugar beet posted a copy of the June 14th, 2010, "Organic and non-genetically modified organism (GMO) Report" interview with Don Huber that also referenced a similar previous interview with Robert Kremer warning of the impacts of glyphosate use on soils and plant health.

There were 17 respondents from industry or trade organizations,[3] citing a number of agronomic and economic benefits to sugar beet growers and submitting similar comments in support of deregulation of H7-1 sugar beet. These expressed benefits include reduced weed pressure; improved disease treatments; increased sugar beet yields; less manual cultivation; reduced use of "harsher" (more toxic and/or less environmentally benign) herbicides and less complex herbicide regimens which improve worker safety, reduce environmental effects, and are less harmful to the crop; less tillage, which decreases erosion, reduces carbon release, and allows for more cover crops; and fewer tractor emissions. Associations urged the USDA to return H7-1 sugar beet to nonregulated status, since most sugar beet growers have adopted equipment and rotation plans suitable for the GR varieties that are unsuitable for a return to conventional methods. These commenters also expressed concerns that a return to conventional varieties would cause an unbearable financial hardship for growers, who would lose several years' worth of revenue in the process of reverting back to pre-GR equipment and technology; that growers would rather abandon growing sugar beet altogether than resume conventional sugar beet cultivation; and that no longer growing sugar beet would cause wide-ranging economic impacts.

The California Beet Growers Association stated that GR technology is needed to address the severe weed control problem in their State. The U.S. Beet Sugar Association, in addition to the above general comments supporting deregulation, stated that after processing, sugar derived from H7-1 sugar beet contains no DNA fragments, and its molecular structure is identical to that produced from conventional sugar beet. The Minn-Dak Farmers Cooperative states that "Roundup Ready® sugar beet have provided a safety net that does not exist with conventional sugar beet when the crop has been injured from excessive spring rains." The Nebraska Sugarbeet Growers Association commented that spring rains prevent growers from timely herbicide spraying, but with H7-1 sugar beet, growers can control larger weeds.

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[3] American Sugar Beet Association, Beet Sugar Development Foundation, Red River Valley Sugar Beet Growers Association, Nyssa-Nampa Beet Growers Association, Idaho Sugar Beet Growers Association, California Beet Growers Association, Montana Dakota Beet Growers Association, Big Horn Basin Beet Growers Association, Michigan Sugar Company, United States Beet Sugar Association, Minn-Dak Farmers Cooperative, Wyoming Sugar Growers, LLC, Colorado Sugarbeet Growers Association, Southern Minnesota Beet Sugar Cooperative, Nebraska Sugarbeet Growers Association, Biotechnology Industry Organization (BIO), and the U.S. Soybean Export Council.

The Biotechnology Industry Organization (BIO) "strongly encourages APHIS to also utilize EPA's human health risk assessments of glyphosate to be used on the glyphosate-tolerant sugar beet." BIO urged APHIS to include facts contained in the report "The Impact of Genetically Engineered Crops on Farm Sustainability in the United States," which details the benefits to U.S. farmers who grow crops developed through biotechnology experience, such "substantial economic and environmental benefits – such as lower production costs, fewer pest problems, reduced use of pesticides, and better yields – compared with conventional crops" and these benefits should be taken into account when undergoing a NEPA process for biotech crops.

The U.S. Soybean Export Council (USSEC) supports deregulation, stating that like bioengineered soybean, economic coexistence between GE sugar beet and conventional sugar beet is possible, provided the appropriate stewardship plans are in place and that risks posed by conventional breeding methods are manageable without Federal oversight. They also stated that the development of other non-GT crops will reduce the selection pressure in developing GR weeds; biotech crops provide substantial health and environmental benefits (see reports from National Academy of Sciences, Council for Agricultural Science and Technology) and do not pose unique risks; and that the use of biotechnology-derived crops will soon be necessary to feed a population approaching 9 billion people. The USSEC opposes the use of consumer preferences and marketing standards as a significant decision-making factor in the EIS, and does not believe that these preferences should trigger an EIS. It recommends that the USDA examine coexistence strategies in *Gene Flow in Alfalfa: Biology, Mitigation, and Potential Impact on Production,* Special Publication 28, published by Council for Agricultural Science and Technology, as well as glyphosate stewardship in statements made by M. Owen and C. Boerboom, National Glyphosate Stewardship Forum, (November 17, 2004) available at www.weeds.iastate.edu/weednews/2006/NGSFpercent20finalpercent20report.pdf. USSEC warns that [w]ere the USDA…[to] "protect" non-GMO or organic exports, it could be seen overseas as implicitly endorsing creation of similar restrictions on biotech crops in overseas markets and points out that the National Organic Program (NOP) does not guarantee the complete absence of genetic material from GE plants in certified organic crops.

APHIS considered all comments received in response to the *Federal Register* NOI to ensure that all pertinent issues were addressed in the DEIS, which carefully examined the potential environmental impacts that could result from a decision on the petition to change the regulatory status of H7-1 sugar beet to nonregulated status.

APHIS thereafter issued the DEIS for the petition for a determination of nonregulated staus for H7-1 sugar beet and sought public comment on the

DEIS through publication of a Notice of Availability (NOA) for the DEIS in the Federal Register on Oct 14, 2011 (76 FR 63922) and amended on Nov. 4, 2011(76 FR 68438-68439). The NOA explained how interested agencies, organizations, and individuals could access the DEIS for review and comment. The NOA also explained the process for submitting comments on the DEIS to APHIS. The DEIS was available for public comment for 60 days. At the end of the 60-day comment period (December 13, 2011), APHIS analyzed and considered comments in preparing this Final EIS. There was substantive information provided in public comments that was considered in the analysis for this Final EIS . Our Response to Comments that we have prepared in order to address all the comments received in reference to the DEIS is in appendix H.

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II. Alternatives

A. Introduction

This Final Environmental Impact Statement (FEIS) analyzes in detail the three reasonable and appropriate alternative approaches for APHIS to make the required regulatory response to the petition from Monsanto Company and KWS SAAT AG (Monsanto/KWS SAAT AG) seeking a determination of nonregulated status of H7-1 sugar beet. This FEIS informs the APHIS Administrator of the potential impacts on the human environment resulting from the selection of each of the three alternatives. Each of the alternatives poses potential environmental impacts that differ in context and intensity. Additional alternatives (described in section II.F) were considered but eliminated from further consideration because they were either unreasonable, or inappropriate since they failed to meet the regulatory program's legally authorized need and purpose.

B. Alternative 1 – No Action Alternative: Sugar Beet Regulated and Planted by Notification or Permit

Under Alternative 1, APHIS would deny the petition seeking a determination of nonregulated status of H7-1 sugar beet. All environmental releases and interstate movements of H7-1 sugar beet would continue to be subject to APHIS' biotechnology regulations and their requirements in 7 Code of Federal Regulations (CFR) part 340. Thus, H7-1 sugar beet as a regulated article under Part 340 would continue as the status quo for H7-1 sugar beet and so Alternative 1 is the No Action Alternative. Notifications or permits with conditions specified by APHIS would be required to move viable plant material and to plant H7-1 sugar beet outdoors. This Alternative 1 would only allow environmental releases and interstate movements of H7-1 sugar beet pursuant to the Part 340 notifications or permits. No partial or full deregulation of H7-1 sugar beet would be allowed under Alternative 1. Historically, when H7-1 sugar beet was released under notification prior to 2005, the yearly acreage of authorized plantings varied from 45 to just over 500 acres. Under Alternative 1, the environmental release of H7-1 sugar beet would not be expected to exceed 1,000 acres for reasons explained below.

If neither full nor partial deregulation of H7-1 sugar beet will be allowed, research and development activities associated with H7-1 sugar beet are expected to diminish because developers would receive no return on investment to support such activities. If the reason for denying the petition for nonregulated status was event specific for H7-1, it is possible but unlikely that other herbicide-tolerant sugar beet would be developed in the future. There has been other herbicide-tolerant sugar beet events developed: Glyphosate-tolerant sugar beet, GTSB77, developed by Novartis (now Syngenta) and Monsanto was determined to have nonregulated status on January 8, 1999, and glufosinate-tolerant sugar beet, T-120-7, developed by AgrEvo (now Bayer) were determined to have nonregulated status on May 7, 1998. According to regulatory staff at both Monsanto and Bayer, neither trait is being bred into commercial sugar beet varieties (H. Keith Reding and Ali Bayer, personal communications). Monsanto informed APHIS that “there is no intent to reintroduce GTSB77, even if Event H7-1 is not fully deregulated” (Reding, 2011). Therefore, it is unlikely that development of sugar beet with previously approved events would resume if Alternative 1 is selected.

For genetically engineered (GE) crops that are regulated under 7 CFR part 340, the importation, release into the environment, or interstate movement, requires regulatory authorization from APHIS. During the development of the GE crop, environmental releases such as field trials are conducted by companies and organizations to select high performing GE plants and to collect data needed to petition APHIS for nonregulated status. For H7-1 sugar beet, 98 field trials were conducted from 1998 to 2002. All of these field trials, as well as all movements and importations into the United States, were authorized under APHIS’ notification system in accordance with 7 CFR § 340.3. They could have also been authorized under the permit system as described in section II.D.1.a. Notification is a Part 340 administratively streamlined alternative to the permit process to allow the introduction of a certain subset of GE plants (see APHIS notification guidance at http://www.aphis.usda.gov/biotechnology/downloads/notification_guidance_0810.pdf).

The goal of the notification procedure is the same as the permit system: preventing the unintended release of the regulated article. The notification procedure for introduction of GE plants may only be used if the introduced plant meets all of the six eligibility criteria specified in the guidance and in 7 CFR § 340.3, and the introduction (the importation, environmental release, or interstate movement) will meet all of the six specified performance standards. By submitting a notification to APHIS, the applicant certifies to APHIS that the regulated article and its introduction (environmental release) will meet the specified eligibility criteria and performance standards, respectively. The submission document contains information, including design protocols, that helps APHIS determine the appropriateness of the notification process for the proposed introduction. Each notification is individually assessed for meeting confinement standards by review of design protocols submitted as part of the application.

So this No Action Alternative 1 would return all H7-1 sugar beet production (both the root and seed crops) to its fully regulated status of January 2011, before a determination of partial nonregulated status of H7-1 sugar beet was made in February 2011 and when all environmental releases of H7-1 sugar beet were conducted under Part 340 notifications. (H7-1 sugar beet was likewise fully regulated prior to APHIS' 2005 Determination that H7-1 sugar beet should have nonregulated status since it did not pose a plant pest risk. As explained above, that 2005 Determination of nonregualted status was eventually vacated by a U. S. District Court decision.)

It is expected that under Alternative 1, once all H7-1 sugar beet crops again became fully regulated and required Part 340 notifications for any planting of any H7-1 sugar beet root crop, all H7-1 sugar beet that was planted for commercial seed and root production under the current partial deregulation status effective in February 2011 would eventually be phased out of U.S. agriculture because commercial planting under partial deregulation would not be an option. Sugar beet growers of H7-1 would then need to either replace H7-1 varieties with conventional sugar beet varieties, grow other crops, use the land for other purposes, or allow the land to become fallow. The environmental release of H7-1 sugar beet would most likely no longer be expected to be field tested for commercial development but might be used for research purposes such as gene flow studies. Under such a scenario, the planting acreages of H7-1 sugar beet would be expected to be well under 1,000 acres per year and any field testing would likelybe limited to sites that have been in agricultural production for a minimum of 3 years.

C. Alternative 2 – Full Deregulation of H7-1 Sugar Beet

Under Alternative 2 (the Preferred Alternative), APHIS would determine that H7-1 sugar beet and progeny derived from them would have nonregulated status, that is, they would be fully deregulated and therefore no longer be regulated articles under the regulations at 7 CFR part 340. APHIS Biotechnology Regulatory Service (BRS) permits or notifications would no longer be required for any environmental releases or interstate movements of sugar beet derived from the H7-1 event. Under this Alternative 2, growers could freely move and plant H7-1 sugar beet seed, and stecklings and any harvested seeds, stecklings, and roots without any further regulatory oversight from APHIS. Under Alternative 2, in the short term, H7-1 sugar beet would be expected to be grown at 2011 levels where it represented greater than 90 percent of the sugar beet crop. Although the rate of adoption of H7-1 sugar beet is very high, it can still increase as varieties continue to be developed for specialized areas or circumstances. For example, California, which represents 2 percent of the sugar beet production area, uses different varieties than are grown in the more northern States. Varieties suitable for California that contain the H7-1 trait are being developed and are undergoing variety testing. Similarly, certain growers have special needs for disease resistance, and the H7-1 trait is still being bred into these varieties. This FEIS expects that H7-1 sugar beet will eventually be developed for California and other areas of the United States such that adoption could approach 100 percent. APHIS expects that growers will continue to be subject to specific contractual restrictions imposed by Monsanto's technology use agreement. APHIS also expects growers would be subject to stewardship requirements imposed by sugar processors, because all commercial sugar beet is produced under contracts with such processors.

D. Alternative 3 – Permanently Adopt the Interim Partial Deregulation of H7-1 Sugar Beet for Root Crop and Continue Permitting of Seed Crop

Under Alternative 3, APHIS would determine that it would make permanent its February 2011 decision to allow an interim partial deregulation of the H7-1 sugar beet root crop and continue to regulate the H7-1 sugar beet seed crop under part 340 permits. APHIS, in response to a petition request for an interim partial deregulation, pending the preparation of this EIS, decided that it was appropriate to partially deregulate the H7-1 sugar beet root crop with cetain imposed conditions until December 31, 2012. APHIS also decided that, in accordance with 7 CFR part 340, the H7-1 sugar beet seed crop would continue to be regulated under Part 340 permits for environmental releases for planting and harvesting, while movements of H7-1 sugar beet seed could be made under either permit or notification. (see Litigation Summary in chapter 1). APHIS' February 3, 2011 decision imposed certain mandatory conditions that were required for the cultivating and handling of the H7-1 sugar beet root crop. Those mandatory conditions were articulated in that interim deregulation in part decision, implemented by seed companies, grower cooperatives and growers, and enforced through seed companies and grower cooperatives, respectively, under the direct oversight of APHIS. The regulatory mechanism for imposing such conditions under the interim partial deregulation of the H7-1 sugar beet root crop was carried out through APHIS administered compliance agreements similar to APHIS' oversight via permits. Monsanto also stated that, in light of the interim partial deregulation, it would, for education and emphasis, place all of the APHIS-imposed conditions in its Technology Use Guide (TUG), which is implemented through Monsanto Technology Stewardship Agreements (grower agreements), to reinforce the measures imposed by APHIS as conditions of the interim partial deregulation.

Under Alternative 3, APHIS would continue and permanently adopt the interim partial deregulation of the root crop. The root crop would not be under part 340 and could continue to be used for commercial production, processing, and sale of sugar. Seed production activities, such as breeding and production of commercial seed for the planting of the root crop, would be allowed and seed production activities would continue to be regulated under permits in accordance with 7 CFR part 340. However, as required by the February 3, 2011 decision, and pursuant to and in compliance with 7 CFR § 340.6, APHIS would partially deregulate all H7-1 root production activities as long as certain specific mandatory conditions are complied with as specified by APHIS. If commercial root production activities are conducted under these mandatory conditions, they would permanently continue to no longer be subject to the procedural and substantive requirements of 7 CFR part 340. If, however, commercial root production activities were not appropriately conducted pursuant to these mandatory conditions, the APHIS Administrator would continue to have the regulatory authority and discretion to return such H7-1 root production activities to full regulation under 7 CFR part 340.

The mandatory conditions pertaining to the root production activities would be permanently imposed and enforced pursuant to written APHIS compliance agreements or other authorization instrument authorized under the Plant Protection Act (PPA). Similar to a permit, the compliance agreements would be used to authorize the movement and release into the environment of H7-1 root crop and would impose certain mandatory conditions on the movement and environmental release of the H7-1 sugar beet root crop and root production activities. These legally binding and enforceable compliance agreements would specify the mandatory conditions for permanent partial deregulation of the root production activities and would formalize and impose the mandatory conditions under which the root crop and root production activities would be considered partially deregulated on a permanent basis (i.e., no longer ever subject to the procedural and substantive requirements of the 7 CFR part 340 regulation). APHIS would employ these required compliance agreements to authorize movement and release of H7-1 sugar beet and to impose and enforce the mandatory conditions on the import, movement, or environmental release of the root crop and root production activities. The compliance agreement would be a formal, written, and signed agreement between APHIS and a person who wants to import, move, and/or do an environmental release in conjunction with the H7-1 sugar beet root crop production activities (and APHIS would inform any H7-1 sugar beet producer or grower that movement and the environmental release includes the entire production cycle of H7-1 sugar beet root crop – referred to collectively as the “root production activities”; and that the terms person, import, or move have the meanings as they are so defined in the PPA, as amended).

Alternative 3 (allowing the partial deregulation to be permanent) would lead to lower H7-1 sugar beet adoption rates than Alternative 2 (allowing the full deregulation) because under Alternative 3, the sugar beet root crop would not be permitted in California, which currently represents 2 percent of the acreage and 3 percent of U.S. sugar beet production. Adoption of H7-1 sugar beet under Alternative 3 may be further diminished compared to Alternative 2 because Alternative 3 would impose additional regulatory requirements on growers, seed developers, and sugar beet processors. Alternative 3 requires compliance with mandatory conditions, reporting requirements, inspections, and audits. It is possible that some growers will elect not to grow H7-1 sugar beet due to the increased costs and time required to meet the regulatory requirements. Depending on regional production costs, the additional expense may make H7-1 sugar beet less attractive to grow than conventional sugar beet.

The following sections (II.D.1 and II.D.2) contain an in depth explanation of the requirements of the interim partial deregulation of H7-1 sugar beet for root and seed crops that would be in effect under Alternative 3 which would make the partial deregulation permanent.

1. Seed Production Activities: APHIS Permits and Notifications

The environmental release (planting), interstate movement, and importation of H7-1 sugar beet associated with seed production activities under Alternative 3 would continue to be authorized under APHIS permits in accordance with conditions imposed by APHIS. APHIS would only authorize the environmental release and movement of H7-1 sugar beet seeds and stecklings under APHIS permits and notifications in accordance with 7 CFR part 340.

a. Permit Program for Seed production under Alternative 3

Under Alternative 3, APHIS' permitting and notification process for the environmental release and movement of H7-1 sugar beet associated with seed production activities would be carried out in accordance with 7 CFR part 340. As specified in 7 CFR § 340.4, applicants must request permits for a field release (planting) in advance of the proposed planting date. Required data for the permit would include the designation of a responsible person; description of the regulated article and differences between it and the nonmodified parental crop; locations and distribution of the regulated article; size of the field release site(s); confinement procedures and safeguards employed; and methods to dispose of residues or reproductive materials. For movement of sugar beet seeds or stecklings, the quantity of the regulated H7-1 article would be identified in the applications. APHIS would provide States and Tribes, as appropriate, copies of its review of permit applications. APHIS would individually review each application. Specific permit conditions assigned by APHIS to each permit would be designed to prevent the escape, dissemination, and persistence of the regulated article and greatly limit the risk of any potential for inappropriately introducing or disseminating H7-1 sugar beet into the environment.

Importation or interstate movement of H7-1 sugar beet seed or stecklings would occur under an APHIS permit or acknowledged notification. H7-1 sugar beet seed or stecklings could be imported or moved interstate under notifications acknowledged by APHIS BRS as long as they meet the requirements found in §340.3 "Notification for the introduction of certain regulated articles." These include §340.3(c)(1) "Performance standards for introductions under the notification procedure," which require shipment in such a way that the viable plant material is unlikely to be disseminated while in transit and must be maintained at the destination facility in such a way that there is no release into the environment. Permits for importation and interstate movement must meet the requirements identified in 7 CFR §§ 340.4, 340.7, and 340.8, including specific permit conditions assigned by APHIS that would prevent inadvertent release of H7-1 sugar beet into the environment.

APHIS maintains a Web site, http://www.aphis.usda.gov/biotechnology/status.shtml, which automatically updates information about the status of a permit application on the morning of the next business day after such information is entered into the system. Information about APHIS' receipt of a permit can be obtained by anyone accessing the APHIS Web site and searching for information about the status of a permit. APHIS would use this Web site to inform the public in a timely manner on the status of all permit applications for H7-1 sugar beet.

b. Scope of the Permit Program for the H7-1 Seed Crop
The Willamette Valley is the principal area where sugar beet seed crops are grown in proximity to some Swiss chard and table beet seed crops. However, there are other areas where Swiss chard and table beet seed are grown where no sugar beet seed is presently produced. Under Alternative 3, one of the mandatory conditions would be the creation of zones outside the Willamette Valley where the growth of H7-1 sugar beet is prohibited in order to eliminate the potential for gene flow from H7-1 sugar beet to non-GE Swiss chard and table beet production. In evaluating where these H7-1-free zones should be, APHIS considered where most of the seed production for Swiss chard and table beet takes place. APHIS identified California and western Washington as two areas where major production of Swiss chard and table beet seed occurs but where no sugar beet seed is produced. The H7-1 sugar beet-free zones would create mandatory isolation conditions far in excess of what has been scientifically determined to be adequate.

Permits with specific permit conditions would be issued for each of the following sugar beet production systems in any State except California and western Washington: nonflowering steckling production and seed production from flowering stecklings or directly from seed. The environmental release of H7-1 sugar beet would be limited to sites that have been in agricultural production for a minimum of 3 years. In addition, importation and interstate movement of seed and steckling shipments within and into the United States would require a notification acknowledged by APHIS. For each type of sugar beet production system for which APHIS receives an application, APHIS would issue a permit to any organization, association, corporation, institution, or any other entity that is in the business of growing and/or producing H7-1 sugar beet. This includes, but is not limited to seed companies producing H7-1-derived sugar beet seed. These entities then would allow farmers/transport drivers to plant and/or move H7-1 sugar beet under their APHIS issued permit or acknowledged notification.

APHIS has knowledge of five seed companies (American Crystal Sugar Company, Betaseed, Inc., Holly Hybrids, SES Vanderhave Sugar Beet Seeds, and Syngenta Seeds, Inc.) that produce H7-1 sugar beet seed, either directly or through a seed production cooperative (West Coast Beet Seed, WCBS). APHIS could issue permits to any of these five seed companies for steckling and direct seed production activities upon receipt and review of a completed permit application. All growers and the locations of their H7-1 sugar beet would be identified in the permits issued to the seed company.

c. Chronology of Permitting the H7-1 Sugar Beet Seed Crop

Upon receipt of a complete permit application and after a thorough evaluation and review, APHIS would make a decision on whether or not to authorize the planting of flowering stecklings in seed production fields in late winter/early spring; the planting of seeds for direct seeding (flowering) for seed production in seed production fields in late summer/early fall; and the planting of seeds for nonflowering stecklings in nursery fields in late summer/early fall. Exact planting dates would vary dependent upon geographic location and local conditions.

d. Enforcing Permit Conditions

An applicant's compliance with APHIS permit conditions would be carried out using the following approaches.

(1) Seed Production

The following permit conditions would apply to seed production:

(1) H7-1 beet seed producers (permit holders) would assign a responsible person pursuant to 7 CFR part 340 to oversee the permit for beet seed production; this individual would oversee the performance of the sugar beet seed growers under the permits. The responsible person, likely an agronomist, would oversee the standard procedures of seed production and would monitor and assess compliance with the conditions assigned by the APHIS permit. Total acreage for all seed production permits is estimated to cover approximately 3,000–5,000 acres.

(2) APHIS would directly inspect the seed production fields to ensure compliance with all mandatory permit conditions and such inspection(s) will be completed prior to any possible pollen shed. APHIS would use the standard inspection process that it uses for inspecting permits under 7 CFR part 340.

(2) Import and Movement under Notification

Site visits by APHIS inspectors would also involve monitoring and assessing compliance with regulations for seed and steckling movement, such as secure storage sites, allowable containers, and vehicle containment devices when used in the movements.

e. Uniformity of Assigned Conditions

All mandatory permit conditions identified under this alternative would be required and applicable to all permit applications that APHIS may receive for H7-1 sugar beet associated with seed production activities. Details of the respective assigned permit conditions for each of the specific production systems (nonflowering steckling production, seed production from flowering stecklings, or directly from seed) are described below.

f. Evaluation of Permit Application for Consistency with the FEIS

Upon receipt of a complete permit application or notification, and prior to issuing the permit or acknowledging the notification, APHIS would evaluate and make a determination about whether the permit application or notification corresponds with all of the required conditions and provisions, as described in the FEIS, to mitigate a plant pest risk. In addition, APHIS would review the applicant's Standards of Practice (SP) for adhering to the requirements set forth in 7 CFR part 340. If APHIS determines that approving the permit is not consistent with any mitigations deemed necessary in the FEIS, APHIS would deny the permit.

g. Information for Non-GE *Beta* Seed Producers Regarding Male Fertile H7-1 Seed Production Locations

Under the requirements of Alternative 3, APHIS would have a record of the location of each field release, including an address, global positioning system (GPS) coordinates, and a diagram of the site. To provide information on the whereabouts of flowering sugar beet that produce pollen containing the H7-1 trait while still protecting the privacy of individuals cultivating flowering H7-1 sugar beet, APHIS would set up a toll-free number that growers of non-GE *Beta* seed crops may use to request from APHIS the approximate distances from the nearest male fertile H7-1 sugar beet plantings to their non-GE *Beta* seed crops. Upon calling this number, the caller would certify to APHIS that the caller is a grower of non-GE *Beta* seed crops or intends to grow non-GE *Beta* seed crops. APHIS would provide the approximate distance from the location of the nearest male fertile H7-1 sugar beet planting to the caller's location of a non-GE *Beta* seed crop.

h. Mandatory Permit Conditions Imposed on Seed Production

Under Alternative 3, the following mandatory permit conditions, which are additional conditions that APHIS would impose beyond those required under 7 CFR § 340.4, would be imposed on plantings of H7-1 sugar beet intended for seed production activities via permit conditions where the seed producer (permit holders) would acknowledge and adhere to these mandatory conditions:

(1) Planting of H7-1 sugar beet is not allowed in the State of California and the following counties in Washington State: Clallam, Clark, Cowlitz, Grays Harbor, Island, Jefferson, King, Kitsap, Lewis, Mason, Pacific, Pierce, San Juan, Skagit, Skamania, Snohomish, Thurston, Wahkiakum, and Whatcom.

(2) A 4-mile separation distance shall be maintained between male *fertile* H7-1 sugar beet and all other commercial Beta seed crops (i.e., table beet, Swiss chard) throughout the United States.

(3) An inventory of H7-1 male *fertile* planting locations shall be provided to APHIS within two weeks of planting.

(4) A 4-mile separation distance shall also be maintained between male *sterile* H7-1 sugar beet and all other commercial *Beta* seed crops throughout the United States. During flowering, fields shall be scouted for male *sterile* H7-1 plants that shed pollen and such plants shall be destroyed.

(5) A visual identification system, such as labeling, that accompanies the regulated material (e.g., basic seed, stock seed, stecklings, and commercial seed) throughout the production system, is required.

(6) A companion seed-lot based tracking and tracing system that is fully auditable shall be maintained. Records must be retained for five years.

(7) Other than non-GE *Beta* seed material used in the production of hybrid-seed, all H7-1 material shall be physically separated from nonregulated material to prevent commingling at all points throughout the production process.

(8) Planting, cultivation, and harvesting equipment shall be cleaned to prevent H7-1 stecklings or seed from being physically transferred out of production areas or mixed with non-GE *Beta* material by inadvertent means.

(9) All unused H7-1 stecklings shall be treated as regulated articles until devitalized and discarded.

(10) All H7-1 seed and steckling material shall be moved in contained transport systems to avoid inadvertent release into the environment. Vehicles or movement containers shall be thoroughly cleaned after transport and any regulated material recovered shall be devitalized.

(11) Sexually compatible varieties (e.g., Swiss chard/red beet) cannot be planted or produced in the same location (the same field) as H7-1 in the same growing year.

(12) Planting/cultivating/harvesting equipment that might be used in Swiss chard/red beet seed production shall not be used for regulated GE material in the same growing year.

(13) Measures to force same year sprouting of H7-1 seed left in production fields are required. Any seeds that sprout from such leftover seed shall be destroyed. Fields shall be monitored for three years and any volunteer beet plants shall be destroyed. If the same land is used for crop cultivation during the 3-year volunteer monitoring period, that crop shall be visually distinct from sugar beet or the fields left fallow.

(14) A management plan shall be submitted and followed. The management plan will set forth best practices for oversight of the movement, transportation, and confined field production of H7-1 seed. The management plan shall include, but not be limited to, required resources, training of relevant personnel, monitoring of growers, recordkeeping, and verifying compliance with the permit conditions. The applicant shall also provide the standard operating procedures (SOPs) that will be utilized to conduct the field trials and comply with the permit and permit conditions.

(15) No H7-1 seed shall be cleaned or processed in any processing facility that also cleans and processes table beet or Swiss chard seed.

(16) Interstate movement of H7-1 sugar beet stecklings and seed may only be authorized with a movement notification or permit consistent with regulations described in 7 CFR part 340.

(17) The applicant shall ensure that all site cooperators/growers have received the permit conditions and are trained in all the processes and procedures.

(18) The applicant shall maintain records of all the activities authorized under the permit to demonstrate adherence to 7 CFR part 340, the permit, and the permit conditions. These records shall be made available to APHIS BRS.

2. Root Production Activities – Not Considered a Regulated Article under 7 CFR part 340 with Compliance Agreement Conditions/ Restrictions

Pursuant to and in compliance with 7 CFR § 340.6, the H7-1 sugar beet root crop, when grown under specific mandatory conditions imposed by APHIS, would not be subject to the procedural and substantive requirements of 7 CFR part 340. The H7-1 sugar beet root crop and root production activities would be considered partially deregulated provided that there is compliance with mandatory conditions on the environmental release and movement of the H7-1 sugar beet root crop. These mandatory conditions would be enforced and required pursuant to APHIS compliance agreements authorized under the PPA, and would restrict the movement and environmental release of the H7-1 sugar beet root crop and root production activities. The compliance agreement system, outlined below, for root crop production and root production activities is comparable in rigor and enforceability to the permitting scheme. Like the requirements imposed on permittees, the compliance agreement system requires the responsible parties to give APHIS notice of the locations of the crops, to agree to APHIS oversight, and to be subject to suspension, revocation, and possibly civil and/or criminal penalties in the event of noncompliance.

a. Compliance Agreements for the H7-1 Sugar Beet Root Crop

Under Alternative 3, any person who wants to import, move, and/or do an environmental release in conjunction with the H7-1 sugar beet root crop (root production activities) would have to first contact APHIS BRS at Regulatory Operations Programs in Riverdale, MD at (301) 851-3867 and enter into a compliance agreement in advance of the shipment (import/movement) and/or planting (environmental release) of H7-1 sugar beet (seeds and roots) associated with the H7-1 sugar beet root crop production activities. These required compliance agreements would be formal, written, and signed agreements between APHIS and a person who wants to import, move, and/or do an environmental release in conjunction with the H7-1 sugar beet root crop. For the environmental release of H7-1 sugar beet associated with the root crop production activities, any organization, association, corporation, institution or any other entity that is in the business of growing and/or producing H7-1 sugar beet (i.e., sugar beet cooperatives or processors) would have to first request and then enter into a signed compliance agreement in advance of the proposed planting date. APHIS expects that sugar beet cooperatives and processors (or other associations or entities that conduct H7-1 sugar beet root crop activities) would be the only entities that would enter into compliance agreements and will do so on behalf of their respective members/farmers. Required information for the compliance agreement would include: identifying the Responsible Entity, contact information, location of the environmental release(s), and total number of acres to be planted. For the movement and/or importation of H7-1 sugar beet associated with the root crop production activities, any organization, association, corporation, institution or any other entity that is in the business of growing and/or producing H7-1 sugar beet (i.e., seed company, sugar beet cooperatives or processors) would have to first request and then enter into a signed compliance agreement in advance of the movement and/or importation. Required information for the compliance agreement includes identifying the Responsible Entity, contact information, and point of origin and final destination(s). The industry is familiar with compliance agreements as they were used by APHIS to ensure compliance with mandatory conditions. The compliance agreement would include a training component to ensure that all persons conducting root crop production activities under the compliance agreement would receive a copy and would be adequately trained in the processes and procedures necessary to comply with its terms. A sample compliance agreement that would be used for Alternative 3 is included in appendix D.

b. Scope of H7-1 Root Crop Production under Alternative 3

Under Alternative 3, compliance agreements with mandatory conditions and restrictions would be issued for the environmental release (planting) of H7-1 sugar beet associated with root production activities in any region within the United States with the exception of Western Washington and California. Currently sugar beet root production is primarily located in ten States: Minnesota, North Dakota, Nebraska, Wyoming, Colorado, Michigan, Idaho, Montana, Oregon, and California. The environmental release of H7-1 sugar beet would be limited to sites that have been in agricultural production for a minimum of 3 years. APHIS would issue a compliance agreement to any organization, association, corporation, institution, or any other entity that is in the business of growing and/or producing H7-1 sugar beet. This includes, but is not limited to, seed companies producing H7-1-derived sugar beet seed, and sugar beet cooperatives or processors. These entities would then enter into a compliance agreement with APHIS on behalf of all its members/farmers. Because of the logistical impossibilities of dealing with the huge number of potential individuals involved in growing and transporting H7-1 sugar beet, APHIS would not envision issuing compliance agreements to individual farmers or transport drivers.

As mentioned previously, APHIS has knowledge of five seed companies (American Crystal Sugar Company, Betaseed, Inc., Holly Hybrids, SESVanderhave Sugar Beet Seeds, and Syngenta Seeds, Inc.) that produce H7-1 sugar beet seed, either directly or through a seed production cooperative (West Coast Beet Seed (WCBS)), and nine sugar processors, including American Crystal Sugar Company, Michigan Sugar, Minn-Dak Farmers Cooperative, Sidney Sugars Incorporated, Snake River Sugar Company, Southern Minnesota Beet Sugar Cooperative, Spreckels Sugar Company, Western Sugar Cooperative, and Wyoming Sugar Growers, LLC in the United States, with a tenth, Rogers Sugar Company, located in Alberta, Canada. One company, Spreckels Sugar, is in California and owned by Southern Minnesota Beet Sugar Cooperative. Under Alternative 3, no compliance agreements for root production activities would be granted in California where conventional sugar beet, but no H7-1 sugar beet, are currently grown, or in western Washington, where no sugar beet industry currently exists in this region.

c. Chronology of the Use of Compliance Agreements

Upon receipt of a request to enter into a signed compliance agreement in conjunction with the H7-1 sugar beet root crop and after a thorough evaluation and review, APHIS would make a decision on whether or not to authorize the planting of H7-1 sugar beet seed in root production fields in the spring. Exact planting dates would vary dependent upon geographic location and local conditions. The compliance agreement would be valid from the date of issuance (i.e., the date signed by APHIS BRS) until revoked or superseded by APHIS BRS to allow changes in conditions as deemed necessary.

d. Enforcing Compliance Agreements for Root Crop Production Activities under Alternative 3

The oversight of APHIS compliance agreements would be carried out using the following approaches:

- Prior to planting H7-1 sugar beet, any person who wants to do an environmental release in conjunction with the H7-1 sugar beet root crop would have to have a signed compliance agreement in place that identifies the responsible party, contact information, location of the environmental release(s) (county/State), total number of acres to be planted, and applicable restrictions that will be followed to ensure confinement. The compliance agreement may be signed by the responsible entity or an authorized representative on behalf of the responsible entity and all persons engaging in root crop production activities.

- The responsible entity confirms its understanding of the requirements/conditions set forth in the agreement and confirms that the responsible entity and all persons conducting root crop production activities under this compliance agreement would have to comply with the requirements/conditions of the agreement.

- Prior to moving H7-1 sugar beet, any person who wants to import and/or move seed or roots in conjunction with the H7-1 sugar beet root crop would have to have a signed compliance agreement in place that identifies the responsible entity, contact information, point of origin and final destination(s), and applicable restrictions that will be followed to ensure confinement.

- Within 28 days after planting H7-1 sugar beet root crops under the compliance agreement, the responsible entity would have to provide APHIS a report that includes the names and addresses of all growers, the county and State where each release occurred, at least one GPS coordinate for the release site, the location of the GPS coordinate (e.g., the northwest corner of the field), confirmation that the release site has been in agricultural production for at least the past three years, the exact planting date(s) for each release site, and the actual acreage planted at each site. Each report shall include plantings occurring during the prior 28 days (to the extent such information is reasonably available at the time of the report) and information for plantings occurring in prior reporting periods for which information was not available at the time the prior report was submitted.

- The responsible entity through its authorized representative would have to notify APHIS within 48 hours of any change in the information provided to APHIS BRS, either upon application for a compliance agreement or at anytime thereafter, regarding planting and/or movement/importation activities (e.g., changes/updates to planting locations, GPS coordinates, shipping addresses for seed and/or root movement).

- The responsible entity through its authorized representative would have to notify APHIS, orally and in writing (via email) within 24 hours, after becoming aware of unauthorized releases and/or movements. In addition, the responsible entity through its authorized representative shall notify APHIS, orally and in writing (via email) within 48 hours, after becoming aware of any instance of noncompliance with the conditions of the compliance agreement. In incidents involving unauthorized releases and/or noncompliance, growers shall give notice immediately to the responsible entity so that the responsible entity may notify APHIS. When contacting APHIS, the authorized representative shall describe the incident, the date it occurred, the location (including county and State and GPS coordinates of release site), name and address of grower, and field personnel associated with the incident. The authorized representative shall also provide immediate or short-term corrective actions and, if necessary and available, long-term plans to return the situation to compliance and prevent similar incidents from occurring in the future. APHIS will review the information provided by the authorized representative and request additional information, if necessary, within 24 hours of the receipt of the notice. APHIS may require additional corrective actions if APHIS deems it necessary. The responsible entity and all persons engaged in root crop production activities in association with or on behalf of the responsible entity must cooperate with APHIS until the situation is resolved and the incident brought back to compliance. APHIS will record the incident and submit a response in writing, summarizing the incident and corrective measures, as per APHIS standard procedure in handling noncompliance incidents, to the authorized representative, no later than 10 days of the receipt of the notice.

- APHIS would conduct some direct inspections to ensure that persons importing, moving, and/or doing an environmental release (planting) in conjunction with the H7-1 sugar beet root crop comply with all conditions and restrictions identified in the compliance agreements.

- For the H7-1 sugar beet root crop production activities under Alternative 3, APHIS would require third-party inspectors to conduct the majority of the inspections. APHIS would evaluate the third-party inspectors’ credentials provided by the responsible entity through its authorized representative in the request for the compliance agreement. The credentials will be evaluated for information such as prior experience with biotechnology inspections, general experience in conducting inspections, and overall experience/background in agriculture. After evaluating the inspectors' credentials, APHIS would notify the authorized representative which third-party inspectors it believes are qualified to conduct H7-1 sugar beet root crop inspections on behalf of the agency. The responsible entity will have 15 business days from the date of the notice to retain the services of the third-party inspector(s). The responsible entity may choose to retain the services of one or more of the APHIS-approved inspectors. Upon retaining the services of the third-party inspector(s), the authorized representative shall supply the name(s) of the third-party inspector(s) to APHIS. APHIS officials would contact the third-party inspectors to schedule inspection training. (APHIS would provide an inspection form to be used by inspectors to capture inspection data.) The third-party inspectors would schedule and conduct inspections according to APHIS' instructions. APHIS would coordinate with a third-party inspector to randomly choose a statistically representative sample of fields, from those fields designated by APHIS to inspect, to conduct inspection for bolters. The third-party inspectors would submit inspection reports directly to APHIS, and APHIS would work directly with the inspectors if the reports require additional information. A large number of the root production fields and facilities would be inspected by the third-party inspectors, sufficient to give statistically significant conclusions ($p = 0.05$) on overall compliance. If the compliance agreement only covers seed movements, no third-party inspectors are required. Total acreage for all root production is estimated to cover approximately 1–1.4 million acres.

- For the H7-1 root crop production activities under Alternative 3, APHIS would also require third-party audits to review grower records. APHIS would evaluate the third-party auditors’ credentials provided by the responsible entity through its authorized representative in the request for the compliance agreement. The credentials would be evaluated for information such as prior experience with biotechnology inspections, general experience in conducting inspections, and overall experience/background in agriculture. After evaluating the auditors’ credentials, APHIS would notify the authorized representative which third-party auditors it believes are qualified to conduct H7-1 sugar beet root crop audits on behalf of the agency. The responsible entity would have 15 business days, from the date of the notice, to retain the services of the third-party auditor(s). The responsible entity may choose to retain the services of one or more of the APHIS-approved auditors. Upon retaining the services of the third-party auditor(s), the authorized representative shall supply the name(s) of the third-party auditor(s) to APHIS. APHIS officials would contact the third-party auditors to schedule audit training. APHIS would provide an audit form to be used by auditors to capture audit information. The third-party auditors will schedule and conduct audits according to APHIS' instructions. APHIS would require third-party auditors to review shipping records and/or grower records and to submit auditing reports directly to APHIS for review. APHIS would work directly with the auditors if the reports require additional information.

- Activities conducted by growers to comply with compliance agreement conditions and restrictions may be either audited or inspected by APHIS, third-party auditors, or both. APHIS would provide detailed inspection forms for the information to be supplied by processors/growers, and the subsequent records will be made available to APHIS for audit. Growers must keep records of these compliance activities and make them available to APHIS and/or third-party auditors upon request. APHIS would carefully examine a representative sample of these records to ensure compliance with all conditions and restrictions identified in the compliance agreement. The responsible entity would have to ensure that all persons conducting root crop production activities under the compliance agreement provide access to all records required to be maintained under the compliance agreement and provide access, during regular business hours, to inspect planting locations, facilities, and transport vehicles, upon request by APHIS or its authorized representative(s).

- The responsible entity would have to ensure that all persons conducting root crop production activities under the compliance agreement receive a copy of the compliance agreement and are trained in the processes and procedures necessary to comply with the terms of the compliance agreement. In addition, the responsible entity would have to ensure that written documentation of the training is maintained and that all training records are maintained for the duration of the compliance agreement.

- For importation and interstate movement, APHIS inspections and/or third-party inspections/audits would be required to ensure that persons importing and/or moving H7-1 sugar beet seeds or roots in conjunction with the H7-1 sugar beet root crop comply with all conditions and restrictions identified in the compliance agreements. APHIS would carefully examine these records to ensure compliance with all conditions and restrictions identified in the compliance agreement.

- In the event of a finding of noncompliance or violation of the terms of a compliance agreement, APHIS may revise, suspend, revoke, or otherwise withdraw the compliance agreement and/or the partial deregulation of any and all root crop grown under the compliance agreement. APHIS may also, at its discretion, use the full range of PPA authorities to seek, as appropriate, criminal and/or civil penalties, and to take remedial measures including seizure, quarantine, and/or destruction of any H7-1 sugar beet root crop production that is found to be in violation of the conditions set forth in the compliance agreements.

e. Uniformity of Conditions and Restrictions for Root Crop Production Activities

Conditions and restrictions identified in the compliance agreement would be required and applicable to all persons utilizing this partial deregulation authority. These mandatory conditions imposed and required pursuant to the partial, conditional deregulation of the root crop would be enforced and required pursuant to APHIS compliance agreements authorized under the PPA. Details of the specific conditions and restrictions are described below.

f. Evaluation of Compliance Agreement for Consistency with the FEIS

Prior to issuing the compliance agreement, APHIS would evaluate and make a determination about whether the compliance agreement corresponds with all of the required conditions and provisions, as described in the FEIS, and, if so decided, in any subsequent final decision. If APHIS determines that approving the compliance agreement is not consistent with any mitigations deemed necessary in the FEIS, APHIS would not issue the compliance agreement.

g. Mandatory Conditions/Restrictions Imposed on Root Production Activities

Under Alternative 3, the following mandatory conditions and restrictions would be imposed on H7-1 sugar beet intended for root production via compliance agreements:

(1) Planting of H7-1 sugar beet would not be allowed in the State of California, and the following counties in Washington State:

Clallam, Clark, Cowlitz, Grays Harbor, Island, Jefferson, King, Kitsap, Lewis, Mason, Pacific, Pierce, San Juan, Skagit, Skamania, Snohomish, Thurston, Wahkiakum, and Whatcom.

(2) Root growers would have to ensure that root crop fields are surveyed to identify and eliminate any bolters before they produce pollen or set seed. Fields shall be surveyed every 3–4 weeks beginning April 1. Root growers would also have to ensure that field personnel maintain records of their field observations and removal of bolters. Reports where bolters are not observed must be maintained as well. Root growers shall notify APHIS BRS within 48 hours after finding bolters, with the location and action taken by the field personnel. Additionally, root growers would have to maintain all records of inspection and bolter removal and records must be made available to APHIS BRS and/or to authorized third-party inspectors upon request.

(3) Third-party inspectors procured by beet processors (usually a cooperative) would randomly choose a statistically representative sample of fields and conduct inspection for bolters. If bolters are identified, field personnel shall be notified immediately and those bolters must be removed. APHIS would provide an inspection form to be used to capture these data.

(4) Planting/cultivating/harvesting equipment that might be used in Swiss chard/red beet production shall not be used or shared for regulated GE material in the same growing year.

(5) Root crop fields shall be monitored for 3 years following harvest for volunteers and any volunteer plants must be destroyed. If the same land is used for crop cultivation during the volunteer monitoring period, that crop shall be visually distinct from sugar beet or the fields must be left fallow. Records of observations must be maintained and provided to APHIS BRS or third-party auditors upon request.

(6) All root crop growers and field personnel would have to receive all conditions and restrictions identified in the compliance agreements and must be trained in all processes and procedures necessary to comply with the terms of the agreement.

(7) Root growers would have to maintain records of all the activities being carried out under the compliance agreements to demonstrate adherence to the mandatory conditions and restrictions. These records shall be made available to APHIS BRS and/or to authorized third-party inspectors/auditors upon request.

h. Mandatory Conditions/Restrictions Imposed on Importation and Interstate Movement of the H7-1 Root Crop

Under Alternative 3, the following mandatory conditions and restrictions would be imposed on the interstate movement and importation of H7-1 seeds and roots associated with root production activities via compliance agreements:

(1) The responsible party would have to ensure that all personnel have received all conditions and restrictions identified in the compliance agreements and are trained in all the processes and procedures necessary to comply with the terms of the agreement.

(2) The responsible party would have to maintain records of all the activities being carried out under the compliance agreements to demonstrate adherence to the mandatory conditions and restrictions. These records shall be made available to APHIS BRS and/or to authorized third-party inspectors/auditors upon request.

(3) During transport, chain of custody and records shall be maintained. Records shall be made available to APHIS BRS and/or to authorized third-party inspectors/auditors upon request.

(4) Trucks used for the movement of root crop from field to storage/processing shall be loaded in a manner to minimize loss of sugar beet during transport, or equipped with a retaining device.

(5) Sugar beet seeds shall be transported in a sealed plastic bag, envelope, or other suitable container (primary container) to prevent seed loss.

(6) The primary container for transporting seeds shall be placed inside a sealed secondary container that is independently capable of preventing spillage or loss of seed during transport.

(7) Each set of containers (primary and secondary) for transporting seeds shall then be enclosed in a sturdy outer shipping container constructed of corrugated fiberboard, corrugated cardboard, wood, or other material of equivalent strength. Each container shall clearly identify that the seed contents within shall only be used for the planting of sugar beet root crop.

(8) The shipping containers for transporting seeds shall be transported in enclosed trucks or trailers with closed sides.

E. Alternatives Considered but Eliminated from Further Consideration

APHIS assembled a comprehensive list of alternatives that might be considered for H7-1 sugar beet as part of the decision process for this FEIS. The agency individually evaluated each alternative based on legality, environmental safety, efficacy, reasonableness, appropriateness, and practicality to identify which alternatives would be further considered during the decision process. Based on this evaluation, APHIS rejected a number of alternatives from further consideration and analysis. In order to fully inform the agency decisionmaker as well as the public, these considered but eliminated alternatives are discussed briefly below, along with the specific reasons for rejecting each.

- APHIS considered a "**Completely Prohibited Introduction**" Alternative where no H7-1 sugar beet would be regulated by APHIS but would not be allowed to be released into the environment or moved interstate for any reason whatsoever, named not even under part 340 permitting or notification. APHIS considered but rejected this alternative because GE organisms that APHIS regulates (of which one has been H7-1 sugar beet) may be released into the environment or moved subject to the regulations in 7 CFR part 340 under conditions specified by APHIS and designed to confine the regulated article. This Completely Prohibited Introduction alternative both contradicts and frustrates the purpose and need of the agency to authorize the safe and appropriate introduction of GE organisms it regulates in accordance with 7 CFR §§ 340.3 and 340.4.

- APHIS also considered an alternative (**Partial Deregulation of Both Root and Seed Crops Using Compliance Agreements**) where the seed and root crops would both be partially deregulated using compliance agreements unlike Alternative 3 where the root crop is partially deregulated under compliance agreements and the seed crop continues to be regulated under the permitting procedures of 7 C.F.R. Part 340. This alternative was rejected from further analysis since APHIS determined that the conditions for seed production that APHIS imposed under part 340 permitting would not substantially differ from the required conditions that APHIS would impose using compliance agreements under a partial deregulation of the seed crop. The primary difference between the alternatives would be the regulatory instrument used to enforce the conditions. Therefore, this alternative would not be substantially distinct from Alternative 3 with regard to the environmental impacts.

- APHIS considered an alternative (**Partial Deregulation of the Root Crop but No Environmental Release of the Seed Crop Whatsoever**) where root production would no longer be regulated, that is would be partially deregulated, but all environmental releases of H7-1 sugar beet associated with seed production would be prohibited, i.e. not allowed even under part 340 permitting. Under this alternative, since H7-1 sugar beet seed could not be grown in the United States, such seed would have to be imported from outside the United States and foreign H7-1 seed would be the only source for such seed. Most likely, imported H7-1 sugar beet seed would not provide an adequate supply for H7-1 sugar beet root production in the United States. APHIS considered but rejected this alternative because GE organisms regulated by APHIS may be released into the environment or moved subject to the regulations in 7 CFR part 340 under conditions specified by APHIS. Moreover, this alternative both contradicts and frustrates the purpose and need of the agency to authorize the safe and appropriate introduction of GE organisms in accordance with 7 CFR §§ 340.3 and 340.4.

- APHIS also considered an alternative (**Partial Deregulation of the Seed Crop but Regulation of the Root Crop**) where H7-1 sugar beet seed production is no longer under regulation, but all importation, interstate movements, and environmental releases of H7-1 sugar beet associated with root production activities would continue to be regulated under 7 CFR part 340. APHIS determined that this alternative is not appropriate nor reasonable because a determination of nonregulated status of the seed crop would in effect mean that APHIS had conclusively determined that the H7-1 plant throughout it's lifecycle is unlikely to pose a plant pest risk. The lifecycle of the seed crop includes the life cycle of the root crop; therefore it is not possible for the root crop to pose a plant pest risk if the seed crop does not. Once APHIS conclusively determined that the sugar beet seed production without conditions did not pose a plant pest risk and should no longer be regulated, APHIS would have no sound scientific basis to conclude that the root production posed a plant pest risk and should therefore continue to be regulated

F. Comparison of Impacts by Alternative Matrix

CEQ NEPA regulations (40 CFR § 1502.14) state that agencies should compare the impacts of the alternatives proposed to provide a clear basis for decisionmaking. Table 2–1 provides a comparison of the impacts under each alternative and these impacts will be discussed extensively in chapter IV.

Table II-1. Alternatives

Alternative 1: No Action (Regulated by Permit/Notification)	Alternative 2: Full Deregulation	Alternative 3: Extend Partial Deregulation
Potential Impacts on Production and Management of Beet Crops		
H7-1 Sugar Beet Adoption		
In the short term, adoption of H7-1 sugar beet would be limited to research done under permit. Acreage would be expected to be less than the amount historically done under research and development permits (<1,000 acres) and each plot location would be approved by APHIS. In the long term, H7-1 sugar beet acreage would be expected to approach zero. Conventional seed varieties available to farmers in the short term (~1–10 years) would likely not contain the most desirable trait combinations for each region due to the breeding lag. As the State of California has not yet adopted H7-1 varieties, farmers in that State are not expected to have a shortage of conventional sugar beet seeds. Patent expiration would have no impact on how H7-1 sugar beet seed plots would be handled.	In the short term, adoption of H7-1 sugar beet for seed and root production would be 95%. In the long term, adoption is expected to approach 100 %. Location of H7-1 sugar beet seed production would not be restricted but is not expected to substantially move from the current seed production areas due to climatic conditions and limitations on land availability imposed by pinning mechanisms aimed at establishing priorities for the use of land. Similarly, location of root production areas are not expected to change from the current root production areas due to the need for proximity to sugar processing plants. H7-1 sugar beet would be expected to be adopted by California root farmers, and use of H7-1 in the other regions would continue. In the next 10 to 15 years while H7-1 sugar beet are under patent, APHIS assumes that growers would continue to be subject to contract restrictions imposed by Monsanto's Technology Stewardship Agreement (MTSA). In the long term, APHIS assumes that there might be no binding enforcement mechanism to ensure that farmers follow the Technology Use Guide (TUG), which does not allow seed saving and requires bolters to be removed. However, because the Grower Cooperatives would maintain control of which sugar beet varieties are allowed to be planted and all sugar beet are produced from hybrids anyway, APHIS concludes that patent expiration would not lead to seed saving and stewardship practices would still be followed.	In the short term, H7-1 sugar beet adoption in the Great Lakes, Midwest, Great Plains, and Northwest would be 95%. In the long term, sugar beet root production would be expected to approach 100 % outside of California. H7-1 sugar beet would not be grown in California. Alternative 3 also excludes production in western Washington where there is currently no production and none is expected. Distances between H7-1 seed and chard of table beet fields would be set by permit conditions at 4 miles. Under Alternative 3, patent expiration would have no impact on how H7-1 sugar beet seed fields would be handled. Mandatory measures imposed on H7-1 sugar beet production would still be required in compliance agreements and permits.

Table 2–1. (continued)

Alternative 1: No Action (Regulated by Permit/Notification)	Alternative 2: Full Deregulation	Alternative 3: Extend Partial Deregulation
Control of Weeds and Volunteers		
No changes to weed control in sugar beet seed production have occurred as a result of H7-1 sugar beet, so no impact would be expected in seed production by a return to conventional varieties. For the root crop, weed control measures would include the use of herbicides, tillage, and mechanical cultivation.	Alternative 2 would not impact weed control measures in seed production because glyphosate is rarely used on the H7-1 sugar beet seed crop Glyphosate use would increase compared to Alternative 1. The use of other herbicides would decrease. The use of cover crops and planting into crop residue is expected to increase compared to Alternative 1. . In the Great Lakes, there would be an increase in stale seed bed planting and a decrease in hand-hoeing and in-crop mechanical cultivation compared to Alternative 1. In the Midwest, rotary hoeing, hand-hoeing, and mechanical cultivation would be lower than under Alternative 1. In the Northwest and Great Plains, in-crop mechanical cultivation and hand-hoeing would decrease compared to Alternative 1. No-till and strip till practices for seed bed preparation, would increase compared to Alternative 1 In the Imperial Valley, hand-hoeing and mechanical cultivation would be reduced compared to alternative 1. Conventional tillage would remain similar to that used in Alternative 1 H7-1 sugar beet volunteers from the root crop are not a concern because the crop rarely if ever produces seed and leftover roots do not survive the winters of the north or the summers of the south	Alternative 3 would impact weed control measures in the same way as described for Alternative 2, except in the Imperial Valley. Under Alternative 3, H7-1 sugar beet would not be permitted in California or western Washington, so weed control measures in those locations would be the same as under Alternative 1. Alternative 3 requires surveying and removal of bolters from root production fields planted in H7-1-derived varieties to ensure that no seeds are produced from H7-1 sugar beet root crops. Volunteer sugar beet plants rarely occur in sugar beet root production fields because it is uncommon for a bolting plant to set seed.

Table 2–1. (continued)

Alternative 1: No Action (Regulated by Permit/Notification)	**Alternative 2: Full Deregulation**	**Alternative 3: Extend Partial Deregulation**
	Swiss Chard and Table Beet (Vegetable Beet)	
There would be little to no potential for unintended gene flow from H7-1 sugar beet seed production into vegetable beet seed production. Isolation distances between vegetable beet seed production and other *Beta* ssp. would be expected to be determined by the industry to meet market needs.	Cross-pollination between H7-1 sugar beet and chard or table beet seed fields is expected to be below 1 in 10,000 seeds in areas where both H7-1 sugar beet seed and vegetable seed are produced. Cross-pollination rates are less in areas where the sugar beet seed and vegetable beet seed production are not co-localized. Some vegetable beet seed growers may be required under their contracts to test seed Some vegetable seed companies may choose to issue contracts only in areas where sugar beet seed is not grown.	Impacts under Alternative 3 are expected to be the same as Alternative 2 except in California and western Washington. Companies that contract beet seed for GE sensitive markets might choose to enter into contracts with growers in these areas because H7-1 sugar beet production is not allowed.
	Fodder Beet	
Fodder beet are not grown commercially in the U.S..	Alternative 2 is not likely to change (increase or decrease) fodder beet production in the U.S. when compared to Alternative 1.	Alternative 3 is not likely to change (increase or decrease) fodder beet production in the U.S. when compared to Alternative 1.

Table 2–1. (continued)

Alternative 1: **No Action (Regulated by Permit/Notification)**	**Alternative 2:** **Full Deregulation**	**Alternative 3:** **Extend Partial Deregulation**
	Gene Flow and Beta Species	
Under Alternative 1, isolation distances for planting *Beta* seed would follow the WVSSA guidelines in the Willamette Valley, which is 1 mile from hybrids of the same color and group, 2 miles between hybrids and open pollinated plants of the same color and group, 3 miles between unlike hybrids, and 4 miles between unlike open pollinated plants and hybrids. These guidelines result in cross-pollination rates between *Beta* seed varieties to be at or below market tolerances. Gene flow between H7-1 beet and other beet varieties would not occur because H7-1 beet would not be grown for commercial purposes.	Under Alternative 2, isolation distances for *Beta* seed crops would follow the WVSSA guidelines in the Willamette Valley like under Alternative 1. The WVSSA guidelines also state that all GMO plants would need to be at least 3 miles from any other *Beta* species. These conditions are expected to result in non-detectable levels of gene flow (<1 seed in 10,000) between H7-1 sugar beet and other *Beta* crops in Oregon, the only State where *Beta* seed crops are grown in proximity. Root bolters in California could potentially hybridize with *B. macrocarpa* but desynchronized flowering time, partial hybrid sterility barrier, and self fertility of *B. macrocarpa* all reduce the potential to negligible levels. Wild *B. vulgaris* occurs in California but has not been confirmed in the Imperial Valley where sugar beet production occurs. Best management practices prevent sharing of harvesting, cleaning, and storage equipment between sugar beet and other *Beta* crops. Therefore,seed admixture between *Beta* crops is not expected.	Under Alternative 3, the rate of cross-pollination between *Beta* seed crops is expected to be similar to Alternative 2. H7-1 sugar beet planting would be prohibited in California and western Washington. This planting restriction would ensure that certain areas of vegetable beet seed production remain isolated from H7-1 sugar beet seed production by geographic barriers and isolation distances that vastly exceed those used in the Willamette Valley. This could futher reduce rates of cross-pollination when compared to Alternative 2 Because H7-1 sugar beet would not be allowed in California, it could not cross pollinate with wild beet. Best management practices to minimize seed admixture between *Beta* seed crops would be mandatory.

Table 2–1. (continued)

Alternative 1: No Action (Regulated by Permit/Notification)	Alternative 2: Full Deregulation	Alternative 3: Extend Partial Deregulation
Potential Impacts on Biological Resources		
Animals		
Animals forage in sugar beet fields. Growers may use various means to deter animals from foraging in fields. Sugar beet production uses a variety of herbicides. Potential toxic effects from these herbicides on animals include impaired growth, development, reproduction, and long-term survival. Cycloate, glyphosate (single application high pre-emergent usage), and quizalofop-p-ethyl could be used at rates that pose concern for chronic effects to individual mammals. Birds and reptiles could be subject to chronic effects from high application rates of sethoxydim and trifluralin. Trifluralin is very toxic to fish and aquatic-phase amphibians though it is not expected to be used at levels that raise unreasonable concerns. Herbicide use could cause indirect effects on aquatic organisms by adversely impacting habitat by drift and runoff. Potential impacts on aquatic species from tillage include impaired habitat conditions from soil erosion, which can result in harm to individual species, including individual mortality.	Beets grown under Alternative 2 will not change the foraging behavior of sugar beet fields by animals when compared to Alternative 1. H7-1 sugar beet may not be planted in wildlife plots. Under Alternative 2, more glyphosate would be used on sugar beet than under Alternative 1. Under Alternative 2, glyphosate is expected to be used primarily for post-emergent applications at about three fold lower rates than the maximum allowed rate for pre-emergence. At this lower rate, there is no concern for chronic effects to mammals as noted under Alternative 1. Glyphosate is practically nontoxic to mammals and terrestrial invertebrates, practically nontoxic to slightly toxic to birds and fish, and slightly toxic to aquatic invertebrates. Glyphosate is not expected to pose an acute or chronic risk to birds, mammals, terrestrial and aquatic invertebrates, and fish when used within label limits. The use of cycloate, quizalofop-p-ethyl, sethoxydim and trifluralin are all expected to decrease under Alternative 2 when compared to Alternative 1. Toxic effects attributed to these herbicides under Alternative 1 are likely to be reduced under Alternative 2. Potential impacts on aquatic species from soil erosion would be less than Alternative 1 due to an expected decrease in conventional tillage Herbicides could have indirect effects on aquatic organisms through habitat destruction as a result of drift and runoff, however these effects are expected to be less than for Alternative 1 because sprayings are expected to be less frequent and are less likely to be applied aerially. The selection and spread of glyphosate resistant weeds in sugar beet fields could reduce the benefits of Alternative 2 to be more similar to Alternative 1	Alternative 3 would be the same as Alternative 2 with the exception of the Imperial Valley where the effect would be the same as Alternative 1

Table 2–1. (continued)

Alternative 1: No Action (Regulated by Permit/Notification)	Alternative 2: Full Deregulation	Alternative 3: Extend Partial Deregulation
Micro-organisms		
Herbicide use and tillage practice like those used in conventional sugar beet production systems can limit microbial biodiversity and activity.	Tillage practices used under Alternative 2 are expected have less impacts on micro-organisms relative to Alternative 1.	Tillage practices used under Alternative 3 are expected to have the same impacts on micro-organisms as Alternative 2 with the exception of the Imperial Valley where the impacts will be the same as Alternative 1

Table 2–1. (continued)

Alternative 1: No Action (Regulated by Permit/Notification)	**Alternative 2: Full Deregulation**	**Alternative 3: Extend Partial Deregulation**
	Resistant Weeds (Target Plants)	
Weed biotypes resistant to non-glyphosate herbicides are expected to persist in sugar beet fields where they are not well controlled by available herbicides. The selection and spread of glyphosate resistant weeds will continue in other glyphosate resistant crops where growers do not adopt diverse weed management strategies. Weed biotypes that are not well controlled can cross with other weed biotypes that are not well controlled creating the possibility of weeds that acquire multiple herbicide resistance through reproduction.	Under Alternative 2, selection of herbicide-resistant biotypes is expected to be delayed by the use of an additional mode of action for weed control. H7-1 sugar beet root production would be expected to contribute to the spread and persistence of glyphosate-resistant weeds that disperse from rotation crops or other crop types. The impact would be low due to the small acreage of H7-1 relative to other Roundup Ready® crops. Rotation to other crop types would be expected to reduce persistence through altered tillage and herbicide practices. In states that utilize rotations with multiple Roundup Ready® crops, impacts are expected to be higher than in states where sugar beet are the only Roundup Ready® crop. Incremental selection of glyphosate-resistant biotypes would not be expected as a result of H7-1 sugar beet seed because post-emergent use of glyphosate is rarely used in H7-1 seed production. Selection of new glyphosate-resistant biotypes would not be expected as a result of H7-1 sugar beet root production. Resistant weeds most often are selected under repeated use of a single herbicide in a single continuous cropping system whereas sugar beet are frequently grown in a 3 to 4-year crop rotation. The persistence and spread of multiply resistant weeds is expected to be delayed because glyphosate provides another mode of action for weed control in sugar beet fields reducing the overall presence of weeds on the landscape.	Impacts would be as in Alternative 2 for the regions currently producing H7-1 sugar beet. No impacts would be expected in western Washington because no sugar beet are grown there. In Imperial Valley, selection of biotypes resistant to non-glyphosate herbicides would be accelerated relative to Alternative 2.

Table 2–1. (continued)

Alternative 1: **No Action (Regulated by Permit/Notification)**	**Alternative 2:** **Full Deregulation**	**Alternative 3:** **Extend Partial Deregulation**
	Non-target Plants	
The non-glyphosate herbicides used on conventional sugar beet target specific groups of plants (monocots or dicots). Incidental exposure to these herbicides could result in impaired plant growth or death. Non-target plants adjacent to sugar beet fields would experience the greatest risk of effects from spray drift under Alternative 1. No unreasonable effects on non-target plants are expected.	Glyphosate targets all types of plants (monocots and dicots). Incidental exposure to glyphosate could result in impaired plant growth or death. Non-target terrestrial plants (monocots and dicots) adjacent to sugar beet fields would experience the greatest risk of effects from spray drift under Alternative 2. Because herbicide applications are less frequently applied to H7-1 than to conventional sugar beet and the use of aerial spraying is less frequent with glyphosate compared to non-glyphosate herbicides, less drift is expected under Alternative2 compared to Alternative 1. No unreasonable effects on non-target plants are expected.	In California where conventional sugar beet are grown, effects would be similar to Alternative 1. In other areas,effects would be similar to Alternative 2. .
	Sugar Beet Weediness	
Sugar beet is not considered weedy and feral populations of sugar beet have not been identified.	H7-1 sugar beet has no altered traits associated with weediness. No change is expected when compared to Alternative 1	H7-1 sugar beet has no altered traits associated with weediness. No change is expected when compared to Alternative 1

Alternative 1: No Action (Regulated by Permit/Notification)	Alternative 2: Full Deregulation	Alternative 3: Extend Partial Deregulation
Potential Impacts on Socioeconomics		
U.S. Sugar and Sugar Beet Markets		
The sugar beet industry could continue to consolidate with reduction in the number of sugar beet farmers and number of processing plants If conventional sugar beet seed or herbicide for conventional sugar beet production is not sufficient to address demand, a temporary reduction in domestic sugar production could occur resulting in increased sugar prices.	Sugar beet root growers would continue to benefit from an increase in the overall economic return to sugar beet root production with adoption of H7-1 sugar beet varieties, particularly outside the Midwest. Processing plants would likely continue operations. Opportunities for agricultural workers in hand weeding in sugar beet production would be reduced, when compared to Alternative 1.	Sugar beet root growers would continue to benefit from an increase in the overall return to sugar beet root production with adoption of H7-1, although there would be a minor cost to comply with regulatory restrictions on production. These benefits would not occur in California, where no H7-1 adoption would be allowed. Western Washington, where H7-1 would also not be allowed, would not be impacted because it is not a sugar beet producing area, nor expected to become one. Processing plants outside California would likely continue operations. Opportunities for agricultural workers in hand weeding in sugar beet production would be reduced, when compared to Alternative 1.

Table 2–1. (continued)

Alternative 1: No Action (Regulated by Permit/Notification)	**Alternative 2: Full Deregulation**	**Alternative 3: Extend Partial Deregulation**
U.S. Sugar Beet Seed Market		
Sugar beet seed producers would need to discard H7-1 seed inventory estimated to be worth $110 million for 2013 alone. This is a number that is subject to all sorts of economic factors and is used here to illustrate magnitude. Substantial losses would be incurred for R and D efforts that resulted from the investment in resources to develop sugar beet varieties that could not be used. Substantial resources would need to be invested to develop new varieties to replace the H7-1 varieties. Returns to past investments in the development of H7-1 varieties that depend on production in the United States would no longer be realized. To the extent that there is a shortage of domestic conventional seed in 2013, sugar beet seed growers would temporarily experience decreased sales of seed. Future investments in genetically engineered varieties of sugar beet might be reduced if expectations of regulatory approval are diminished.	If sugar beet seed growers produced conventional sugar beet seed for 2013 due to uncertainty from the litigation, they may accrue losses if they are unable to sell that seed. Seed companies would not lose the heavy investment made in the H7-1 seed inventory. Past investments in development of H7-1 varieties would be preserved as well as incentives for future development of genetically engineered sugar beet.	Like Alternative 2 except California would continue to demand conventional sugar beet seed and there would continue to be no production of sugar beet seed in California or western Washington. Enforcement of seed production regulatory requirements could slightly increase costs to H7-1 sugar beet seed production, but would unlikely substantially affect supply or seed prices. To the extent that the enforcement of isolation distances in seed production affect any current sugar beet seed producer, the seed grower might be forced to relocate his/her seed production, produce conventional seed, or abandon the production of sugar beet seed.

Alternative 1: No Action (Regulated by Permit/Notification)	Alternative 2: Full Deregulation	Alternative 3: Extend Partial Deregulation
Organic and Non-GE Sugar Beet and Sugar Markets		
All sugar sold in the domestic market would be conventional or organic. Sales of organic sugar would likely continue to increase. Organic sugar is expected to be derived from imported cane sugar. Consumers would have the option of choosing between conventional and organic sugar. Sugar beet seed and root growers and processors would not have the option of growing and processing H7-1 varieties of sugar beet.	Sugar from cane sold in the domestic market would be conventional or organic, while beet sugar would be expected to be predominantly from genetically engineered sugar beet. Consumers of sugar are expected to have the option of obtaining conventional or organic cane sugar. Sugar beet growers and processors would have the option of producing and processing conventional or H7-1 varieties of sugar beet and the process of commingling H7-1 and conventional beet sugar would be expected to continue.	Like Alternative 2 except of California beet sugar production would be from conventional varieties. No production in western Washington is expected. . Sugar beet growers and processors would have the option of producing and processing conventional or H7-1 varieties of sugar beet, with the exception of California producers, for which H7-1 varieties would not be available. Sugar beet seed production is not expected to occur in California or western Washington but would not have the option of adopting H7-1 sugar beet varieties if it did occur.
Vegetable Beet Markets		
U.S. production and consumption of vegetable beet would likely continue to be between 100,000 tons and 150,000 tons a year. Exports would likely remain few and mostly destined to Canada. Because the demand for vegetable beet seed is derived from the demand for vegetable beet, vegetable beet seed production would not be expected to grow. Foreign demand might remain stable at around 700 tons to 800 tons a year. Vegetable beet seed production would likely continue to be concentrated in the western States of Washington, Oregon, and California, with a strong concentration in Western Washington.	No impacts would be expected to vegetable vegetable growers or consumers as gene flow is not possible to the vegetable crop. Vegetable beet seed growers in Oregon could be impacted by the perceived possibility of presence of GE material in vegetable beet seed fields. These impacts could include increased testing costs and loss of clients. Some vegetable beet seed farmers could cease production of vegetable beet seed. Vegetable seed production intended for a GE sensitive market might diminish in Oregon and become more prevalent in Western WA, California, and Arizona. Consumers would still have the choice to consume conventional or organic vegetable beet.	No impacts would be expected to vegetable beet vegetable growers or consumers as gene flow is not possible to the vegetable crop. Like alternative 2 except that to the extent that production practices enforced under Alternative 3 reduce the market perception of potential presence of GE material in vegetable beet seed, any negative impacts could be reduced. Because H7-1 sugar beet production would not be allowed in California or western Washington, vegetable seed producers in these areas would not be negatively impacted. Consumers would still have the choice to consume conventional or organic vegetable beet.

Table 2–1. (continued)

Alternative 1: No Action (Regulated by Permit/Notification)	Alternative 2: Full Deregulation	Alternative 3: Extend Partial Deregulation
	Potential Impacts on Physical Environment	
	Land Use	
Growers who find producing conventional sugar beets to be unprofitable will switch to growing other crops. Over the short term, a decrease in sugar beet acreage could occur due to a potential shortage of conventional sugar beet seed. If conventional sugar beet seed is available, and growers choose to plant conventional sugar beet, the acreage would be expected to be similar or less than 2011 sugar beet planted acreage. .	H7-1 sugar beet adoption would be expected to continue at greater than 90 percent in the short term, and to approach 100 percent in the long term, including planting of H7-1 sugar beet crops in California when suitable varieties of H7-1 sugar beet become available. An increase in the prevalence of H7-1 sugar beet would be expected but the overall acreage under sugar beet production would not be expected to change notably with the adoption of H7-1 sugar beet when compared to historic land use patterns. However, when compared to Alternative 1, growers in certain regions may continue to grow sugar beet because H7-1 allows them to produce beets at a profit due to lower input costs.	The acreage of H7-1 sugar beet would be less than under Alternative 2 due to the mandatory exclusion of California. The mandatory exclusion of western Washington would be expected to have no impact on land use because there is no sugar beet production in that area, nor would any be expected under any of the alternatives. Adoption of H7-1 sugar beet would be expected to range from 95 percent to 97 percent in the long term and the overall acreage of sugar beet production would not be expected to change notably with the adoption of H7-1 sugar beet. The mandatory conditions imposed by Alternative 3 on H7-1 sugar beet growers would generally not be expected to diminish overall H7-1 sugar beet adoption behavior across sugar beet growing regions. To the extent that it does, impacts would be more likely to affect growers in the Midwest region where differential returns of H7-1 might be less than in other growing regions.
Swiss chard and table beet seed production is not expected to relocate from the Willamette Valley.	Some Swiss chard and table beet seed production might relocate from the Willamette Valley to other areas of seed production such as California and western Washington, if the continued presence of H7-1 sugar beet production in the Willamette Valley has a negative impact on the marketing of Swiss chard and table beet seed to markets sensitive to the presence of GE material.	Some Swiss chard and table beet seed production might relocate from the Willamette Valley to other areas of seed production such as California and western Washington, if the continued presence of H7-1 sugar beet production in the Willamette Valley has a negative impact on the marketing of Swiss chard and table beet seed to markets sensitive to the presence of GE material.

Table 2–1. (continued)

Alternative 1: No Action (Regulated by Permit/Notification)	Alternative 2: Full Deregulation	Alternative 3: Extend Partial Deregulation
	Soil Quality	
Micro-organism Contribution to Soil Quality Sugar beet growers would be expected to primarily use conventional tillage practices, which can reduce organic matter build-up, increase tillage activities, and increase soil disturbances. This would be expected to lead to a limited micro-organism diversity or elimination of some micro-organisms.	*Micro-organism Contribution to Soil Quality* Sugar beet growers would continue to use more conservation tillage practices, which would increase organic matter buildup, reduce tillage activities, and reduce soil disturbances relative to Alternative 1, favoring higher micro-organism diversity.	*Micro-organism Contribution to Soil Quality* Micro-organism impacts from the increased use of conservation, reduced, and strip-tillage methods would be similar to those described under Alternative 2 in all areas of production except California, where no H7-1 adoption would be allowed. In California, there would not be expected to be a difference in conservation tillage but there may be more tillage in Alternative 3 relative to Alternative 2 due to more reliance on mechanical cultivation in this Alternative. Western Washington, where H7-1 would also not be allowed, would not be impacted because it is not a sugar beet producing area, nor expected to become one.
Sugar beet growers would shift to more non-glyphosate herbicides, which could lead to applying herbicides that are more toxic to micro-organisms in soil. This could limit micro-organism diversity or eliminate some micro-organisms.	Sugar beet growers would continue to apply more glyphosate-based herbicide and less non-glyphosate herbicides on sugar beet. The reduction in non-glyphosate herbicides that might be more toxic to micro-organisms could result in less impact than Alternative 1.	Sugar beet growers would continue to apply more glyphosate-based herbicide and less non-glyphosate herbicides on sugar beet. The reduction in non-glyphosate herbicides that might be more toxic to micro-organisms could result in less impact than Alternative 1 but slightly more than Alternative 2 because H7-1 sugar beet would not be grown in Imperial Valley.
Manganese in Soil Sugar beet growers would predominantly use non-glyphosate herbicides. No impacts are expected on soil manganese.	*Manganese in Soil.* Sugar beet growers would predominantly use glyphosate on sugar beet. No impacts of herbicide use on soil manganese is expected. If manganese became limiting for sugar beet production, however, growers could rectify the situation through foliar application of manganese.	*Manganese in Soil* Manganese availability in the soil from the increased use of glyphosate would be similar to those described under Alternative 2 in all areas of production except California, where no H7-1 adoption would be allowed. Western Washington, where H7-1 would also not be allowed, would not be impacted because it is not a sugar beet producing area, nor expected to become one.

Table 2–1. (continued)

Alternative 1: No Action (Regulated by Permit/Notification)	Alternative 2: Full Deregulation	Alternative 3: Extend Partial Deregulation
	Air Quality and Climate	
Alternative 1 is expected to have emissions of criteria pollutants, greenhouse gases (GHGs), and airborne herbicides, with associated potential impacts on air quality and climate that are associated with machinery use and soil disturbance under conventional farming practices.	Alternative 2 is expected to lead to a reduction in mechanical cultivation, which would decrease machinery usage and reduce soil disturbances relative to Alternative 1. Furthermore, less tractor passes are expected from the reduced tillage and fewer applications of herbicide. Therefore, Alternative 2 is expected to have lower emissions of criteria pollutants, GHGs, and airborne herbicides, with associated reductions in potential impacts on air quality and climate, compared to Alternative 1.	Tillage practices, machinery and herbicide use associated with H7-1 sugar beet farming would be expected to be similar to Alternative 2 except in Imperial Valley where it would be similar to Alternative 1. Alternative 3 is expected to have levels of emissions of criteria pollutants, GHGs, and airborne herbicides, with associated potential impacts on air quality and climate, that are similar to or slightly higher than under Alternative 2 but lower than Alternative 1.
	Water	
Tillage and Water Infiltration and Runoff Sugar beet growers would be expected to primarily use conventional tillage practices, which can expose soil to the erosive forces of wind and water, which can increase sedimentation and turbidity in nearby surface waters during rain and irrigation.	*Tillage and Water Infiltration and Runoff* Alternative 2 may lead to the adoption of more conservation tillage practices, which would expose less soil to the erosive forces of wind and water, decrease soil erosion, and sedimentation and turbidity in nearby surface waters.	*Tillage and Water Infiltration and Runoff* Soil impacts from the increased use of conservation, reduced, and strip tillage methods would be similar to those described under Alternative 2. In California, conventional tillage is expected to be used.
Herbicides and Water Infiltration and Runoff Herbicides used during conventional sugar beet production have a greater potential to leach into groundwater than glyphosate. During erosion events, most non-glyphosate herbicides used on sugar beet would have a low potential to move in surface water runoff in solution and when attached to soil particles, which could lead to a reduced potential for herbicides reaching surface waters.	*Herbicides and Water Infiltration and Runoff* Under Alternative 2, the increased use of glyphosate and decreased use of non-glyphosate herbicides is expected to reduce the risk of herbicides leaching into groundwater but increase the risk of herbicide adsorbed onto soil particles moving from erosion when compared to Alternative 1. It is not known which impact on water quality would be greater. The expected increase in conservation tillage practices in some regions is expected to reduce erosion and the corresponding movement of herbicide coated soil particles.	*Herbicides and Water Infiltration and Runoff* The effect of herbicides on surface and groundwater would similar to those described under Alternative 2.

Table 2–1. (continued)

Alternative 1: No Action (Regulated by Permit/Notification)	**Alternative 2: Full Deregulation**	**Alternative 3: Extend Partial Deregulation**
Potential Impacts on Human Health and Safety		
Public Health and Safety		
Sugar beet sugar would continue to provide a readily available high energy carbohydrate.	Sugar beet sugar would continue to provide a readily available high energy carbohydrate. There is no difference between the three alternatives.	Sugar beet sugar would continue to provide a readily available high energy carbohydrate. There is no difference between the three alternatives.
Increased exposure to fugitive soil particulates and engine exhaust could result from cultivation and other equipment. Health effects from herbicide exposure are expected to be below the level of concern.	Use of cultivation and other equipment would be expected to decrease compared to Alternative 1, decreasing adverse health effects from exposure to engine exhaust and fugitive soil particulates; health risks from herbicides would be expected to be lower and there would be less aerial spraying of herbicides.	Use of cultivation and other equipment would decrease compared to previous conventional sugar beet practices decreasing adverse health effects from exposure to engine exhaust and fugitive soil particulates, but risks could be slightly higher than Alternative 2. Health risks from herbicides would be lower and aerial spraying of herbicides would be less, when compared to Alternative 1, except in California, where no H7-1 adoption would be allowed.
Sugar beet pollen would continue to cause seasonal allergies near sugar beet seed farms.	No change in the allergenicity of pollen is expected in H7-1 sugar beet relative to conventional varieties.	No change in the allergenicity of pollen is expected in H7-1 sugar beet relative to conventional varieties.
Sugar beet would continue to be a source of fiber, human and livestock nutritional supplements, pharmaceuticals, and other products.	Other products, genes, gene products, nutrients, and other components would remain to be a source of fiber, human and livestock nutritional supplements, pharmaceuticals, and other products There is no difference between the three alternatives.	Other products, genes, gene products, nutrients, and other components would remain to be a source of fiber, human and livestock nutritional supplements, pharmaceuticals, and other products. There is no difference between the three alternatives.

Table 2–1. (continued)

Alternative 1: No Action (Regulated by Permit/Notification)	Alternative 2: Full Deregulation	Alternative 3: Extend Partial Deregulation
Worker Health and Safety		
Sugar beet pollen would continue to cause seasonal allergies to workers at sugar beet seed farms.	No change in the allergenicity of pollen is expected in H7-1 sugar beet relative to conventional varieties.	No change in the allergenicity of pollen is expected in H7-1 sugar beet relative to conventional varieties.
Farm workers are exposed to pesticides such as Clethodim (a category I skin irritant), clopyralid (a category I eye irritant), desmedipham (a category II eye irritant), ethofumesate (category II for inhalation), and triflusulfuron-methyl (category II for inhalation).	Risks to workers from herbicides are expected to be lower compared to Alternative 1) due to lower worker toxicity of H7-1 herbicides (mostly glyphosate) compared to some of the conventional herbicides and less potential impact of accidents or misuse. For example, clethodim is a much more toxic skin irritant than glyphosate, clopyralid and desmedipham are much more toxic eye irritants, and EPTC, ethofumesate, and tirflusulfuron-methyl are much more toxic by inhalation than is glyphosate.	Risks to workers from herbicides could be lower compared to Alternative 1 due to lower toxicity of H7-1 herbicides compared to some non-glyphosate herbicides and less potential impact of accidents or misuse, except in California where risks would be the same as Alternative 1. In western Washington, where there is currently no production and none is expected, the risks are the same for all three alternatives.
Emissions of engine exhaust and soil particulates due to equipment use would increase compared to recent H7-1 practices, which could increase adverse worker health effects	Emissions of engine exhaust and soil particulates due to equipment use are expected to be less than those of conventional sugar beet practices, which could decrease adverse worker health effects.	Like Alternative 2 except in California. This could decrease adverse worker health effects, although risks would be expected to be slightly higher than Alternative 2.
Equipment accidents are expected to result in an average of about 95 non-fatal injuries each year and about 0.7 fatal injuries each year to workers	Equipment accidents are expected to average about 66 non-fatal injuries each year and about 0.5 fatal injuries each year to workers	Like Alternative 2, although there is a potential for these rates to be slightly higher than Alternative 2 because of the slightly higher use of equipment.
The number of workers in the field would increase, which could increase the numbers exposed to equipment emissions, soil particulates, and pesticides.	The number of workers in the field would decrease compared to Alternative 1, which could decrease the numbers exposed to equipment emissions, soil particulates, and pesticides.	The number of workers in the field would decrease compared to Alternative 1, except in California. This could decrease the numbers exposed to equipment emissions, soil particulates, and pesticides, although not quite as much as Alternative 2.

III. Affected Environment

A. Introduction

For the purpose of this EIS, the affected environment for H7-1 sugar beet grown in the United States is described in the context of the production practices used to farm and process sugar beet, specifically the practices related to weed control and the genetic environment that could be influenced by gene flow from H7-1 sugar beet. These practices and conditions are described in this chapter to set the stage for the chapter IV discussion of how the different action alternatives may change activities and cause impacts on the human environment. The production practices under each alternative also determine how the various "resource areas" of the affected environment are affected by the decisions of the growers and producers. Those resource areas have been grouped into the biological environment (wildlife and ecosystems), socioeconomic environment, physical environment (land use, air, water, soil), and human health and safety.

This chapter describes key aspects of the affected environment in terms of two scenarios: (1) pre-2005 when production practices were based on the exclusive use of conventional sugar beet seeds and roots; and (2) from March 2008 to August 2010 when production practices switched almost exclusively to the use of H7-1. This distinction is especially relevant because the production practices used to farm sugar beet are different under those two scenarios. These differences are important to understand when comparing the various alternatives, which represent varying degrees and combinations of pre-deregulation and deregulation conditions. This chapter also describes key regional differences in the affected environment based upon differences in production practices.

The remainder of the chapter is organized into five main sections, as follows.

Section III.B, *Production and Management of Beet Crops*, describes how sugar beet are farmed, including an overview on how the crop is used (e.g., sugar, feed). It also discusses weed management practices in sugar beet farming because the H7-1 trait influences the weed management options. An analysis of herbicide quantities applied to total acres used on sugar beet that represent pre-deregulation and deregulation conditions is also included. Section III.B also describes Swiss chard, table beet or red beet, hereafter referred to as table beet, and fodder beet production practices and uses, as well as the potential for gene flow between beet crops and gene flow to and from wild beet, where they occur. Finally, section III.B discusses H7-1 sugar beet volunteers (crop plants that grow in a field after they have been rotated out of the field because of leftover seed in the soil) in agricultural systems and estimates the quantity of herbicides used for sugar beet.

Section III.C, *Biological Resources,* describes how sugar beet and the practices related to sugar beet production interact with living organisms in ecological and agricultural settings. The biological resources are divided into animals, micro-organisms, and plants. Section III.C discusses selection of weeds resistant to herbicides and weed shifts due to herbicide usage patterns (e.g., application method and timing), the potential for sugar beet weediness in ecosystems, the H7-1 sugar beet traits (including disease resistance with and without glyphosate application), and horizontal gene transfer (HGT).

Section III.D, *Socioeconomics,* describes the supply and demand for sugar beet and vegetable beet including foreign markets and suppliers as well as organic and conventional segments. These markets are described from seed to consumer and the role of sugar beet in the U.S. sugar market is discussed.

Section III.E, *Physical Environment,* describes how sugar beet and farming practices (e.g., tillage and herbicide usage) interact with soil, air, and waterbodies.

Section III.F, *Human Health and Safety,* describes both consumer and worker health and safety with respect to the: (1) production and use of sugar beet and their products; and (2) use of pesticides that are applied before or during the production of sugar beet. The direct ingestion of the products of sugar beet, such as sugar, food additives, and dietary supplements, is addressed, as is the inhalation of sugar beet pollen and the indirect exposure via the consumption of meat, dairy, and other products derived from livestock that are fed sugar beet pulp.

B. Production and Management of Beet Crops

Sugar beet (*Beta vulgaris* L. subsp. *vulgaris* var. *altissima)* are in the Chenopodiaceae, or goosefoot, family (OECD). The Chenopodiaceae family includes approximately 1,400 species divided into 105 genera (CFIA, 2002). The genus *Beta* comprises 15 recognized species that are divided into four sections: *Beta* (formerly *Vulgares*), *Corollinae*, *Procumbentes* (formerly *Patellares*), and *Nanae* (see Table 3–1). As shown in Table 3–1, *Beta* ssp. grow in various locations throughout the world and vary with regard to the number of sets of chromosomes (their ploidy level), existing in diploid, tetraploid, and hexaploid forms with a base chromosome number of nine (OECD). The center of origin of beet (*Beta*) is believed to be the Middle East, near the Tigris and Euphrates Rivers (CFIA, 2002). Beet have been grown for their tops and roots since

Greek and Roman times and historically, have been used for both livestock and human consumption.

In Europe, wild sea beet, *B. vulgaris* ssp. *maritima* L., occurs as a wild plant. As shown in Table 3–1, wild *B. vulgaris* ssp.*maritima* is distributed along the border zones of the Mediterranean from southern Russia, the Near East, and Syria to the Canary Islands and Madeira. It is also found along the European Atlantic coasts near the Gulf Stream. *Beta. vulgaris* has been introduced into the Baltic and Central and South America. In North America, the species has become naturalized in parts of California, resulting from the introduction of plants, thought to be Swiss chard, for cultivation (OECD). There are no native beet species in North America.

Important economic cultivars of *B. vulgaris* include sugar beet, primarily grown for sugar; fodder beet/mangolds, an important cattle feed in Europe; red table beet, grown for the root and leaves; and Swiss chard/leaf beet grown for the leaves (Duke, 1983; OECD). All cultivated beet are biennial and require two years to complete their lifecycle. During the first year, beet grow as a rosette (a circular arrangement of leaves often at the same height) and in the case of sugar and table beet, develop a swollen storage root. In the second year, the energy contained in the storage root is used to produce a seed stalk, completing the lifecycle. Exposure to a period of cool temperatures (39.2–44.6 °F) and long nights, referred to as vernalization, triggers the transition from the vegetative to reproductive phases of growth (CFIA, 2002). Under certain environmental conditions, however, such as low, vernalizing temperatures early in the growing season of the first year, sugar beet can "bolt" (produce a flowering stalk that elongates, or bolts, from the root) and act as an annual by flowering the first year (CFIA, 2002).

The tall seed stalk can produce hundreds of flowers, each releasing a large quantity of wind-borne pollen. The female flowers can remain receptive for more than two weeks (Kockelmann and Meyer, 2006). A complex system of self-incompatibility promotes cross-pollination. In most cases, the fruits, sometimes referred to as seed balls, are multiple (multigerm) such that each typically contains from two to four true seeds (Milford, 2006). However, commercial sugar beet seed takes advantage of a naturally occurring trait that causes the fruit to be monogerm, containing a single seed per fruit.

Table III-1. Taxonomic Division and Distribution of the Genus Beta

(based on De Bock, 1986)

Species	Chromosome Number	Distribution
Section 1: *Beta* (syn: *vulgares*)		
B. vulgaris ssp. *vulgaris* L.	18	Global (cultivated)[1]
B. vulgaris ssp. *maritima* L.	18	N. Africa, Portugal, Spain, Egypt, Israel, Jordan, Syria, Turkey, Albania Belgium, Bulgaria, Denmark, France, Germany, Greece, Ireland, Italy, Netherlands, Sweden, U.K., Yugoslavia[1]
B. atriplicifolia (Rouy)	18	Europe[1]
B. patula (Ait.)	18	Portugal[1]
B. orientalis (Roth.)	18	India (cultivated)[1]
Section 2: *Corollinae*		
B. macrorhiza (Stev.)	36	Turkey, Iran, Caucasus Mountains [3]
B. lomatogona (Fish et Mey.)	18, 36	Caucasus, Western Asia[2]
B. corolliflora (Zos.)	18	Turkey, Iran, Caucasus Mountains[3]
B. trigyna (Wald et Kit.)	36, 45, 54	Caucasus, Western Asia, Eastern Europe, Southeastern Europe[2]
B. intermedia (Bunge)	18	Turkey[3]
B. foliosa (Hausskn.)	Unknown	No data available
Section 3: *Nanae*		
B. nana (Bois. Et Held.)	18	Greece[3]
Section 4: *Procumbentes* (syn. *Patellares*)		
B. procumbens (Chr. Sm.)	18	Canary Islands, Southern Spain, Northwest Africa[3]
B. webbiana (Moq.)	18	Canary Islands, Southern Spain, Northwest Africa[3]
B. patellaris (Moq.)	36	Macaronesia, Northern Africa, Southeastern Europe, Southwestern Europe[2]

[1] **Source: (CFIA, 2002).**
[2] **Source: Wiersema and León, 1999.**
[3] **Source: USDA–ARS, 1996.**

Although beet are biennial, all of the agricultural commodities are produced from beet grown as summer or winter annuals depending on the region. That is, they are harvested during the first year when growth is vegetative prior to vernalization and flowering. Flowering and seed formation will ruin the quality of the vegetable. In contrast, beet seed production requires the completion of the natural biennial lifecycle;

namely the roots must be exposed to low temperatures over the winter to induce flowering that occurs in the spring. Commercial seed producers can produce a seed crop over a 12-month period by sowing seeds in the late summer to generate young plants that are vernalized over the winter and produce a seed crop the following summer.

The following sections describe production and management of each of the economically important "*Beta* species" in turn: sugar beet (section III.B.1), Swiss chard (section III.B.2), table beet (section III.B.3), and fodder beet (section III.B.4).

This section starts with a general introduction to sugar beet. It then describes sugar beet seed crop production, sugar beet root crop production, and weeds in seed and root crops.

1. Sugar Beet

a. General Introduction to Sugar Beet

This general introduction to sugar beet provides useful background information and context before getting into the more detailed production and gene flow issues that follow. It provides an overview of the uses of sugar beet, sugar beet production levels and locations, sugar production processes, United States approvals for GE sugar beet, and international regulatory approvals for H7-1 sugar beet.

(1) Uses of Sugar Beet

Because sugar beet contain from 13 to 22 percent sucrose or sugar, they are primarily grown for sugar for human consumption and are rarely used as a raw commodity (CFIA, 2002). A typical sugar beet root consists of 75.9 percent water, 2.6 percent non-sugars, 18.0 percent sugar, and the remainder pulp (CFIA, 2002). In the sugar fraction, 83.1 percent is recovered as crystalline sucrose and 12.5 percent is recovered as molasses (CFIA, 2002). During the sugar refining process, sugar beet roots are processed into white sugar, beet pulp, and molasses that are used for food, feed, and industrial applications (CFIA, 2002).

Beet pulp is produced in wet (pressed shreds) or dry (shreds or pellets) forms. Pressed beet pulp is a valuable feed – high in energy (85 percent of the energy value of corn) and low in protein (7–10 percent crude protein). Pressed beet pulp is considered a non-forage fiber source (Dalton and Norell, 2005). Conversely, wet pulp contains approximately 75 percent moisture, which limits the distance it can be transported economically. Wet pulp also can be ensiled (placed in silos) with other dry feeds to extend its shelf life and improve storage characteristics (Sugar Knowledge International, 2010). Additionally, high-fiber dietary food additives for human consumption have been manufactured from sugar beet pulp (Cattanach et al., 1991).

Sugar beet molasses is a viscous liquid containing about 48 percent saccharose, a sugar related to sucrose but which cannot be as easily crystallized. In contrast to molasses derived from sugar cane, beet molasses is used mainly for livestock feed. It is sprayed onto dried beet pulp shreds or pellets to enhance palatability (Cattanach et al., 1991). Beet molasses is also used for production of baker's yeast, chemical manufacturing, and pharmaceuticals (CFIA, 2002; SMBSC (Southern Minnesota Beet Sugar Cooperative), 2010a). In addition, sugar beet molasses is used in the production of monosodium glutamate (MSG), a food flavor enhancer (Khan and Abourashed, 2009). Sugar beet molasses can also be mixed with salt brine and applied to roadway surfaces and other areas to prevent the accumulation of snow or ice or the deicing of surfaces on which snow or ice has already accumulated (Maryland DOT (Maryland Department of Transportation), 2010).

Sugar beet tops can be used for livestock feed or as silage. Sheep and cattle can graze beet tops in the fall and can eat small beet left in the field after harvest (Cattanach et al., 1991). Recent advancements in defoliator technology have limited the usefulness of beet tops because the beet tops essentially are mulched as they are removed (Sugar Knowledge International, 2010).

Generally with silage, sugar beet that produce 20 tons per acre of roots also produce about 5 tons per acre of total digestible nutrients (TDN) per acre in the tops. Tops are an excellent source of protein, vitamin A, and carbohydrates (Cattanach et al., 1991). Beet tops also contain oxalic acid, which, depending on the digestive system of the animal and the amount eaten, can cause diarrhea and may bind to calcium in the animals' diet (FAO (Food and Agriculture Organization of the United Nations), 2002). Ruminants, such as beef cattle and sheep, can tolerate larger quantities of oxalic acid and can be fed limited amounts of beet tops whereas pigs and horses do not tolerate oxalic acid as well and generally are not fed beet top silage (OSU (Oregon State University), 2010). For more information on sugar beet use in animal feed, see section III.C.1.a.

Occasionally, regional sugar processors must dispose of whole sugar beet due to spoilage. Whole beet can be fed successfully to cattle. Some producers use manure spreaders to spread whole beet on stubble or stalk fields and allow cows to have access to the beet on the field (Sugar Knowledge International, 2010).

Sugar beet are also planted, sometimes as part of a mix with other plants, to attract deer in wildlife plot habitats (BuckLunch, 2011; Frigid Forage, 2011).

Beet tailings are a specific type of whole beet that can be used for feeding. Beet tailings consist of small beet, broken or damaged beet, soil, and other foreign material not suitable for sugar production. Due to the high moisture content, transportation is a major expense with beet tailings (Lardy and Anderson, 2009).

Additionally, subspecies of *Beta vulgaris*, including sugar beet, table beet, and Swiss chard, have traditionally been used for complementary and alternative medicine. For example, boiled and extracted seeds have historically been used to treat tumors of the intestines and genital tumors. The juice or other parts of the plant purportedly help tumors, leukemia, and other forms of cancer, for example: cancer of the breast, esophagus, glands, head, intestines, leg, lip, lung, prostate, rectum, spleen, stomach, and uterus (Duke, 1983). Recent studies indicate that compounds in *Beta* species members, table beet and Swiss chard in particular, can antagonize (reduce growth of) certain types of cancer development (Kapadia et al., 1996; Lechner et al., 2010).

Waste lime from the processing of sugar beet is an excellent soil amendment to increase soil pH levels. Waste lime is a good source of phosphorus and potassium, two essential plant nutrients. Waste lime is created through the treatment of the sugar juice solution. Solid lime is separated from the juice and pumped to a lime pond where it can be recovered and delivered to farms (Schaetzl, 2008). Treated process wastewater also can be used for irrigation (Schaetzl, 2008).

Sugar beet can also be used to produce ethanol. Although there has been production of sugar beet ethanol in the United Kingdom since 2007 (British Sugar, 2010), there is currently no production of sugar beet ethanol in the United States. However, there are several efforts underway to develop sugar beet ethanol plants as early as 2012 (Iowa State University, 2009; Austin, 2010; U.S. EPA 2010a).

(2) Sugar Beet Production

Sugar beet are grown in temperate regions around the world, and beet sugar accounts for about 30 percent of global sugar production (Sugar Knowledge International, 2010). The largest sugar beet producing countries are France, Germany, the United States, and Russia, in that order (FAO (Food and Agriculture Organization of the United Nations), 2010). It is estimated that in 2009, more than 229 million tons of sugar beet were produced globally (FAO (Food and Agriculture Organization of the United Nations), 2010).

The United States has large and well-developed sugar beet and sugar cane industries. Since the mid-1990s, more than half (approximately 55 percent) of U.S. refined sugar has been produced from sugar beet (USDA-ERS, 2009a). Sugar beet production acreage in the United States has remained relatively constant since 1961. Production has ranged from a low of 1.1 million acres in 1982 to a high of 1.6 million acres in 1975

(USDA-NASS, 2010d). For the 2009-2010 production year, approximately 1.18 million acres of sugar beet were planted and approximately 1.15 million acres were harvested (USDA-ERS, 2009b). Annual cash receipts for sugar beet in the United States in the past few years have ranged up to 1.5 billion U.S. dollars (USD) (USDA-ERS, 2009a) .

When discussing sugar beet production, it is necessary to distinguish between sugar beet seeds and sugar beet roots; seeds are used to grow the roots and roots are used to produce the sugar. Sugar beet seed production and sugar beet root production occur in various, non-overlapping areas throughout the United States. Primary sugar beet root production States, in order from most to fewest acres planted, are: Minnesota and North Dakota (57 percent of U.S. production), Idaho, Michigan, Nebraska, Montana, Colorado, Wyoming, California, and Oregon (USDA-ERS, 2010b). States with minor production (less than 1 percent of U.S. production) are Washington (about one tenth of 1 percent) and South Dakota (about one one-hundredth of 1 percent) (Stankiewicz Gabel, 2010).

In general, sugar beet roots are produced in five regions: Great Lakes, Midwest, Great Plains, Northwest, and Imperial Valley (California). Sugar beet seed production occurs on a much smaller scale in the United States than sugar beet root production. Sugar beet seeds are produced mainly in Oregon and Washington with additional breeder plots in Idaho and Colorado. These production locations are discussed in more detail for seeds in section III.B.1.b, and for roots in section III.B.1.c.

Although sugar beet have been adapted to a very wide range of climatic conditions, they are primarily a temperate zone crop produced in the Northern Hemisphere at latitudes of 30 to 60 °N. The sugar beet plant grows until it is harvested or growth is stopped by a hard freeze. Sugar beet primarily grow tops until the leaf canopy completely covers the soil surface in a field, about 70 to 90 days after planting. Optimal daytime temperatures are 60–80 °F for the first 90 days of growth. Regions with long day length are most suitable for sugar beet growth. The most favorable environment for producing a sugar beet crop from 90 days after emergence to harvest is bright, sunny days with temperatures of 65–80 °F followed by night temperatures of 40–50 °F. These environmental conditions maximize yield and quality in a sugar beet crop. Sugar beet are successfully produced under irrigation in areas with very low rainfall and in regions relying on natural rainfall (Cattanach et al., 1991). During the first growing season – the vegetative stage – the sugar beet plant typically has glabrous, or smooth, oval and dark green leaves that form a rosette from an underground stem. A white fleshy taproot develops, prominently swollen at the junction between the leaves and the root (CFIA, 2002).

Most cultivars of sugar beet require 90–110 days of exposure to vernalizing temperatures to initiate reproductive development or the flowering process. The bolt or seed stalk forms an inflorescence (a cluster of flowers growing on a stalk) and grows to approximately 1.2–1.8 meters (3.9–5.9 feet) tall. Sugar beet produce a perfect flower meaning that the flowers have both male and female organs. These flowers are small and sessile (grow directly from the stalk) and do not have petals (CFIA, 2002). Flower formation commences on the top shoot and flowers mature from the base upward, with secondary shoots following. The sugar beet plant flowers for about 4 weeks. Flowers open primarily in the morning, but continue throughout the day, with the stigmas (female reproductive parts of the flower) remaining receptive or fertile for more than 2 weeks (OECD).

The pollen grains produced are round and have numerous indentations. Approximately 17,000 pollen grains are produced per anther (male reproductive part of the flower), resulting in approximately one billion pollen grains produced per plant (OECD, 2001). Pollen is viable for a maximum of 24 hours, depending on environmental conditions, especially moisture. Pollen is transported primarily by wind currents and, to a much lesser extent, by insects such as hoverflies (Syrphidae), though a wide range of insects such as Ladybugs (Coccinellidae), soldier beetles (Cantharidae), tachina flies (Larvaevoridae), and house flies (Muscidae) have been observed to visit sugar beet flowers (Free et al., 1975). Honey bees have been reported to visit sugar beet fields when more attractive sources of pollen and nectar are not available (McGregor, 1976).

The fertilized ovary forms a fruit, which is embedded in the base of the flower. Each fruit contains a single seed, which varies in shape from round to kidney-shaped. A monogerm seed is formed when a flower occurs singly. Multigerm beet seed is formed by an aggregation of two or more flowers (CFIA, 2002). Sugar beet seeds currently sold on the market in the United States are monogerm and contain only one seed (OECD).

Most of the sugar beet varieties grown since the 1970s have been diploid or triploid hybrids. The development of hybrid sugar beet was made possible by the discovery of cytoplasmic male sterility (CMS) (CMS is a maternally inherited form of genetic male sterility in which plants fail to produce pollen resulting in a functionally “female” plant) used in conjunction with polyploidy. For more information on CMS and seed production, see the sections below (III.B.1.b(8)). Breeding programs using the CMS lines to form diploid or triploid hybrids have enabled the development of superior sugar beet varieties with higher root yield and higher sugar content, better extraction yield (juice purity), higher seed germination percentages, lower tendency to bolt, physical attributes of the root well adapted to mechanical harvesting, and higher resistance to leaf and root diseases (OECD). The current trend is towards diploid hybrids because it is easier to generate strains resistant to beet necrotic yellow vein virus in the diploid compared to the triploid (Bosemark, 2006) (Betaseed, 2011).

(3) Sugar Production

As stated previously, sugar beet are primarily grown for sugar for human consumption and are rarely used as a raw commodity (CFIA, 2002). Sugar beet processing to make sugar is composed of six steps: harvesting, extraction, pressing, carbonation, boiling, and production of final products (Sugar Knowledge International, 2011). Each of these steps leading up to final production step is summarized below. While typically just called "sugar," the type of sugar extracted from sugar beet is sucrose. To avoid confusion, the word "sucrose" is used below in describing the sugar production process.

Harvesting. Harvesting dates and procedures are strictly regulated and vary between the sugar beet root production regions and the harvesting facilities. For the Great Lakes, Midwest, Great Plains, and Northwest, harvesting generally begins around September and ends around November (McDonald et al., 2003) (Mikkelson and Petrof, 1999). In California's Imperial Valley, sugar beet roots are harvested between April and July (California Beet Growers Association, 1999; Lilleboe, 2010). (For more information on root harvesting see section III.B.1.c(2) below). Throughout the harvest in the northern states, growers transport their sugar beet by truck to the designated receiving station where sugar beet are stored until processing (American Crystal Sugar Company, 2011). In California where it is too hot to store sugar beet, sugar beet are harvested on a schedule to meet the demands of the processing plant. Sugar beet are thoroughly washed and separated from any remaining beet leaves, stones, and other trash material before processing (Sugar Knowledge International, 2011).

Extraction. Sugar beet processing starts by slicing the cleaned beet into thin strips, called cossettes, to increase the surface area of the beet to make it easier to extract the sucrose (Sugar Knowledge International, 2011). The cossettes are submerged into hot water (usually between 122 and 176 °F) to extract the sucrose by diffusion (U.S. EPA 1997). The resulting sucrose-enriched water that flows from the diffuser is called raw juice and contains 10–15 percent sugar (U.S. EPA 1997).

Pressing. The wet beet slices from the diffuser are further pressed to remove any remaining water and sucrose (Sugar Knowledge International, 2011). The juice is sent back to the diffuser and the leftover cossettes, or pulp, are conveyed to the dried-pulp manufacture operations to make animal feed and other products (Sugar Knowledge International, 2011); (U.S. EPA 1997).

Carbonation. The raw juice must be purified to remove non-sucrose impurities, such as other molecules and small cossette particles, so that the pure sucrose can be crystallized (U.S. EPA 1997). Purification is done by a process known as carbonation where the mixture is heated and chalk or "milk of lime" [$Ca(OH)_2$] is added to the juice and carbon dioxide (CO_2) gas is bubbled through the mixture to precipitate the lime. The "clumps" of lime adsorb to the majority of the non-sucrose and can be easily filtered out from the raw juice. The resulting juice is very dilute (U.S. EPA 1997); (Sugar Knowledge International, 2011). Therefore,the sucrose mixture is put through a series of evaporators to increase the sucrose concentration to approximately 50–65 percent (U.S. EPA 1997). The resulting solution is known as standard liquor.

Boiling. To form sucrose crystals, the standard liquor is boiled and powdered sugar is added to seed (initiate) crystal formation. After the crystals grow to the desired size, the mixture of crystals and liquor is spun in a high-speed centrifuge to separate the crystals from the liquid (known as syrup). The crystals are then dried with hot air. Once cooled, the sugar is either packaged or stored for future packaging (U.S. EPA 1997); (Sugar Knowledge International, 2011).

(4) U.S. Approval of GE Sugar Beet

The Animal and Plant Health Inspection Service (APHIS) originally approved a petition seeking a determination of nonregulated status of H7-1 sugar beet in March 2005 (see chapter I for more information). Following deregulation, widespread seed production began in 2006 as did the multiyear breeding programs to develop appropriate varieties for growers in all sugar beet production states. To date, varieties have been released and adopted in all areas except California (Colacicco, 2010b). See section III.B.1.b(3) for more information on sugar beet breeding. According to the U.S. Department of Agriculture Economic Research Service (USDA–ERS), H7-1 sugar beet accounted for about 60 percent of sugar beet-planted areas in the 2008 crop year and 95 percent in the 2009 and 2010 crop years (USDA-ERS, 2009a) . California is the only sugar beet production State that did not grow H7-1 sugar beet in those three crop years (Colacicco, 2010b). To provide a clear context for the comparison of potential environmental impacts for the alternatives analyzed in this EIS, this chapter describes the affected environments for both pre-deregulation (pre-2005) and after widescale adoption post deregulation (after March 2009).

APHIS previously deregulated two other GE traits in sugar beet which were never produced commercially as a root crop:

- AgrEvo (now Bayer) glufosinate-tolerant sugar beet event T120-7 (97-336-01p) approved in United States on May 7, 1998 (USDA-APHIS, 1998a) also approved in Canada and Japan (CERA, 2011) and

- Novartis Seeds (now Syngenta) and Monsanto glyphosate-tolerant sugar beet line GTSB77 (98-173-01p) approved in United States on January 8, 1999 (USDA-APHIS, 1998b) (also approved in Australia, Japan, New Zealand, the Philippines and the Russian Federation) (ISAAA (International Service For the Acquisition of Agri-biotech Applications), 2011).

Neither of these traits is evaluated in or affected by this EIS. APHIS does not anticipate that industry will begin commercial production of sugar beet containing these events (Reding, 2011). Neither Monsanto nor Bayer has plans to stack T120-7 with H7-1 to make a sugar beet resistant to both glufosinate and glyphosate.

(5) International Regulatory Approvals for H7-1 Sugar Beet

Multiple countries that regulate the importation of biotechnology-derived crops and derived products have granted regulatory approval to H7-1 sugar beet. Each country independently determines for which type of use the crop or derived product is approved. Categories or types of approval typically include food, animal feed, imports, processing, and planting. For example, the Canadian Food Inspection Agency (CFIA) approved H7-1 sugar beet for livestock feed in 2005. As summarized in Decision Document DD2005-54, the CFIA "determined that this PNT and novel feed does not present altered environmental risk nor does it present livestock feed safety concerns when compared to currently commercialized sugar beet varieties in Canada" (CFIA, 2005). H7-1 sugar beet was also approved for planting in Canada in 2005. As another example, the European Food Safety Authority (EFSA) has also concluded that food and feed from H7-1 sugar beet are as safe as food and feed from conventional sugar beet (EFSA, 2006). In response to EFSA information requests, Monsanto/KWS SAAT AG conducted a 90-day toxicity study, feeding processed pulp to rats, which did not indicate any adverse effects. The Genetically Modified Organism (GMO) Panel reported additional studies of sugar beet pulp to sheep, also with no adverse effects (EFSA, 2006).

In alphabetical order, other countries besides the United States, and the uses for which H7-1 sugar beet or derived products are approved, include the following: Australia (food and import); Canada (food, feed, and planting); Columbia (feed and import); European Union (EU) (food, feed, and import); Japan (food, feed, import, and processing); South Korea (food and import); Mexico (food, feed, and import); New Zealand (food and import); Philippines (food, feed, and import); Russian Federation (food and import); and Singapore (food, feed, and import) (ISAAA (International Service For the Acquisition of Agri-biotech Applications), 2011). These diverse regulatory authorities have all reached the same conclusion, that food and/or feed derived from H7-1 sugar beet are as safe and healthy as food and feed derived from conventional sugar beet.

H7-1 sugar beet have received regulatory approval from more countries than the other two herbicide-resistant sugar beet seed varieties derived through genetic engineering, GTSB77 and T120-7. For more information on GTSB77 and T120-7 see section III.B.1.a(4). As stated above, H7-1 has received regulatory approval from 12 countries, event GTSB77, has been approved by six regulatory bodies (ISAAA (International Service For the Acquisition of Agri-biotech Applications), 2011), and T120-7 has received regulatory approval from just three countries: Canada, Japan, and the United States (ISAAA (International Service For the Acquisition of Agri-biotech Applications), 2011). Neither GTSB77 nor T120-7 has been approved by the EU. The fact that both GTSB77 and T120-7 lack many of the regulatory approvals attained for H7-1 makes it extremely unlikely that these traits will ever be stacked with H7-1.

b. Seed Crop

(1) Sugar Beet Seed Production

In 2011, all of U.S. H7-1 sugar beet seed production (including commercial, foundation, breeder, and research seed) is occurring on a total of less than 5,000 acres in Oregon, Washington, Idaho, and Colorado (APHIS proprietary data). Table 3–2 (U.S. H7-1 Sugar Beet Seed Production by State) below shows the percentage of total seed production that is grown in each State.

Table III-2. 2011 U.S. H7-1 Sugar Beet Seed Production by State

State in which H7-1 Planted	Percent of Total U.S. Production (%)
Oregon	50
Washington	49
Idaho	<0.5
Colorado	<0.1
Total	**100**

Source: APHIS proprietary data

As part of the permitting requirements, all producers growing H7-1 seed were required to submit planting reports that specified the location and acreage of their seed production activity in the United States. From these planting reports, APHIS determined that in 2011, H7-1 sugar beet seed production occurred in the following counties: Eastern Washington (Adams, Franklin, and Grant counties), Idaho (Cassia, Canyon, Gooding, Payette, Twin Falls, and Washington counties), and Oregon (Benton, Clackamas, Douglas, Jackson, Josephine, Lane, Linn, Malheur, Marion, Polk, and Washington counties) (APHIS proprietary data). There is also a small amount of seed production in Boulder County, Colorado. See Fig. 3–1 below for a map of the H7-1 sugar beet seed producing counties listed above.

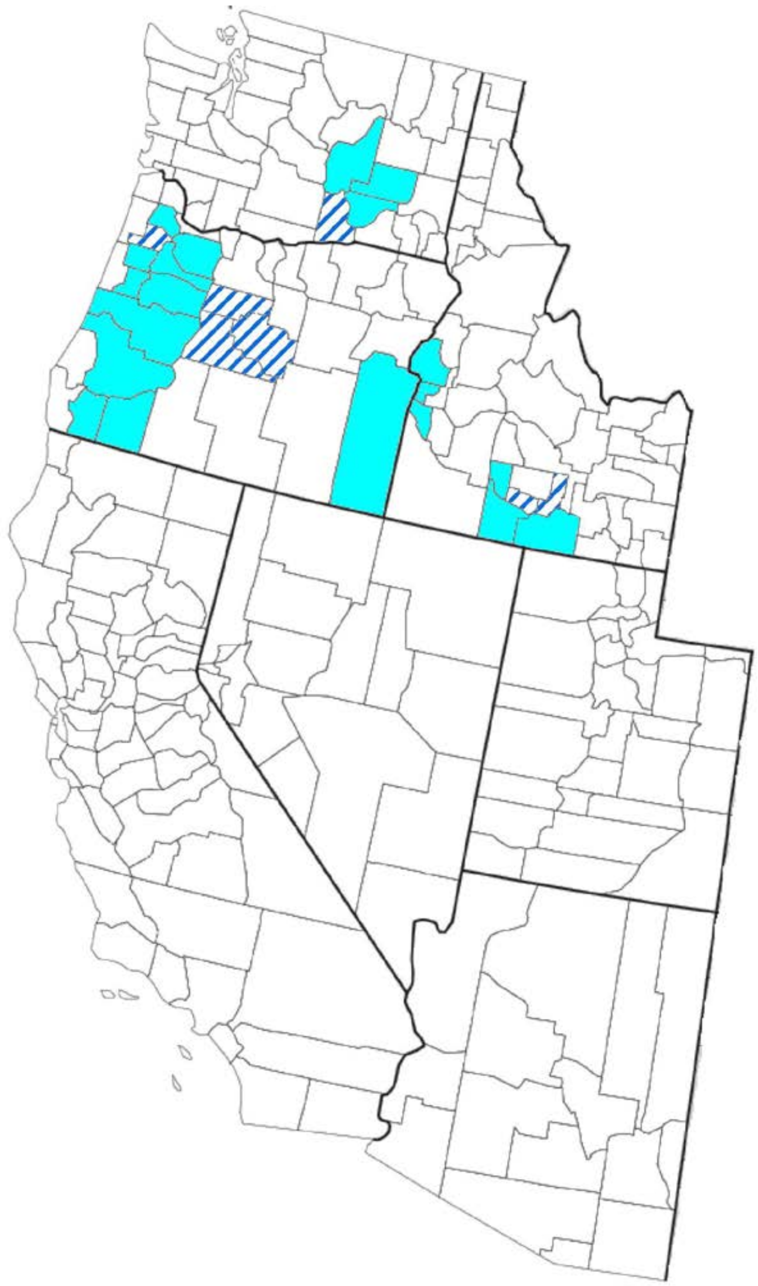

Figure 3-1. Counties where H7-1 sugar beet seed was produced in 2011 shown in solid color.

Striped counties indicate counties in which applications for permits to plant H7-1 sugar beet seeds in 2011 were received, but seeds were ultimately not planted. Planting in a single county in Colorado is not shown. (APHIS proprietary data).

As non-H7-1 sugar beet seed is not regulated, APHIS does not have any permit or other information as to where these seed crops may be grown. Given that the same five seed companies that produce H7-1 sugar beet seed also produce conventional seed, it is assumed that non-H7-1 sugar beet seed is grown in the same counties as H7-1 sugar beet seed (for more information on sugar beet seed production companies see section III.B.1.b(2).

Additionally, small fields of breeder's seed (both H7-1 as listed above and non-H7-1) are included in the states listed in Table 3–2. Small breeder seed fields have occurred in Minnesota in the past, but were not planted to H7-1 sugar beet in 2011 (APHIS, proprietary data).

Small acreage production of stecklings,sugar beet roots that are grown in plant nurseries from seed for less than a full season, are dug up and are replanted in a different location for seed production–occurs in Oregon, Arizona, and eastern Washington (USDA-APHIS, 2011b).

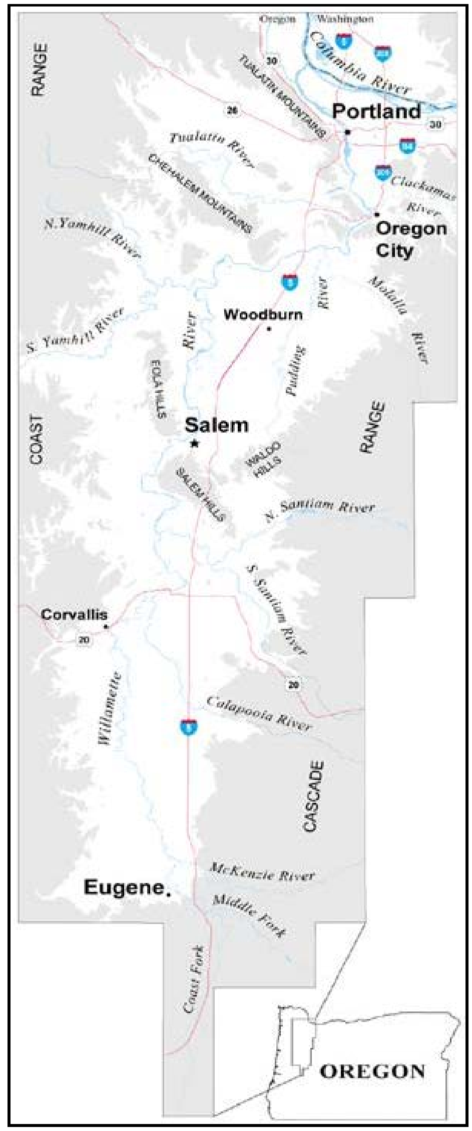

Figure 3- 2. Willamette Valley (Source: (Givler and Wells, 2001)

At least 98 percent of all Oregon H7-1 sugar beet seed production (equal to about 50 percent of the total U.S. H7-1 production), is in the Willamette Valley (APHIS proprietary data), located between the Coast Range and the Cascade Range. The remainder occurs in Jackson and Josephine counties in the south and Malheur county in the east. The Willamette Valley runs through parts of the following counties: Benton, Clackamas, Douglas, Lane, Linn, Marion, Multnomah, Polk, Washington, and Yamhill (see Fig. 3–2 and 3-3). The Willamette River Basin contains more counties as it contains all lands that drain in to the Willamette River. The Willamette River Basin contains the above counties in addition to the following counties: Columbia, Lincoln, and Tillamook (Oregon Explorer, 2010). The Willamette River Basin is about 180 miles long and 100 miles wide (290 by 161 kilometers), and encompasses 11,478 square miles (29,728 square kilometers), or 12 percent of the State of Oregon (Oregon Explorer, 2010). The climate in the valley is cool enough for winter vernalization but warm enough for most roots to survive an average winter. Summers are very dry, producing ideal conditions for seed harvesting.

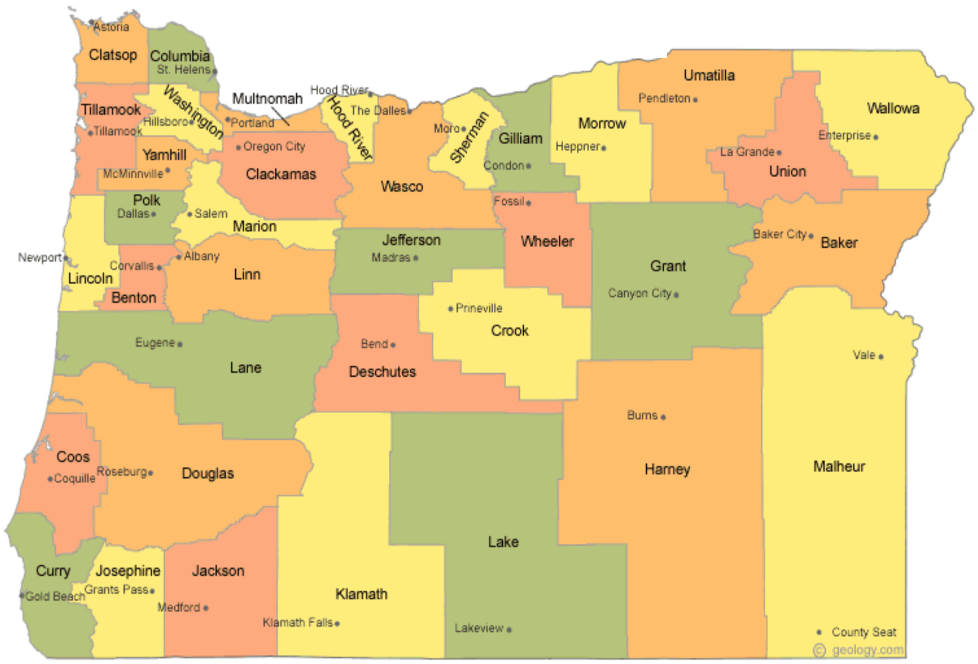

Figure 3-3 County map of Oregon

The Northern edge of the Willamette Valley includes parts of Washington and Clackamus county and extends south through Douglas county. Source: http://geology.com/county-map/oregon.shtml

(2) Seed Crop Producers

Sugar beet seed production consists of developing, growing, and processing the seed that commercial sugar beet growers use to plant their crop. As mentioned previously, sugar beet seed production and sugar beet root production occur in different locations in the United States. Sugar beet planted for seed production make up less than 0.5 percent of the total acreage of beet cultivation (Miller, 2010).

Commercial sugar beet seed in the United States is produced, processed, and marketed by five private entities:

(1) American Crystal Sugar Company is a grower-owned cooperative based in Moorhead, Minnesota, which markets seed to its shareholders in the Red River Valley.

(2) Betaseed, Inc., based in Shakopee, Minnesota, is a wholly owned subsidiary of the German seed company, KWS SAAT AG.

(3) Syngenta Seeds, Inc., with sugar beet seed operations based in Longmont, Colorado, is a division of Syngenta.

(4) SES Vanderhave Sugarbeet Seed, based in Fargo, North Dakota, is a subsidiary of the French company, Florimond Desprez SES.

(5) Holly Hybrids, with beet seed operations based in Sheridan, Wyoming, is owned by Southern Minnesota Beet Sugar Cooperative and shares an alliance with SESVanderHave Sugarbeet Seed.

As stated above, most Oregon sugar beet seed production (approximately 50 percent of U.S. production) takes place in the Willamette Valley of Oregon. There are two commercial beet seed production entities in the Willamette Valley: West Coast Beet Seed (WCBS) and Betaseed. West Coast Beet Seed, based in Salem, Oregon, is a cooperative, producing seed for its member companies, which include American Crystal Sugar, Syngenta, Holly Hybrids, and SES VanderHave. Betaseed has seed production and processing facilities based in Tangent, Oregon. Although there is some degree of overlap, the seed production operations of these two seed producers are geographically separated: Betaseed is located in the southern and southeastern fringes of the Willamette Valley, and WCBS produces seed to the north in the Salem area. Betaseed accounts for approximately half of all sales of sugar beet seeds in North America (Lehner, 2010).

The Willamette Valley produces seed for a wide variety of crops, including vegetable beet. Sections III.B.2 through III.B.4 present more information on production of seed for other *Beta* species. In addition to seeds, many vegetables are also grown in the valley, which is a major area for production of "most temperate vegetables, herbs and vegetable seeds" (Mansour, 1999). Because high quality and seed purity are important to many growers, and because the valley is the site of varied seed production, sugar beet seed production companies have worked cooperatively to develop and implement protocols for maintaining the purity and quality of seed. Most seed companies in the Willamette Valley, including WCBS and Betaseed, belong to the Willamette Valley Specialty Seed Association (WVSSA) and follow the guidelines for isolation and minimum separation distances between fields. Additionally, WCBS and Betaseed have both developed explicit standard operating procedures (SOPs) and grower guidelines intended to minimize or eliminate the possibility of pollen movement between seed fields and inadvertent seed mixing. Isolation distances and grower guidelines are discussed further in sections III.B.1.b(10) and III.B.1.b(11), respectively, below.

(3) Seed Variety Development

The development of sugar beet varieties is a competitive, technological, and expensive multi-year activity. Seed companies develop varieties with the combination of agronomic and quality traits desired by both growers and processors. Up to 12 years is required to develop and bring to market a new sugar beet variety (Syngenta, 2010). This includes the time required for the initial breeding of parent lines, development of hybrid seed varieties , and the 3 years of variety testing required by processors as described below. Information about seed breeding and developing hybrids is described in more detail in section III.B.1.b(6).

Sugar beet seed produced outside the United States may not be suitable for commercial production in the United States, and this lack of suitability varies by region. For example, some European varieties might perform well in the Red River Valley, the market with the least severe disease pressure. Sourcing varieties with sufficient *Cercospora* resistance for production in Michigan, however, would be difficult, and no European varieties could provide the beet curly top virus (BCTV) resistance required for production in Idaho. Furthermore, due to concerns about importing wild beet from Europe, some sugar processors (e.g., American Crystal Sugar) have policies that prohibit the use of seed not produced in North America (Colacicco, 2010b). Wild beet occur across regions of Europe, including in sugar beet root and seed production fields. Wild annual forms of beet can cause crop failure and complicate the harvest and processing of sugar beet. Wild beet are difficult to eradicate in conventional sugar beet due to their similar morphology and physiology which renders conventional control methods for annual wild beet ineffective (Mücher et al., 2000).

(4) Variety Approval

Each sugar processor conducts official variety trials to generate a list of approved varieties, and growers are obligated to grow only varieties that appear on this list. To achieve full approval, new varieties must be tested in the official trials for 3 years and must generate data that meet or exceed the specific performance criteria established by each company’s seed committee. Criteria include how well each variety tolerates exposure to particular diseases and pests known to infest the growing region, adverse growing conditions, and the variety’s ability to deliver acceptable tons/acre and sugar content. Approved variety lists are updated annually with new varieties added that were approved the previous year. Although seed policies vary by region, seed companies are generally obligated to “enter” approved varieties in the official trials to maintain approval for unlimited sales. When sales of a given variety decline, the seed company must decide whether it is worth the cost of the official trial entry fees needed to support the declining market share of that specific variety. The approval systems are designed to enforce continuous improvement, so the lifespan of any given variety in the market is relatively short.

The approved variety list denotes only those sugar beet varieties that may be delivered to the processor for sugar production. Similarly, growers may only plant seed of approved varieties. As a cooperative member, a grower is contractually obligated to deliver sugar beet from a specified number of acres. Sugar cooperatives are described in section III.D.1.

In early 2009, the American Crystal Sugar Company Seed Committee exempted approved conventional varieties from continued variety testing (Niehaus, 2010) Since the seed industry was no longer entering these older varieties in the official trials, this policy change was enacted to allow these varieties to continue to be sold without testing fees assessed to the seed companies. Based on this decision, there were 31 conventional varieties available to American Crystal Sugar Company growers in 2010, but only 7 of these were tested in the 2009 official variety trials.

(5) Planting and Lifecycle

For seed production, sugar beet plants are sown in the late summer or early fall in regions with mild winter climate that reach the required vernalizing temperatures of 4–7 °C (39.2–44.6 °F). These direct seeded plants will produce seed in the following summer (OECD). In the United States, sugar beet seed plants are planted around August to September and harvested the next summer about the same time (Meier, 2010). This cultivation technique for sugar beet seed crops is known as the overwintering method and eliminates the need for two spring/summer growing seasons for production of this biennial crop. After seed germination and emergence, vegetative growth and development of the crop occurs during the fall. The crop enters dormancy in the winter at which time it is vernalized by the low temperatures. Once vernalized, the crop switches from vegetative development to reproductive development in spring (Chastain, 2005). The overwintering method is only suitable in mild climates such as found in the Pacific Northwest, which is why the majority of sugar beet production occurs in this area. Sugar beet cannot survive the year in any of the regions they are grown for root production. In the four northern regions, the winters are too cold for roots to survivewhile in the Imperial Valley, the summer temperatures are too hot (2011).

(6) Breeder Seed

The breeding process involves selection of the desired genetic traits and backcrossing those traits through several plant generations to ensure consistent reproduction in subsequent generations. This process culminates in what is called pre-basic seed (also known as breeder seed). Pre-basic seed is the purest form of seed and is always retained by the commercial breeder in sufficient quantities to ensure that it can be replicated to recreate the variety. Pre-basic seed is multiplied (planted, grown, allowed to set seed, and harvested) into basic seed, which is then planted and crossed to create the hybrid seed required for commercial production (Meier, 2010).

(7) Monogerm vs. Multigerm

Plants in the *B. vulgaris* species produce perfect flowers, meaning that the flowers have both male and female organs, and polygerm fruits or seed balls, meaning that each fruit contains multiple seeds which can sprout into multiple plants (CFIA, 2002). Plants in the *B. vulgaris* species are strongly self-incompatible, meaning that a flower cannot fertilize itself or other flowers on the same plant. For fertilization to occur, self-incompatible plants must outcross with individuals that do not contain identical copies of self-incompatibility genes (Larsen, 1977). Despite this strong self-incompatibility, sugar beet can be "selfed" or inbred to a breeding population which contains a range of self-incompatibility genes (Bosemark, 2006).

Due to genetic manipulation and complex breeding programs, all of the sugar beet varieties grown in the United States since the 1970s have been diploid or triploid, monogerm hybrids. Monogerm means that the fruit contains just a single sugar beet seed which will give rise to a single plant. A monogerm beet seed is formed when a flower occurs singly on the "seed parent" and multigerm beet seed is formed by an aggregation of two or more flowers on the "seed parent" (CFIA, 2002). The monogerm trait is advantageous because it facilitates high precision planting — fruits can be planted at an optimal spacing and no thinning is needed because typically one plant will sprout from each fruit.

Each hybrid seed is derived from two genetically different parents of the same (diploid) or different (triploid) ploidy levels (have different numbers of chromosome sets) (Bosemark, 2006). Hybrid seeds are produced by crossing "male" pollen parents with male sterile "seed parent" plants. In hybrid seed production, to produce a phenotypically monogerm seed, the female "seed parent" must be monogerm. The male parent, however, is typically polygerm as polygerm plants produce more pollen and have fewer undesirable vegetative plant growth traits than monogerms. The resulting hybrid seed is phenotypically monogerm (only one seed per seed ball) and genotypically polygerm (if allowed to flower, it would produce seed balls with multiple seeds) (Panella and Lewellen, 2007). These seeds are superior to previous types of seeds for the reasons previously described (OECD).

(8) Cytoplasmic Male Sterility

The development of hybrid sugar beet was made possible by the discovery of CMS. CMS allows the breeder to develop male-sterile (nonpollen producing) “female” parental lines from which the seed is harvested (CFIA, 2002). CMS female seed parents are developed and maintained through a complex breeding program requiring two generations of crosses, as the gene required for CMS is maternally inherited and the monogerm trait is recessive (Bosemark, 2006).

Because of the number of specialized traits that must be combined, the development of a new female parental line takes 10–12 years, about twice as long as required to develop a new male parent line (Miller, 2010). The CMS female lines generally produce no pollen, ensuring that any seed produced will be hybrid. There are rare cases, however, where a CMS female plant does produce pollen. Seed production fields are routinely inspected prior to pollen release to identify and rogue (remove) these rare individuals to eliminate inadvertent pollination (Lehner, 2010; Miller, 2010).

The CMS female parent is itself a single cross produced by pollinating a monogerm CMS line with a monogerm “maintainer” line (also called the O-type line) that is nearly identical to the CMS female parent except that it also produces pollen (Hovland, 2010). The purpose of the maintainer line is to make more of the female parent while maintaining the cytoplasmic male sterility in the resulting seed. When crossed, the resulting progeny will be homozygous for the monogerm and H7-1 traits, will be male sterile, and will contain the desired genetics for the female parent, including disease resistance and yield characteristics (see Fig. 3–4). The offspring then is used as the female seed parent in crosses with polygerm diploid or tetraploid pollinator lines (CFIA, 2002). The cross will result in either a diploid or triploid hybrid monogerm seed. Because triploids are sterile, when triploid seed is used to produce the root crop, little to no fertile pollen will be produced from bolters should they arise.

Fig. 3–4 provides a graphic representation of genetics used to produce H7-1 hybrid seeds using CMS. Part A of the figure shows crosses used when the H7-1 gene is on the CMS female parent. Part B shows crosses used when the H7-1 gene is on the male pollen producing parent. The genetic crosses used to produce hybrid H7-1 seed are identical in both cases with the exception of which parent carries the H7-1 gene.

The first cross shown in either case is used to produce more of the female parent. In the early stages of breeding when only small amounts of breeder seed are needed and the goal is to produce a highly inbred line, both the CMS line and the maintainer line are from the same cultivar (Cultivar A). When the goal is to produce commercial hybrid seed, larger quantities of the female parent are needed. Highly inbred lines do not have as much vigor and do not produce as much seed. For the cross used to produce the female parent for commercial seed production, the maintainer line is typically derived from a different Cultivar (B) than the CMS line, as shown in Fig. 3–4, so as to increase the vigor and seed production in the F1 hybrid used as the female parent. This female parent hybrid (Cultivar A x B), is then crossed to a third cultivar used as the pollen parent (Cultivar C).

It is not possible to only have the H7-1 trait on the female parent because an H7-1 pollen parent is needed to produce more of the H7-1 female parent line. In the crosses shown in Fig. 3–4A, where H7-1 is on the female parent, the first cross to generate the female parent (Cultivar A x B) requires an H7-1-pollen parent. If the O-type maintainer pollen producing lines did not carry the H7-1 trait, the CMS female sterile lines would only pass on the H7-1 trait to half of the offspring. A cross to produce the parent lines is typically planted on less than one acre. The second cross used to produce the commercial seed constitutes the bulk of hybrid seed production, may be planted on 50–60 acres, and utilizes a pollen parent that does not produce H7-1 pollen. In (B), just the opposite occurs: the significant hybrid seed production utilizes a pollen parent that produces H7-1 pollen.

In Willamette Valley in 2011, 85 percent of the H7-1 hybrid seeds were produced with the H7-1 gene on male sterile plants (APHIS proprietary data) and where the pollen parent lacks the H7-1 gene. In 2010, about 78 percent of the hybrid seed was produced using H7-1 on the male sterile lines. While the trend to use H7-1 on the male sterile lines is increasing, there are two reasons why pollen parents producing H7-1 pollen are still used. First, as described above, a small percentage of the seed production requires use of H7-1 pollen parents in order to produce the CMS line (female parent) containing the H7-1 gene. Second, because the female parent lines take twice as long to develop as the male parent lines, companies sometimes prefer to produce commercial seed from pollen parents having the H7-1 gene so they have the flexibility needed to respond quickly to develop new and improved hybrid varieties demanded by its customers as growing conditions change and disease pressures evolve and emerge (Meier, 2010). Except in very rare cases, no H7-1 pollen is produced by the H7-1 female parent. Fields are routinely inspected and these plants are destroyed by seed producers to remove inadvertent pollination that would otherwise occur (Lehner, 2010; Miller, 2010). As such, H7-1 pollen movement and potential for pollen gene flow is limited to just 15% of the sugar beet seed acreage in Oregon in 2011 (see section III.B.5 for further discussion on gene flow).

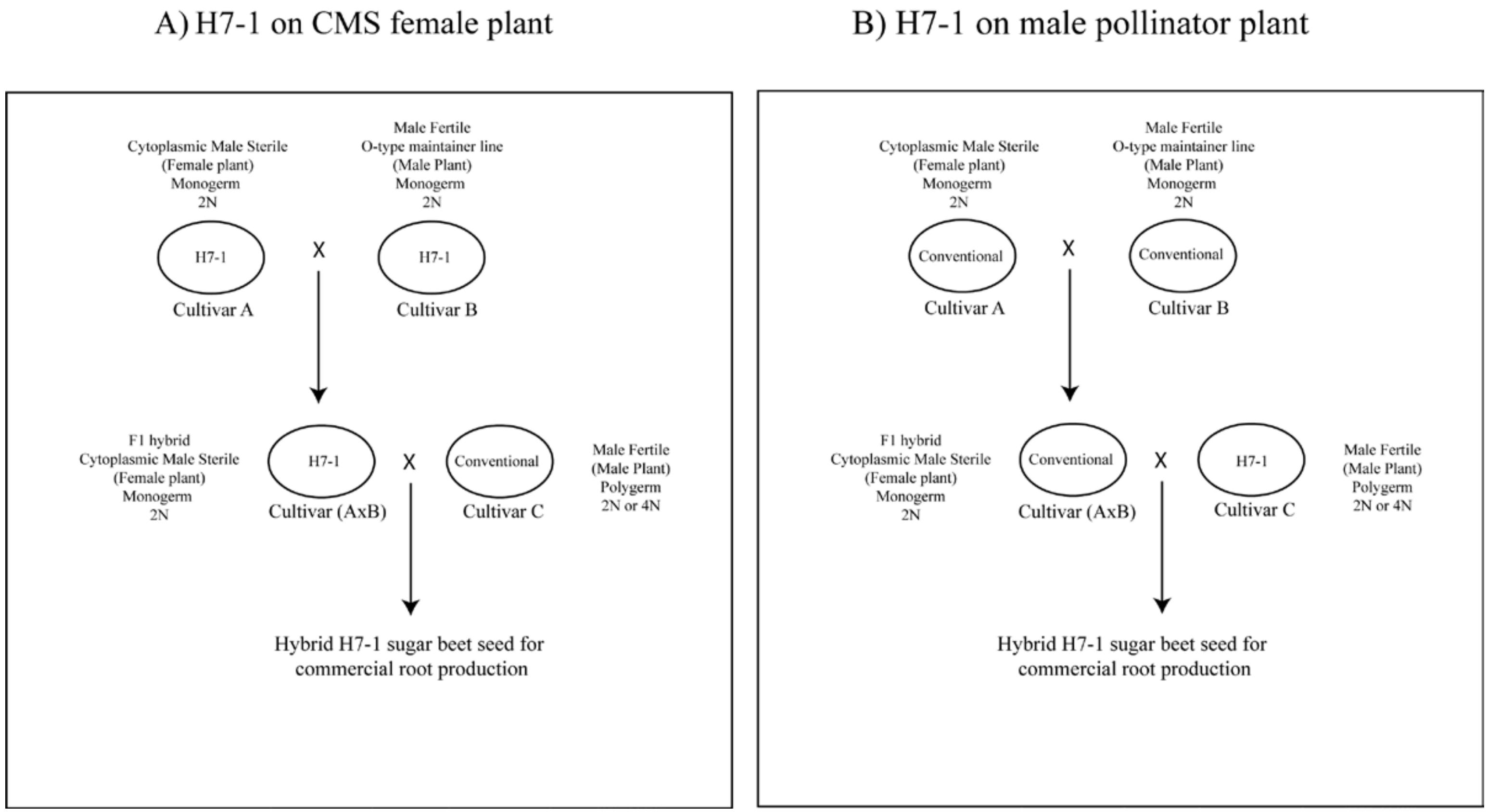

Figure 3-4. Sugar beet hybrid seed production using cytoplasmic male sterility (CMS)

(Source: Modified from (Bosemark, 2006))

(9) Hybrid Crosses in the Field

Hybrid crosses occur in fields that have been planted with specific ratios of genetically distinct male “pollen parents” and CMS female “seed parents.” Pollination typically takes place from late May through June (Chastain, 2010). The two types of parents are typically grown in blocks (Kockelmann and Meyer, 2006). For example, in the Willamette Valley, typical plantings include 4 rows of pollen parents for every 12–14 rows of seed parents (Kockelmann and Meyer, 2006; Meier, 2010). Spacing between and within rows varies, but 61 cm (24 inches) between rows and 5 cm (2 inches) between plants within rows is common for Oregon, although there is currently a trend towards 30 inches between rows (Kockelmann and Meyer, 2006; Chastain, 2010). Fertile plants are rogued from the female rows to minimize unwanted pollination. Seed mixture and volunteers are the main sources of rogued fertile plants in the female rows (USDA-APHIS, 2011b). Sugar beet seed crops are managed intensively throughout the growing season with special attention paid during the pollination period. For example, staff members of WCBS are in the field approximately three times a week during pollination (Loberg, 2011).

Fig. 3–5 illustrates hybrid sugar beet crosses for commercial production in the field. Part A of the figure shows a 1:4 ratio of pollen (male fertile) to seed (CMS) parents. Pollen parents are shaded in grey. Part B of the figure shows a field of seed parents after the pollen parents have been removed following pollination.

After the males have completed pollinating CMS seed parents and 2–3 weeks before harvest, the male pollinator rows are removed to ensure that only hybrid seed matured on the female plants is harvested (Kockelmann and Meyer, 2006) (see Fig. 3–5). The tall (3.9–5.9 feet) flower stalks on the seed parent plants and the male pollinator plants can become tangled given that rows are typically only 24 inches apart. Custom-built machines called separators are used to separate the plants to ensure that the seed parents are preserved during the removal of the pollen parents. Pollen parents are destroyed by flailing or tilling prior to harvest (Chastain, 2005).

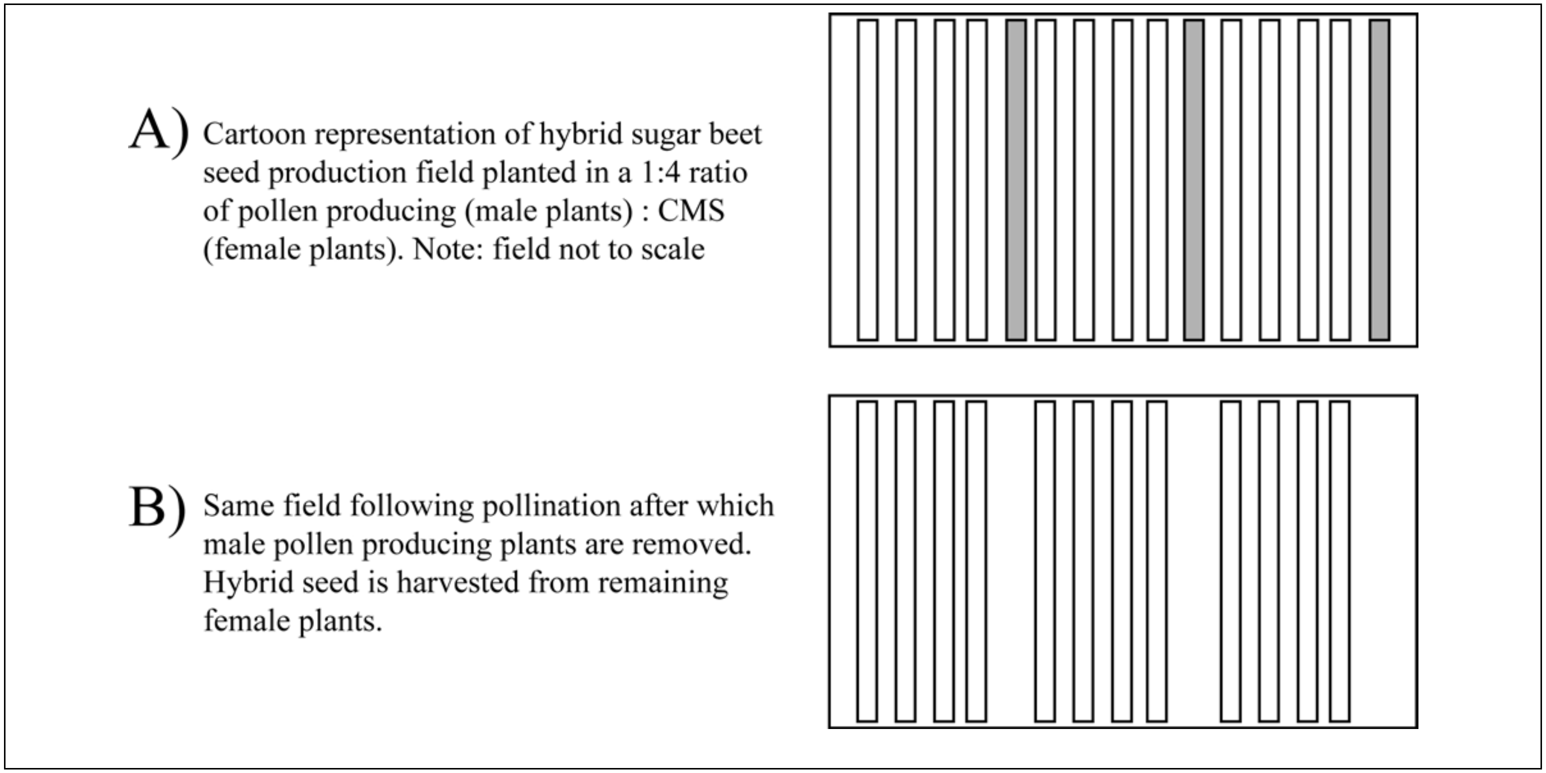

Figure 3-5. Illustration of hybrid sugar beet crosses for commercial production in the field

(Source: Modified from (Bosemark, 2006)

Seed is harvested from mid-July through August. Irrigation must cease 10 days prior to swathing (swathing is the process of cutting the stalks) (Chastain, 2005). Then the seed is cut with a swather and left in the field to dry after which it is harvested by a combine that separates the seed from most of the stalk (Holly Hybrids, 2007b). Yields for sugar beet seed crops range from 2,000–3,000 pounds per acre (Chastain, 2005).

Post-harvest management practices of sugar beet seed crops are focused on controlling and destroying any remaining seeds in the soil. After harvest, post-harvest residue remaining in the field is irrigated to germinate volunteers, which are then destroyed by tillage and/or herbicides (Chastain, 2005).

(10) Isolation Distances

As described above, production of high-quality hybrid seed requires that the "correct" genetic cross take place; the pre-determined pollen donor must fertilize the pre-determined seed parent for the desired pre-determined cross to occur. The main way in which seed producers ensure that the desired pollen fertilizes the desired seed donor is to use isolation distances. As described in detail below (see section III.B.5 on gene flow), pollination rate, or gene flow, decreases rapidly as distance from the pollen source increases (Eastham et al., 2002; Darmency et al., 2009). In general, the farther a pollen source is from a seed production field, the less likely it is to cross pollinate plants in the seed production field. Therefore, seed producers follow strict isolation distances when producing sugar beet seed as described below.

As an example of isolation distances used to increase seed purity for sugar beet, the Oregon Seed Certification Service (OSCS) has established standards for certified seed and corresponding isolation distances. Note that most sugar beet seed is not certified (Chastain, 2010) (Miller, 2011). OSCS has set the following standards for those items for certified sugar beet seed (OSCS (Oregon Seed Certification Service), 1993):

- Pure seed, minimum: 99.00 percent;
- Other crops, maximum: 0.10 percent;
- Inert matter, maximum: 1.00 percent; and
- Weed seed, maximum: 0.10 percent.

Minimum isolation distances required for certified seed are as follows:
- From sugar beet pollen of similar ploidy or between fields where male sterility is not used – 2,600 feet (0.49 mile); and
- From other pollinator or genus *Beta* that is not a sugar beet – 8,000 feet (1.5 miles).

The maximum specified OSCS required isolation distance, for “stock” seed that has a maximum allowable concentration of “other crop” seed of 0.00 percent, is 10,200 feet (1.9 miles) from other, non-sugar beet *Beta* species (OSCS (Oregon Seed Certification Service), 1993).

The following information on seed production practices and isolation distances are specific to the Willamette Valley, where 50 percent of the total U.S. H7-1 seed production takes place. Isolation distances and/or pinning maps are used to coordinate the production of *Beta* seed crops in the Willamette Valley, Yuma, Arizona, Parma, Idaho, and Western Washington (McReynolds, 2011). However, Willamette Valley is the only region in which sugar beet seed (H7-1 and non-H7-1), Swiss chard seed, and table beet seed are known to be grown within the same counties (see Fig. 3–12 in section III.B.5).

All growers of commercial specialty seed in the Willamette Valley, including all commercial companies producing sugar beet or vegetable beet seed, are members of the WVSSA. WVSSA has strict (although not mandatory) isolation distances and pinning guidelines for growers to follow (pinning is the process growers use to coordinate their plantings — growers put a pin on a map to show the specific location of where they intend to grow a crop that is sexually compatible with a nearby crop) (see Table 3–3). WVSSA’s guidelines for isolation of *Beta* species are summarized in Table 3–3.

The pinning maps enable growers to see where sexually compatible crops are being grown so that they may take steps to ensure that the seed isolation distances are met. Pinning rules are required to be followed by all members of the WVSSA. These rules help growers maintain seed purity standards. There are specific rules on when pinning can occur, which seed producers have priority in pinning, and methods for arbitration if agreement between producers cannot be reached (WVSSA, 2007).

Female basic seed production is different from commercial seed production. It occurs on a much smaller scale and is typically done in more remote locations, with isolation distances in excess of 10 miles (Hovland, 2010). The WVSSA does not specify increased isolation distances for basic seed production.

Table III-3. WSVVA Specialty Seed Production Isolation Guidelines

1 mile	2 miles	3 miles	4 miles
Between one O.P.[1] and another of the same color and group	Between hybrid and O.P. of the same color and group	Between different colors within a group	Between hybrid and O.P. of different groups
Between hybrids[2] of the same color and group	Between stock-seed and a hybrid within a group	Between stock-seed and O.P. within a group	–
–	–	Between GMOs[3] and any other *Beta species*[4]	–

Source: (WVSSA, 2008).

[1] Open Pollination (O.P.) a population of plants that intermate randomly without human intervention to produce seed; typically done for table beet, fodder beet and Swiss chard but not for sugar beet.

[2] Hybrid plants are a cross between two or more genetically distinct plants.

[3] Genetically Modified Organisms (any plant developed through the use of genetic engineering- including H7-1 sugar beet).

[4] Must be no closer than 3 miles and is excluded from exception to lessen this distance.

(11) H7-1 Sugar Beet Seed Guidelines

Since the approval of H7-1 sugar beet in 2005, the two commercial beet seed production entities, Betaseed and WCBS, have developed strict guidelines for H7-1 seed production to further maximize seed purity and minimize low level presence (LLP). These guidelines include all steps from basic crosses to produce hybrid seed through seed processing. Guidelines from each company are presented below.

Seed Production by West Coast Beet Seed. WCBS produces the commercial sugar beet seed for the U.S. beet seed providers, Syngenta, SES Vanderhave, Holly Hybrids, and American Crystal in Willamette Valley, Oregon.

Key features of their seed tracking system include the following (Loberg, 2010a):

- Fields and planting locations are controlled with a tracking and tracing system. The system distinguishes seed lots of basic seed from the moment of initial delivery to WCBS through subsequent planting and harvest.
- Management continues until the delivery of pre-cleaned seed to member companies.
- Some member companies further incorporate various computerized and digital tracking systems designed to manage real-time seed batch movement and quality testing.

- Many of these companies have sealed packaging and specified color coding designations to further identify seed batches/lots (Meier, 2010).

Key features of WCBS's production practices include the following:

- WCBS contracts to individual growers for seed production. As stated above, all commercial seed growers in the Willamette Valley, including WCBS, are members of the WVSSA.
- WCBS prohibits production of a vegetable beet seed crop by any WCBS grower in a year in which that grower is producing sugar beet seed, whether GE (which would currently only include H7-1 derived varieties) or conventional.
- WCBS prohibits the sharing of planting, cultivation, and harvesting equipment for vegetable beet seed, whether they are producing GE or conventional sugar beet seed.
- Since 2006, WCBS has followed a comprehensive stewardship and best management practices (BMP) Protocol for Genetically Modified (GM) Seed Production.
- WCBS requires its growers, by contract, to adhere to minimum isolation distance within a 3-mile radius of any GE field.
- WCBS maintains control of all material, whether GE or conventional, from point of origin to return of the seed to the member seed company.
- WCBS controls the disposal of any excess GE stecklings that are not used for seed production, including those that are removed from, or remain in, the nursery field.
- The prevailing method of disposing of stecklings is destruction through standard agricultural practices (physical destruction with tillage and chemical destruction in the subsequent crop) (Loberg, 2010a).

Key features of WCBS's seed processing procedures include the following:

- WCBS pre-cleans the seed prior to shipment to the seed provider. The pre-cleaning takes place in a dedicated WCBS facility. This process removes sticks, chaff, weeds, and the like that might be contained in the seed when initially harvested.
- WCBS does not handle vegetable beet seed. Its seed pre-cleaning operations present no opportunity for mechanical mixing of sugar beet seed, whether conventional or GE, with table beet or Swiss chard seed.
- When WCBS produces both GE and conventional sugar beet seed, physical separation requirements and cleaning protocols protect against inadvertent mixing.
- After pre-cleaning, WCBS ships each seed lot to the member companies in sealed containers with color-coded labeling and shipping documents.

Key features of WCBS's volunteer removal practice include the following:

- The WCBS BMP has requirements for monitoring, within a 3-mile radius of any H7-1 field, and removal of any volunteer seedlings for a minimum of 5 years or until no volunteers are observed, whichever is later.
- WCBS contracts also require seed growers to diligently control volunteer plants after H7-1 sugar beet seeds are harvested by tilling and monitoring fields (Loberg, 2010a).

Seed Production by Betaseed. Betaseed produces commercial sugar beet seed in Willamette Valley, Oregon.

Key features of their seed tracking system include the following (Lehner, 2010):

- Betaseed has adopted Standards of Practice (SOPs) that require all materials to be adequately identified and tracked through a computerized, bar-coded system. This system is in place from basic seed production to commercial seed production to final processing and shipping.
- All Betaseed personnel involved in seed production are trained in the SOPs and required to sign an acknowledgement that they have read, understood, and will comply with the SOPs.
- According to the SOPs, Betaseed personnel are present for the beginning of every harvest by a commercial grower. Betaseed provides barcoded tote boxes into which the harvested seed is placed for transport to Betaseed's processing facility (Lehner, 2010).

Key features of Betaseed's production practices include the following:

- Betaseed contracts commercial seed production to individual growers.
- Betaseed requires its growers, by contract, to use the WVSSA's pinning information and isolation procedures.
- Betaseed is a member of WVSSA and pins all of its commercial seed fields in compliance with the WVSSA's rules to ensure that isolation distance guidelines are followed.
- Betaseed requires its growers, by contract, to adhere to isolation distances of 4 miles from other crops that could cross-pollinate with sugar beet.
- Betaseed supervises its commercial seed growers' practices for conformance with Betaseed's stewardship requirements. Betaseed's grower contracts provide for such supervision, as well as Betaseed's right to enter the grower's fields and take remedial action if the grower does not comply with Betaseed's instructions.

- Starting in 2010, for all commercial seed production, sugar beet plants carrying the glyphosate-tolerance gene were on the CMS male sterile seed-producing parent (Lehner, 2010). This reduces the possibility of gene flow of H7-1 pollen to close to zero, as approximately 1 CMS plant per 16,000 plants produces pollen (Lehner, 2010).

Key features of Betaseed's seed processing procedures include the following:

- Betaseed requires growers to clean their equipment before and after harvesting a sugar beet variety, and to monitor for and eliminate volunteer sugar beet.

Key features of Betaseed's volunteer removal practice include the following:

- Betaseed has a regime in place for controlling volunteers.
- Betaseed informs farmers about when and where volunteers could appear and instructs farmers to remove them.
- Betaseed knows the locations of all fields where its plants are grown, and inspects those fields for volunteers each year.
- When personnel find a small amount of volunteers, they destroy them.
- If Betaseed finds a larger quantity of volunteers, it alerts the grower and instructs him or her to destroy them (Lehner, 2010).

In addition to practices designed to minimize seed admixture and loss of purity in seed lots, BMP have also been implemented to prevent the unintentional mixing or release of stecklings. In May 2009, an incident was reported involving H7-1 steckling disposal. In or around May 2009, peat moss acquired by the Pro Bark garden store in Corvallis, Oregon from the seed producer Betaseed was reported to contain some stecklings and steckling materials. Following repossession of the peat moss, Betaseed reported that the stecklings found in the mixture were not likely to survive and produce pollen. Because of this incident, Betaseed subsequently revised its SOPs to provide for proper disposal of the peat moss in which it transports stecklings (Lehner, 2010). Now stecklings that are removed from the nursery, but are not used, are destroyed or securely disposed. The prevailing method is returning unused stecklings to the nursery field of origin and subsequent destruction through standard agricultural practices (physical destruction with tillage and chemical destruction in the subsequent crop) (Loberg, 2010a).

During the Public Meeting in Corvallis, OR, a couple that produces organic seeds noted that sugar beet volunteers were growing on land they leased in 2009 (USDA, 2011a) [pp. 66-69 of transcript]. They expressed concern that if the sugar beet were GE, such volunteers would be a problem for their organic farm and that H7-1 sugar beet are supposed to be monitored for volunteers but no monitoring was occurring. In a followup conversation with the commenter, APHIS learned that all sugar beet plant samples from the farm have tested negative for the H7-1 trait. In a followup conversation with Betaseeds, APHIS learned that the previous owner was under contract with Betaseeds to grow conventional sugar beet seeds in 2007-2008 and 2008-2009. To our knowledge H7-1 sugar beet was not grown on the property.

Land Preparation. A 4- to 8-year rotation with non-*Beta* crops is required to avoid contamination from volunteer plants that might grow from fallen seeds from previous crops (Desai, 2004; American Crystal Sugar Company, 2010). Different seed producing companies may have different requirements for the number of years between rotations. For more on crop rotations see section III.B.1.b(16) below. Land is prepared by plowing, two or three harrowings (to break up clumps of soil and to provide a finer finish to the soil), and leveling to bring it to the desired tilth (soil structure suitable for seeding) (Desai, 2004). Seed beds are frequently irrigated prior to planting (Chastain, 2010).

Once the soil is prepared, hybrid sugar beet seed crosses from breeder seed are initiated by one of two methods: the direct-seeded method and the steckling (transplant) method. Most sugar beet seed production in the United States uses the steckling method. Although both methods rely on the same breeding practices to produce hybrid seed, there are differences in when and how the parental lines are planted. Regardless of which method is used, seed producers in Willamette Valley, Oregon plan which seed crops they will plant in which fields before August of the year in which the seeds will be planted to meet the August 1 WVSSA field pinning deadline for field isolation priority (Loberg, 2010a).

(12) Direct-Seeded Method

When the direct-seeded method is used, seeds for the male and female parents are planted in blocks in the same field (usually in August/September). As the weather becomes colder, the plants become dormant and are vernalized in the ground. Plants begin to bolt to form a flowering stalk in April, produce pollen in late May through June, and seeds in July and August (Kockelmann and Meyer, 2006; Chastain, 2010). Most cultivars of sugar beet require 90−110 days of exposure to vernalizing temperatures to initiate reproductive development or the flowering process. The direct seeded method saves labor costs from transplanting individual plants but uses more seed. It is primarily used when the basic seed supply is ample.

(13) Steckling Method

Stecklings are young beet plants that have a small tap root. When the steckling (transplant) method is used, the vegetative phase of the seed production cycle is considered as a separate crop in specialized steckling nurseries. Seeds for CMS male sterile and pollinator stecklings (described in more detail above) are planted in August/September and grown in separate plots, where each can be treated according to its individual requirements. Stecklings are harvested between January and March when roots are large enough to withstand the stress of replanting. During its growth, the steckling may have received some vernalization in the field. If needed, vernalization may be supplemented by additional cold treatment, which is accomplished by storing the stecklings in cold storage. Transplants are replanted in seed fields before late March to allow transplants to have an adequate root system so that seed production is robust (Kockelmann and Meyer, 2006; Lehner, 2010; Loberg, 2010a) (Chastain, 2010).

Although more expensive, the steckling method of seed production provides an additional opportunity for seed companies to flexibly manage product inventory and allows for increased production when stock seed is limited. Historically, the vast majority of U.S. sugar beet seed was produced by the direct seeded method; however, an almost complete shift to the steckling method has occurred during the past decade.

(14) Fertilization

Fertilizer application is done according to soil analysis, taking into account the preceding crop and regional experiences in production (Kockelmann and Meyer, 2006). Beet seed crops require 125–150 percent of the fertilizer nutrients that root crops require (Desai, 2004). Generally, two applications of fertilizer are made during production of sugar beet seed crops. The first application is made prior to planting (mid-August to mid-September) and is incorporated into the seed bed (Chastain, 2010). This application consists of a balanced fertilizer containing nitrogen, phosphorus, potassium, sulfur, and sometimes boron. The second application is made during the spring, and is often split between early spring (late February) and late spring. The early spring application contains nitrogen, sulfur, and boron, whereas the late application only contains nitrogen. The availability of nutrients during seed development can affect seed quality and nitrogen availability can affect seed germination (Chastain, 2010). Lime is applied when pH declines below 6 (Chastain, 2005).

(15) Crop Rotation

Sugar beet crops grown for seed are usually grown on a 5- to 8-year rotation with other crops (American Crystal Sugar Company, 2010). Rotation crops for seed and steckling production are highly variable but suitable crops include cereals such as wheat, vegetable crops, and grasses (USDA-APHIS, 2011b); (Kockelmann and Meyer, 2006). WCBS requires a minimum of five crops between sugar beet seed crop rotations, and does not allow sugar beet seed producers to grow other *Beta* crops (Loberg, 2010b). Selection of crops preceding seed production must consider the following: (1) time of harvesting to allow for sufficient time for field preparation, (2) whether the crop might result in an increase in sugar beet pathogens, and (3) whether the crop might result in detrimental or prohibited herbicide residues (Kockelmann and Meyer, 2006).

(16) Disease Management

Similar to sugar beet root crops, sugar beet seed crops are often infested with a variety of diseases and pests. Seed fields must be protected systematically against pests and diseases to ensure healthy crops that produce hybrid monogerm seed of the high-quality demanded by root-crop growers (Kockelmann and Meyer, 2006). (See Table 3–4 below for the typical pests or diseases that attack sugar beet seed plants and the timing and possible treatment methods.) Seeds are coated with fungicides and insecticides to minimize diseases and early infestations with aphids (Kockelmann and Meyer, 2006). One way to reduce infestations, especially aphid-transmitted viruses, is to ensure that steckling and seed production plots are isolated from other nearby *Beta* species (Kockelmann and Meyer, 2006). Control of diseases carried by aphids and other pests depends on effective control of insect pests acting as vectors. Diseased plants should be removed and destroyed (Desai, 2004).

(17) Post-harvest Processing

After harvest, the seed is pre-cleaned, a process in which seed is run across round-hole screens to remove sticks and other undesirable material (American Crystal Sugar Company, 2011). Pre-cleaned seed is generally shipped from the Willamette Valley to processing facilities elsewhere, depending on the seed company. As stated above in the seed production methods section for Betaseed and WCBS, both companies have strict protocols to track the seed from the field to the final delivery at the processing facility in order to minimize the possibility of accidental mixing with other seeds (Lehner, 2010; Loberg, 2010). These procedures include grower training, careful monitoring of seed production, prohibiting seed growers from growing other *Beta* species, cleaning equipment before and after harvesting a sugar beet variety, and monitoring for and eliminating volunteer sugar beet after harvest (Lehner, 2010; Loberg, 2010).

Table III-4. Plant Protection Measures in Sugar Beet Seed Crops

Pests or Diseases (Scientific Name)	Pests or Diseases (Common Name)	Time of Attack	Possible Treatment
Conorhynchus sp.	Sugar beet	Bolting to beginning of	Synthetic pyrethroids

Lixus sp. *Cassida* sp.	weevil Cabbage weevil Beet tortoise beetle	flowering (end of April to end of May)	
Aphis fabae *Myzus persicae*	Bean aphid Green peach aphid	Bolting to maturation (May to July)	Carbamates, synthetic pyrethroides
Peronospora farinose	Downy mildew	Vegetative development to beginning of bolting (April to beginning of May)	Acylalanine types
Alternaria sp. *Ramalaria beticola* *Phoma betae* *Uromyces betae*	Leaf spot disease Ramularia leaf spot Phoma leaf spot Sugar beet rust	Bolting (end of April to mid-May)	Triazoles, strobilurines, copper fungicides, thiocarbamates, dicarboximides
Cercospora beticola	Cercospora leaf spot	Beginning of flowering to end of flowering (end of May to June)	Triazoles, strobilurines
Erysiphe betae	Beet powdery mildew	Maturation (June to July)	Morpholines, strobilurines, sulfur

Source: (Kockelmann and Meyer, 2006).

Once the seeds reach the individual processing facilities, they are further processed. Steps include:

Cleaning and Polishing. Seeds are further cleaned to remove any remaining debris. Polishing machines remove the pericarp (the corky part of the fruit) to remove the natural chemical inhibitors that interfere with germination (Kockelmann and Meyer, 2006; Holly Hybrids, 2007c; Betaseed, 2011).

Sizing. Seeds are then sorted by size and separated into different size products (small, medium, large, and extra large). Seed sizing separates out seed by thickness and diameter, while gravity tables separate by weight (Holly Hybrids, 2007b; Betaseed, 2011).

Coating and Coloring. Seed is coated with a colored film enhanced with emergence enhancing fungicides that allow for easier visibility when planting. Coated seed is the irregular shaped seed evenly covered with a colorful film. Pelleted seed is the result of a specialized seed treatment process that creates a sphere out of the irregular shaped seed. Similar to coated seeds, pelleted seeds are also coated with fungicides and/or insecticides that might otherwise be phytotoxic to the seed (Holly Hybrids, 2007c). More germination tests are conducted after coatings are applied (Holly Hybrids, 2007b; Betaseed, 2011).

Packaging. Seed is packaged and shipped to distribution warehouses (Holly Hybrids, 2007a; Betaseed, 2011).

The post-harvest processing procedure takes from mid-September to the end of March. This process is time consuming because of the volume of seed and the degree of processing required prior to sale. Seed is sold concurrently with processing, with 90–95 percent of sales completed by the end of December or early January. The selling period for the remainder of the seed used for late planting and replants continues through early June. Seed shipments to the sugar cooperatives begin in January and can continue through June in some areas. Planting of the sugar beet root crop begins in March and continues through May, except for in the Imperial Valley where it is planted in September and October as described below (Meier, 2010).

(18) Testing for Low Level Presence

Sugar beet seed producers have a strong economic incentive to maintain genetically pure seed in both their breeder and commercial seed. While sugar beet seed is not typically certified (Chastain, 2010); (Miller, 2011), sugar beet seed companies utilize internal purity thresholds. Maintaining high levels of seed purity is important because impure seed lots will not produce plants with the desired yield, sucrose concentration, disease resistance, resistance to bolting, and other important agronomic traits as demanded by growers and grower cooperatives. As a result, impure seed lots will likely lead to grower dissatisfaction and ultimately loss of business to the seed producer.

As described previously, sugar beet root growers can only use seeds that have been approved by their grower cooperative variety trials. (See section III.B.1.b(3) for more information on variety trials.) Variety trials provide an opportunity to evaluate whether varieties have superior agronomic characteristics. They also provide an opportunity to evaluate whether individual seed lots contain visible offtypes and are unsuitable for sale because they do not meet the customer's needs for varietal purity.

As a result of customer demand for high levels of genetic purity, seed genotype is tested using a wide range of molecular markers at several stages during production. It is standard protocol to test for any low level presence (LLP) of all potential sources of undesired seeds or traits (Anfinrud, 2010). Depending on the specific tests done, this type of testing can detect whether varieties are the intended mix of genetic traits and can also detect if the H7-1 trait is present in conventional lines (Anfinrud, 2010). LLP of undesired seeds or traits is the result of unintended pollen movement between flowering fields of compatible *Beta* species and/or through admixtures of seeds (accidental mixing of seeds) if equipment is shared or if seeds are not properly isolated from each other during the post harvesting process. Seed producers are aware of these potential avenues for seed impurities and have preventative protocols in place to keep LLP to a minimum (Lehner, 2010; Loberg, 2010a). (For more information on sugar beet seed production and gene flow, see sections III.B.1.b and III.B.5, respectively.).

The main way to detect LLP is by testing the seeds at multiple points during the breeding and seed production process (Anfinrud, 2010). For example, breeder seed (the seed that is produced through plant breeding with the goal of developing lines to use to make hybrid seeds) is tested prior to distribution to seed producers (who will use the lines to make commercial hybrid seed) and it is tested again when the seed is planted for hybrid seed production. Additionally, hybrid seed is tested following harvest from commercial seed fields prior to storage and sale to sugar beet root growers (Anfinrud, 2010). Finally, genetic purity is assessed by growouts and visible inspection in variety trials as described above.

The testing described above is done either through molecular means by testing for DNA and proteins, or through grow-outs. Grow-outs (planting of a representative sample of seeds, followed by visual screening) are used to evaluate the amount of LLP in different seed crops. Morphological traits can be visually identified to detect the presence of table beet or Swiss chard LLP, help identify the potential source(s) of LLP, and determine the percent of LLP in the seed lot.

In terms of the H7-1 trait, LLP is assessed by using protein strip tests or polymerase chain reaction (PCR) tests designed to detect the specific protein or DNA sequence of the H7-1 trait (Anfinrud, 2010). Additionally, since the H7-1 trait confers glyphosate tolerance, LLP of H7-1 sugar beet seeds in non-H7-1 sugar beet seeds can be examined by conducting spray tests. In spray tests, a representative sample of non-H7-1 sugar beet seeds are planted, germinated, grown, and then sprayed with glyphosate. The percentage of plants that survive the glyphosate reveal the percent of H7-1 sugar beet seeds in the seed lot as non-H7-1 sugar beet seeds will not survive the glyphosate application.

Seed companies test for all potential sources of LLP including the presence of regulated traits (GE traits that have not been deregulated but are being grown in test plots) and all currently deregulated traits (Anfinrud, 2010). The tolerance limits for regulated traits are zero percent. As described previously, the main U.S. sugar beet seed export market—Canada—has approved H7-1 sugar beet seed for planting.

For deregulated traits in conventional sugar beet, LLP tolerances are below 1 percent but companies prefer to keep levels below 0.1 percent to assure customers of seed with greater than 99 percent purity (Anfinrud, 2010). If seed lots exceed tolerance limits, they are not sold.

c. Root Crop

(1) Sugar Beet Root Production

The 10 primary sugar beet root production states, in order from most to least acres planted, are: Minnesota and North Dakota (57 percent of U.S. production), Idaho, Michigan, Nebraska, Montana, Colorado, Wyoming, California, and Oregon (USDA-ERS, 2010b). States with minor production (less than 1 percent of U.S. production) include Washington (about one tenth of 1 percent) and South Dakota (about one one-hundredth of 1 percent) (Stankiewicz Gabel, 2010) These states can be grouped into five regions as shown in Fig. 3–6 below. These regions include: Great Lakes – Michigan and Ontario; Midwest– Minnesota and Eastern North Dakota; Great Plains – Montana, Wyoming, Colorado, Nebraska, and western North Dakota; Northwest – Idaho, Oregon, and Washington; and Imperial Valley – California. These regions are described in greater detail below.

Great Lakes. Great Lakes sugar beet production, now entirely in Michigan in the United States, occurs in the flat area around Saginaw Bay. The Great Lakes region also includes Ohio, where sugar beet was last produced in 2004. Michigan sugar beet are generally not irrigated and the varieties must have a high level of resistance to *Cercospora* leaf spot. Sugar beet are also grown in Ontario, Canada, and then trucked to Michigan for processing.

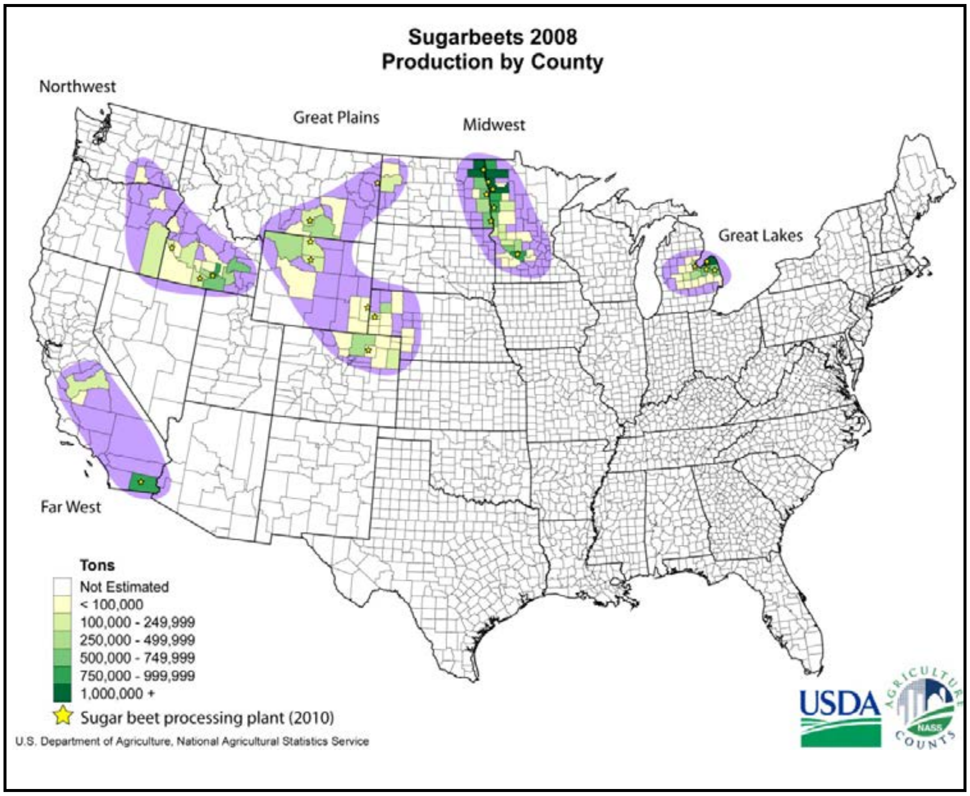

Figure 3-6. Sugar beet production areas in 2008 and processing facilities, 2010

Note: As shown in Table 3–5, sugar beet production in California has decreased from 40,000 acres in 2008 to 25,000 acres in 2010–2011. The only area in California in which sugar beet are currently produced is the Imperial Valley in Southern California. Source: (USDA-NASS, 2011).

Midwest. The Midwest is the largest sugar beet production region in the United States, with the majority of this production in the Red River Valley. The Red River, flowing north into Canada and forming most of the North Dakota/Minnesota border, is all that remains of glacial Lake Agassiz, which dried up 10,000 years ago, leaving a broad, flat valley with highly fertile soils. The Minnesota River Valley, another broad, flat glacial valley that crosses southern Minnesota to the south of the Red River Valley, is also a large production area. Irrigation is uncommon in the Red River/Minnesota River Valleys (Ali, 2004). A moderate level of resistance to *Cercospora* leaf spot is required to achieve variety approval in the Red River Valley, while Southern Minnesota requires a high level of resistance. *Rhizomania* can also be a problem in the Midwest, but rarely as severe as in the irrigated regions to the west.

Great Plains. The Great Plains production region includes areas in northern Wyoming and southern Montana as well as western North Dakota. The major sugar beet growing areas in the Northern Great Plains are the sandy loam soils along the Yellowstone River and its tributaries

(Mikkelson and Petrof, 1999). There is another, much smaller Great Plains production area along the border between Montana and North Dakota, in the valley of the Yellowstone River and its tributaries. The Southern Great Plains production sub-region includes growing areas in western Nebraska, southeastern Wyoming, and northeastern Colorado, primarily in the valley of the Platte River and its tributaries. All Great Plains sugar beet production requires irrigation (Mikkelson and Petrof, 1999; Thomas et al., 2000); (McDonald et al., 2003). The Great Plains region previously included New Mexico and Texas, where sugar beet was last harvested in 1997. Variety approval in the Great Plains region requires a moderate level of resistance to BCTV. Resistance to *Rhizomania* is also essential.

Northwest. Most production in the Northwest region is in the sandy loam soil of the Snake River Valley in Idaho. This area also requires irrigation (Traveller and Gallian, 2000). In addition, production occurs in south central Washington, east of the Cascade Mountains. Variety approval in the Northwest region requires a high level of resistance to BCTV. Resistance to *Rhizomania* is also essential.

Imperial Valley. The only remaining sugar beet root production in California is in the Imperial Valley at the far southern end of the State, where the only operating sugar processing plant in California is located. Production occurred in the Central Valley (near the middle of the State) through 2008; however, the last processing plant in this area closed that same year. As recently as the 1990s, nearly 30 percent of sugar beet root production was in the Central Valley; there were also small areas of production in coastal counties in the past (Kaffka, 1998). This area requires irrigation (Hembree, 2010).

See Table 3–5 below for the number of acres planted by State and region for production years 2000–2010.

As sugar beet roots are primarily grown for the purpose of processing them into sugar, transportation costs of this bulky crop limit profitable production to about 100 miles from one of the 22 U.S. beet sugar processing facilities (Western Sugar Cooperative, 2006). As stated previously, Fig. 3–6 above is a map of U.S. sugar beet production, by county, from the U. S. Department of Agriculture (USDA) 2007 census data (most recent year available). Stars on the map indicate the location of sugar processing plants. For the 2009–2010 production year, approximately 1.18 million acres of sugar beet were planted (USDA-NASS, 2010e). Data from selected years in Table 3–5 are presented graphically by State in Fig. 3–7. This figure presents the acres of beet planted in each State at five-year intervals and demonstrates that from 2000 to 2010 the relative sugar beet acreage between states is fairly consistent. The acreage from eastern and western North Dakota has been added to arrive at a total for the State.

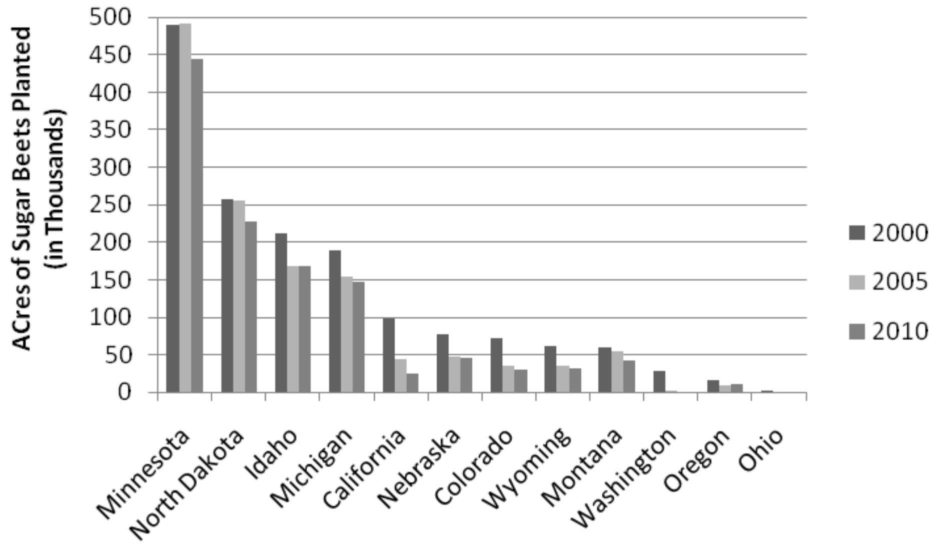

Figure 3-7. Acres of sugar beet planted by State in 2000, 2005, and 2010 (Source: (USDA-NASS, 2011c))

Data from selected years in Table 3–5 are presented graphically by State

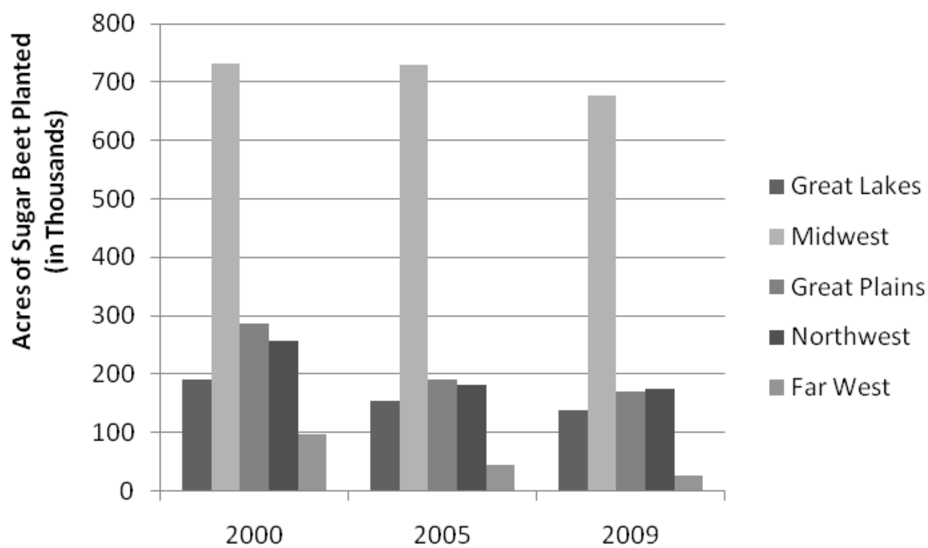

Figure 3-8. Acres of sugar beet planted by region in 2000, 2005, and 2009 (Source: (USDA-NASS, 2011c))

Data from selected years in Table 3–5 are presented graphically by region in Fig. 3–8. Fig. 3–8 shows that from 2000–2009, the Midwest region has consistently grown the largest acreage of sugar beet and the Imperial Valley has grown the smallest acreage

Table III-5. U.S. Sugar Beet Crop Area Planted by State and Region

State and Region	Year[1]										
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
	Area planted in 1,000 acres										
Great Lakes:											
Michigan	189.0	180.0	179.0	179.0	165.0	154.0	155.0	150.0	137.0	138.0	147.0
Ohio	1.2	0.8	1.9	2.0	1.9	0.0	0.0	0.0	0.0	0.0	0.0
Total	190.2	180.8	180.9	181.0	166.9	154.0	155.0	150.0	137.0	138.0	147.0
Midwest:											
Eastern North Dakota	242.4	245.7	249.1	243.3	240.7	239.3	245.7	237.4	199.7	213.2	172.6
Minnesota	490.0	468.0	505.0	492.0	486.0	491.0	504.0	486.0	440.0	464.0	449.0
Total	732.4	713.7	754.1	735.3	726.7	730.3	749.7	723.4	639.7	677.2	621.6
Great Plains:											
Colorado	71.5	41.5	43.9	28.6	36.0	36.4	42.1	32.0	33.8	35.1	28.9
Montana	60.7	57.4	58.0	51.7	53.7	53.9	53.6	47.5	31.7	38.4	42.6
Nebraska	78.2	48.6	57.0	45.3	49.8	48.4	61.3	47.5	45.2	53.0	50.0
Western North Dakota	15.6	15.3	15.9	15.7	15.3	15.7	15.3	14.6	8.3	11.8	44.4
Wyoming	61.0	48.5	40.0	35.0	36.4	36.2	42.8	30.8	29.7	32.4	30.5
Total	287.0	211.3	214.8	176.3	191.2	190.6	215.1	172.4	148.7	170.7	196.4
Northwest:											
Idaho	212.0	199.0	212.0	208.0	195.0	169.0	188.0	169.0	131.0	164.0	171.0
Oregon	16.2	11.9	11.3	10.0	12.9	9.8	13.1	12.0	6.7	10.6	10.3
Washington	28.4	7.2	4.0	4.0	3.8	1.7	2.0	2.0	1.6	0	0
Total	256.6	218.1	227.3	222.0	211.7	180.5	203.1	183.0	139.3	174.6	181.3
Imperial Valley:											
California	98.0	46.6	50.2	50.8	49.1	44.4	43.3	40.0	26.0	25.3	25.0
Total	98.0	46.6	50.2	50.8	49.1	44.4	43.3	40.0	26.0	25.3	25.0
U.S. Total	**1,564.2**	**1,370.5**	**1,427.3**	**1,365.4**	**1,345.6**	**1,299.8**	**1,366.2**	**1,268.8**	**1,090.7**	**1,185.8**	**1,171.4**

Source: (USDA-NASS, 2011c). (Note: the data reported in this table are survey data.)
[1] **Relates to year of intended harvest except for overwintered spring-planted beet in California.**
Abbreviations: N/A = Not available

At the county level, 2010 data from the USDA Farm Service Agency (FSA) indicate that in the states that grow vegetable beet and sugar beet root crops (Minnesota, Michigan, Colorado, Oregon, Montana, California, North Dakota, Nebraska, Washington, and Idaho) fields of vegetable beet and sugar beet root crops can be found in adjacent fields. Where crops were adjacent, in no cases was one or more of the crops grown for seed. The distances between crops change each year as these crops are rotated. It should be noted that FSA data do not include hobby farmers or home gardeners. Additionally, pursuant to section 1619 of the Food, Conservation, and Energy Act of 2008, the data collected by FSA are generally protected from disclosure, unless the information is transformed into a statistical or aggregate form without naming any individual owners or specific data gathering site (Stankiewicz Gabel, 2010). For more information on Swiss chard and table beet vegetable production, see sections III.B.2 and III.B.3, respectively.

(2) Planting/Harvesting Cycle/Bolting

Planting. Sugar beet growers choose seeds for planting based on a variety of criteria. Different growing regions have different needs and preferences in terms of disease resistance, pest resistance, and agronomic characteristics (Miller, 2010). See above for a description of some of the differences between the five growing areas. Additionally, as described earlier, growers may only grow approved varieties as determined by the local sugar beet cooperative, and growers can only deliver a specific quantity of sugar beet to a processor based on a pre-determined contract. Therefore, growers select approved seed varieties that they believe will provide the highest yield in their given location.

In addition to choice of variety, growers purchase seed by size and by shape. Size choices include small, medium, large, extra large, and pelleted. The size fractions result from the natural variability in a beet seed production field. Some growers have planting equipment (e.g., plate planters) that requires a specific seed size. In terms of shape, seed is either coated or pelleted. For more details on seed coatings, see section III.B.1.b(18) above.

With the exception of California, sugar beet root crops are typically planted in the early spring, between March and May, and harvested in fall, between September and November (Mikkelson and Petrof, 1999; McDonald et al., 2003). Ensuring that the planting date falls within the early spring period is crucial for maximizing sugar beet yield (Yonts et al., 2005). In the Imperial Valley, this planting and harvesting cycle is reversed. In California’s Imperial Valley, sugar beet are planted in September and October and harvested between April and early August (California Beet Growers Association, 1999); (Lilleboe, 2010).

The two key factors that affect planting date and sugar beet growth are soil temperature and soil moisture (Yonts et al., 2005). Soil temperature determines how fast sugar beet germinate and emerge, whereas soil moisture determines the quantity of plants that germinate and emerge. These factors combined with the number of acres available for planting determine the length of time needed for planting. For farms with fewer than 100 acres, growers need approximately 4 or 5 days to plant. For farms around 500 acres, planting typically takes about 2 weeks. This planting schedule is also dependent on the weather. For example, 0.50 inch of rain can delay the planting schedule by 1 or 2 days (Yonts et al., 2005).

Because it takes about two months for sugar beet foliage to cover the rows, early season weed control is a critical component of optimizing sugar beet production. Prior to the introduction of herbicide-tolerant sugar beet hybrids, sugar beet farmers typically employed a combination of tillage, hand labor, and chemical weed control, requiring multiple passes through the field with equipment. More information on other types of weed control can be found in section III.B.1.d.

Field selection and seedbed preparation are critical to establishing sugar beet crops. Objectives are to manage crop residues from previous rotations effectively, minimize erosion, improve soil structure to meet needs of the crop, and eliminate early season weeds (Cattanach et al., 1991).

Conventional sugar beet tillage (which can be performed in fall and spring) can help improve soil structure and eliminate early weeds (Häkansson et al., 2006). Conventional fall tillage is primary tillage (using moldboard plows or heavy disks) followed by one or more secondary tillage(s). Fall tillage systems should maintain enough residue on the soil surface to prevent erosion or be compatible with cover cropping systems for erosion control. Spring tillage should be kept to an absolute minimum (Cattanach et al., 1991). Objectives of spring tillage are to preserve seedbed moisture, maintain enough crop residues on the soil to stop erosion, and reduce the chance of wind damage to sugar beet seedlings as they emerge. The spring seedbed should be as level as possible and firm to well-packed to allow good seed-to-soil contact when planting. Common spring tillage tools are light harrows, multi-weeders, and combination Danish tine, harrow, rolling basket tillage tool systems. Spring tillage should be only 1–2 inches deep. Planting should be done as quickly as possible after spring tillage before seedbed drying can occur. Sugar beet are typically planted only 0.75–1.5 inches below the surface (Cattanach et al., 1991). Conventional tillage results in 100 percent soil disturbance (USDA-NRCS, 2008). Conventional tillage is typically used under conditions where weeds cannot be effectively controlled though chemical or other methods.

Sugar beet have also been successfully planted with no till, with strip tillage in previous crop residues, and other conservation tillage systems.

The USDA–ERS defines conservation tillage as cultural operations that maintain at least 30 percent cover of the soil surface by plant residue at the time of planting (Anderson and Magleby, 1997). Conservation tillage can encompass a range of management practices, from no-till to ridge- and strip-till cultivation to minimum tillage systems that restrict equipment traffic to dedicated zones. Special tillage field equipment can often perform the equivalent functions of several standard implements, reducing the necessity for multiple passes through the field. No till, as defined by USDA–ERS, leaves previous crop residue undisturbed from harvest to planting except for nutrient injection or narrow strips, and planting or drilling is accomplished in a narrow seedbed or slot (Anderson and Magleby, 1997). Weed control is primarily accomplished with crop protection products and cultivation may be used for emergency weed control.

Conservation tillage practices have seen increased use throughout the United States in recent years, especially in the Midwest where wind and water erosion are more problematic concerns. The percentage of conservation tillage managed land in the United States increased from 26 percent in 1990 to 41 percent in 2004 (Sandretto and Payne, 2006). The conservation tillage systems described above require more planning and better management than conventional tillage (Cattanach et al., 1991). The use of conventional tillage has decreased in sugar beet since the widespread adoption of H7-1 sugar beet in 2008. This is thought to be largely due to improved weed control through the use of glyphosate applications (NRC, 2010); (Duke and Cerdeira, 2007); (Wilson Jr, 2009). Many growers in the Great Plains region planting H7-1 sugar beet are now using conservation tillage practices (Wilson Jr, 2012), including strip tillage, which is described in more detail below.

Strip tillage involves tilling the soil in strips as opposed to the entire field. Strip tillage only disturbs approximately half of the inter-row area, creating strips 7–10 inches wide (with 22-inch row spacing) with the rest of the soil remaining undisturbed (Overstreet and Cattanach, 2008; USDA-NRCS, 2008) Strip tillage is associated with multiple environmental benefits that include: reduced wind erosion, less release of carbon into the air, maintaining higher levels of soil organic matter, conservation of soil moisture and shedding of excess water, and maintaining larger soil pores as compared to conventional tillage. Additionally, strip tillage has the agricultural benefits of resulting in yields equal to those of conventional tillage and cultivated strips warm up and dry faster than no-till systems in the spring, which is desirable for early-seeded crops (Franzen et al., 2008; Overstreet and Cattanach, 2008). Additional advantages include reduced fuel expenditures and expenses by eliminating some primary and secondary tillage; less labor, time, and machinery use; and the potential for conservation payments through Federal programs, such as the Natural Resources Conservation Service (NRCS), if certain criteria are met (Overstreet and Cattanach, 2008).

A national survey conducted in 2000 (the most recent survey of its kind) found that use of conventional tillage for sugar beet production varied by region (Ali, 2004). Conventional tillage (with and without moldboard plow) was used on 73 percent of farms in the Great Lakes, 64 percent of farms in the Midwest, 94 percent of farms in the Great Plains and 96 percent of farms in the Northwest (Ali, 2004). In Imperial Valley, all farms use conventional tillage. In the same survey, conservation tillage (reduced tillage and mulch tillage) were used on 28 percent of farms in the Great Lakes, 36 percent of farms in the Midwest, and on from 0.1 to less than 5 percent of farms in Great Plains and the Northwest (Ali, 2004). Additionally, the size of the farm (the number of acres of sugar beet planted) affected the type of tillage used in all regions. Twenty percent or greater of farms growing 150 acres or more practiced conservation tillage while conservation tillage was only practiced on 0.1 to less than 5 percent of farms growing 149 acres or less (Ali, 2004). Changes in tillage practices associated with H7-1 are described in greater detail below.

Sugar beet tillage practices in the Imperial Valley differ from those of the other four production areas due to differences in environmental conditions. Conventional tillage practiced prior to planting followed by between row cultivation(s), combined with band applications of an herbicide in the crop row, forms the mainstay of a sugar beet weed management program (Hembree, 2010). Hand hoeing is also used, but can be cost prohibitive (Meister, 2004b; Hembree, 2010). Pre-plant tillage involves building furrows for preplant irrigation, which is necessary in the Imperial Valley to manage salt buildup and supply water during the growing season (2011). Pre-irrigation is also frequently used to control weeds (Meister, 2004b). Fields are generally disked twice and pre-irrigated twice before planting; once through flat flood irrigation, which is followed by further disking, triplaning, then listing beds after which a second pre-irrigation occurs (Meister, 2004a; Meister, 2004b). After planting, crops are cultivated and irrigated (usually) 15–17 times during the growing period as needed (Meister, 2004b).

Several methods have traditionally been used to plant sugar beet root crops. Before the development of monogerm seed, many more plants per acre than desired would germinate and growers would thin the emerged plants until the target population was reached. Since the development of monogerm seeds, most growers "plant-to-stand," meaning that growers plant roughly the amount of seeds they want to have germinate (CFIA, 2002). In the plant-to-stand method, the grower plants enough seeds per acre to compensate for those seeds that do not emerge (Yonts et al., 2005).

Growers generally count on 60–90 percent of planted sugar beet germinating (Cattanach et al., 1991; Hirnyck et al., 2005). This method decreases the need for thinning and the need for hand labor in sugar beet production. Most sugar beet seed currently planted in the United States, including H7-1 sugar beet, are planted using the plant-to-stand procedure (CFIA, 2002).

Changes in the production methods have occurred since the introduction of H7-1 sugar beet in 2005. Since 2008 when H7-1 varieties became widely available, growers have rapidly adopted H7-1 sugar beet with some areas, such as western North Dakota and eastern Montana, converting to nearly 100 percent H7-1 varieties (Stachler et al., 2009a).

Herbicide usage patterns for sugar beet have changed with adoption of H7-1 sugar beet. Analysis of these differences is presented in section III.B.1.f. In brief, non-glyphosate herbicides usage decreased and glyphosate usage increased. Additionally, because weeds can be effectively controlled with glyphosate applications, H7-1 sugar beet usually require less tillage than conventional varieties (NRC, 2010); (Duke and Cerdeira, 2007); (Wilson Jr, 2009).

Differences in tillage, farm machinery use, and labor have been observed with the adoption of H7-1 sugar beet. These differences are described for each growing region below. However, not all differences are described for all regions due to lack of data. Additionally, as stated previously, H7-1 sugar beet have not been grown in the Imperial Valley region so that region is not discussed below.

- **Great Lakes.** Michigan Sugar Company recommends conservation tillage practices to help control erosion resulting from strong early spring winds in the Great Lakes region (Michigan Sugar Company, 2009). In 2010, nearly 25 percent of Michigan's sugar beet fields were planted into stale seedbeds (where fields are tilled in the fall and then left untouched the following spring when planting begins) as compared to less than 5 percent in 2006–2007 (Lilleboe, 2011). The introduction of H7-1 has allowed farmers the option of implementing varying methods of reduced tillage systems.

- **Midwest.** Recent studies by North Dakota State University (NDSU) have found that since the introduction of H7-1, strip tillage can be an effective, productive, and cost-saving tillage alternative to conventional full-width tillage for sugar beet, corn, and soybean production in the Red River Valley (Overstreet et al., 2009; Overstreet et al., 2011). Despite this, ridge tillage has only been used on a limited number of acres (less than 1000) in the region, strip tillage is only used on 1,800–2,500 acres in North Dakota and Minnesota combined, and no tillage is rarely used (Overstreet et al., 2010; Overstreet, 2011).

There have been changes in the amount of postemergence herbicide applications, however. For example, a member of the Minn-Dak Farmers Cooperative, who farms about 1,100 acres of sugar beet annually, has found that instead of three postemergence tillage trips across the fields, with H7-1 he now needs “little to no tillage postemergence” (Mauch, 2010). In Red River Valley trials, cultivation (conventional tillage) with H7-1 beet caused stand reduction and yield loss in two soil types (American Crystal Sugar Company, 2009).

In terms of the rotary hoe, row crop cultivation (mechanical weeding between rows), and hand weeding, a 2010 survey of sugar beet growers in Minnesota and North Dakota farms found changes in all of these weed control methods as compared to the survey conducted in 2000. The rotary hoe or harrow were only used on 2.8 percent of all acres of sugar beet production in 2010 when 93 percent of the sugar beet was H7-1 as compared to 62 percent of all acres in 2000 (Stachler et al., 2011). The main reason for the decline in the use of the rotary hoe or harrow is the introduction of H7-1 sugar beet (Stachler et al., 2011).

Row crop cultivation, including both the percentage of acres cultivated as well as the average number of times rows are cultivated, has also decreased with the adoption of H7-1 sugar beet. In 2010, 11 percent of H7-1 sugar beet acreage was row crop cultivated as compared to 74 percent of the conventional sugar beet acreage (Stachler et al., 2011).

In addition to the reduction in acres being row crop cultivated, the average number of row crop cultivations per field has decreased with the adoption of H7-1 sugar beet. On average, farmers growing H7-1 sugar beet row crop cultivated their fields once as compared to 1.5 cultivations reported by conventional sugar beet growers. In 2000, on average farmers growing conventional sugar beet row crop cultivated their fields twice (Stachler et al., 2011). When looking at the number of row crop cultivations per acre of sugar beet planted, the survey results show an even greater decrease in the amount of row crop cultivation with H7-1 sugar beet. The average number of row crop cultivations per cultivated acre for H7-1 sugar beet is 0.11 as compared to an average of 1.11 row crop cultivations for conventional sugar beet (Stachler et al., 2011). These data cannot be compared to the 2000 survey as the data were not collected in the 2000 survey (Dexter and Luecke, 2001).

Hand weeding has also decreased since the introduction of H7-1 sugar beet. The percentage of all sugar beet acres that were hand weeded was 1 percent in 2010 (93 percent H7-1 and 7 percent conventional) as compared to 25 percent in 2000 (100 percent conventional) (Stachler et al., 2011).

- **Great Plains.** In much of the Great Plains region, conventional sugar beet was cultivated using conservation tillage systems. However, deep tillage was utilized to improve drainage and help reduce the risk of soil borne diseases (mainly the beet necrotic yellow vein virus causing *Rhizomania*) (McDonald et al., 2003). A study conducted in Worland, Wyoming in 2007 compared H7-1 sugar beet production to similar, nearby fields of conventional sugar beet production (Kniss, 2010b). In crop tillage was reduced by 50 percent in the H7-1 sugar beet fields as compared to the conventional sugar beet (Kniss, 2010b). The same study found that none of the H7-1 sugar beet fields required hand weeding whereas all of the conventional sugar beet fields required hand weeding (Kniss, 2010b). Generally, farmers in the Great Plains have reported that strip tilling and H7-1 are compatible, resulting in reduced wind erosion and reduced irrigation requirements, along with fuel and time savings (Lilleboe, 2010). According to Terry Butcher, an Ag Manager for Western Sugar Cooperative, prior to H7-1 sugar beet, strip till was used on 15-20% of the Nebraska sugar beet crop (Wilson Jr, 2012). After four years of H7-1 sugar beet, growers are using strip tillage on at least 75-80% of the beet grown in Nebraska (Wilson Jr, 2012). A small percentage of sugar beet grown in Nebraska is also produced using no-till (Wilson Jr, 2012).

- **Northwest.** As stated above, conventional tillage was used on 96 percent of farms in this region prior to glyphosate-tolerant sugar beet (Traveller and Gallian, 2000; Ali, 2004). Since the introduction of H7-1, some farmers have switched to strip tillage and have reported reduced fuel and labor costs and reduced wind erosion (Lilleboe, 2008). Researchers in Idaho found that while conventional tillage was necessary for weed control with conventional beet, the practice has little to no benefit with glyphosate-tolerant sugar beet (Miller and Miller, 2008).

Harvesting. Sugar beet processors ensure that beet harvesting is systematic and maintain stringent protocols. As previously stated, harvesting sugar beet crops occurs from September through November in the Great Lakes, Midwest, Great Plains, and the Northwest. According to Smith (2006), if crops actively grow during September and October, sugar content increases by 0.1 percent per day; however, growth can slow significantly by the third week in October as temperatures drop. Delays in harvest caused by low or high temperatures or precipitation may occur (Smith, 2006). In the Imperial Valley, the harvest season typically stretches from April until early August to ensure that the sugar beet factory does not receive more beet than it can process in a 12-hour period (Lilleboe, 2010). During harvest, a mechanical defoliator is used to remove all the foliage from the beet root prior to lifting.

Growers are typically assigned to deliver a portion of their production, about 10 percent, during the pre-pile period. The pre-pile period allows the processing facility to begin manufacturing sugar prior to the full harvest. During the full harvest, growers transport sugar beet to multiple piling sites where they are stored outdoors prior to delivery at the processing facility. The processing facility hires truckers to move sugar beet from the piling sites to the processing facility as needed. In northern states, storage occurs during the winter where cold temperatures prevent the beet from spoiling. In California, harvest occurs during warm weather and beet cannot be stored. Instead they are harvested at a rate that meets the capacity of the processing plant.

Bolting. As described above, sugar beet are a biennial plant that produces an enlarged root the first year and then flowers in the second year. Nevertheless, sugar beet can bolt in their first year of production under certain environmental conditions, such as low temperatures (OECD). Much effort has gone into breeding sugar beet varieties that do not bolt, and today's varieties bolt very infrequently, typically at a rate of about 0.01 percent or 4 plants per acre (OECD; Darmency et al., 2009).

For bolting to occur, the plants first require exposure to temperatures below 40 °F in the 4- to 5-leaf stage followed by exposure to increasing day length (12 hours or more). Varieties differ in their sensitivity to bolting, with easy bolting lines requiring only a few to 1,000 hours of exposure to low temperatures, and bolting-resistant lines requiring 2,000 hours or more. Beet can devernalize, or return to the vegetative state, when exposed to high temperatures (OECD).

Bolting is undesirable to sugar beet root producers as it depletes the root of sugars, making them woody and worthless. Additionally, the woody roots that result from bolters can damage harvesting and processing equipment (Ellstrand, 2003). As bolters are much taller than the rest of the crop, they are easily detected and can be removed by growers. The combination of the low frequency of bolting and the requirement of several weeks for the bolters to develop pollen-producing flowers allows for successful stewardship in minimizing pollen production from bolters.

As described above, in the Imperial Valley in California, sugar beet are planted in September, grow through the winter months, and are harvested the following April through July. Bolting occurs more frequently in the Imperial Valley than in the other U.S. sugar beet regions due to the growth through the winter which can expose plants to vernalization temperatures. Furthermore, the longer growing season provides the plants the opportunity to flower before harvest (Kaffka, 1998; Bartsch et al., 2003). Consequently varieties with a high level of bolting resistance are used in California to minimize the frequency of bolting (Biancardi et al., 2010).

(3) Fertilization and pH Adjustment

Fertilization. Fertilization is important for sugar beet growth as it provides the necessary nutrients often lacking in soils. The three main nutrients typically applied to sugar beet are nitrogen, phosphate, and potassium (Jaggard and Qi, 2006)

Nitrogen is a key nutrient for sugar beet as it has both positive and negative impacts on yield, sugar content, and juice purity (Cariolle and Duval, 2006). For example, too little nitrogen can result in decreased sugar beet yield whereas too much nitrogen can injure beet, reduce sugar content, and affect juice purity. Therefore, sugar beet growers carefully control the amount of nitrogen available to their crops. This includes testing the soil for the amount of nitrogen present before adding fertilizer as few soils contain sufficient amounts of available nitrogen required for optimal growth. Additionally, the preceding crop grown in the rotation affects the amount of nitrogen available in the soil (different plant species increase or decrease the amount of available nitrogen in the soil depending on their specific biology) (Lamb et al., 2008); see Crop Rotation below for more information). Therefore, it is recommended that farmers check soil for the amount of nitrogen present and apply nitrogen fertilizer as required (SMBSC (Southern Minnesota Beet Sugar Cooperative), 2011).Different sugar beet cooperatives may have specific recommendations as to application amount, timing of application, and method(s) of application depending on the amount present in the soil (SMBSC (Southern Minnesota Beet Sugar Cooperative), 2011)

Phosphate and potassium are also important for sugar beet growth. Similar to nitrogen, different sugar beet cooperatives may also have specific recommendations as to application amounts, timing of application, and method(s) of application for these depending on the amount present in the soil (SMBSC (Southern Minnesota Beet Sugar Cooperative), 2011)

In recent decades, the use of nitrogen-based fertilizer on sugar beet crops has declined globally. In France, fertilizer use on sugar beet has decreased from 180 pounds nitrogen per acre (lb N/acre) in 1977 to approximately 107 lb N/acre in 2003. During this time, sugar beet yields increased from 3 to 5 tons per acre (7 to 11 metric tons per hectare) (Cariolle and Duval, 2006) (Draycott and Martindale, 2000). Similar nitrogen-based fertilizer decreases have also occurred in Minnesota and eastern North Dakota over the past 25 years (Sims, 2009).

Cariolle and Duval (2006) suggest that the H7-1 sugar beet varieties are capable of both substantially higher yields and more efficient recovery and utilization of available nitrogen. To date, no conclusive studies demonstrate a significant difference between conventional sugar beet and H7-1 in nitrogen recovery and utilization.

The University of Minnesota recommends a one-third rate reduction for potassium and phosphorus when band applied on sugar beet. Band application is more commonly used with strip tillage than conventional tillage. No changes in nitrogen application are recommended with band application (Overstreet, 2011). Additionally, banding fertilizer with strip-tillage may provide enhanced plant availability of phosphorus in phosphorus-fixing soil environments, which are common in the Midwest region (Overstreet et al., 2010).

pH Adjustment. In addition to fertilization, sugar beet grow best in soils with pH levels near neutral to slightly alkaline (Kockelmann and Meyer, 2006). Soil amendment practices such as the application of lime and lime slurries on cropland can be useful in adjusting pH levels, where needed. Sugar beet factory "spent lime" is a byproduct of the sugar production process where juice that has been extracted from the pulp is mixed with lime and spread on farmland. The seven sugar beet processing factories in North Dakota and Minnesota produce approximately 500,000 tons (dry weight basis) of spent lime annually (Sims et al., 2005).

Generally, spent lime has about 86 percent of the acid neutralizing potential as an equivalent quantity of fresh lime (Sims et al., 2005). Most soils in eastern North Dakota and western and central Minnesota, however, are naturally alkaline. Although there are isolated areas where soil pH can be acidic and require lime application as part of the management practice, most of the soils in the sugar beet factory areas of North Dakota and Minnesota are at pH levels of 7.5 or above and do not require lime. Studies have shown that sugar beet spent lime application to both acidic and alkaline pH soils resulted in higher sugar beet yields, apparently due to the increased ability of sugar beet to resist the effect of *Aphanomycetes cochlioides* root rot as a result of the spent lime application (Franzen, 2002); (Sims et al., 2005).

(4) Crop Rotation

Sugar beet are usually grown with other crops in 2- to 5-year rotations to improve the soil (by adding nutrients) and reduce the types and presence of weeds, diseases, and pests (Dewar and Cooke, 2006). The impact of certain soil borne diseases, nematodes (parasitic, microscopic worms) and weeds can be minimized through crop rotations (Mikkelson and Petrof, 1999; Hirnyck et al., 2005; USDA-ERS, 2009b). For more information on pest management, see section III.B.1.c(5) below.

The length of rotations used and the type of crops that are rotated with sugar beet are summarized below on a regional basis. Rotation crops listed below are listed in random order and are not listed in order of rotation. In summary, the length of the rotation, often dictated by contract, and the type of crops that are rotated with sugar beet vary by region, and may include other glyphosate-tolerant crops, such as corn or soybeans.

However, in no regions are sugar beet rotated to other *Beta* crops such as Swiss chard or table beet.

Great Lakes. Sugar beet are usually grown in a 3–4 year rotation. Other crops grown in rotation typically include soybeans, corn, dry beans, pickling cucumbers, and wheat (MSU (Michigan State University), 2011). According to Michigan Sugar (Company, 2012), 34% of growers plant in a three year rotation, 41% use a 4 year, and 24% plant sugar beet in a five-year rotation. Other crops grown in the rotation include alfalfa, corn, pickling cucumbers, dry beans, soybeans, and winter wheat (Company, 2012).

Midwest. Sugar beet are usually grown in a 3 or more year rotation, typically with small grain before sugar beet. Other crops grown in rotation include sweet corn, field corn, soybean and wheat (SMBSC (Southern Minnesota Beet Sugar Cooperative), 2010b).

Great Plains. Sugar beet are usually grown in 2–4 year rotations depending on the specific location within the region. Other crops grown in rotation include barley, dry beans, corn, and potato, and wheat.

Northwest. Sugar beet are usually grown in 2–5 year rotations depending on the specific location within the region. The crops grown in a given rotation are highly dependent on the location of the field within the region. Other crops grown in rotation include corn (sweet and field), wheat, barley, alfalfa, and dry beans.

Imperial Valley. Sugar beet are usually grown in 4–7 year rotations. Other crops grown in rotation include alfalfa, Durum wheat, vegetable crops such as lettuce, carrots, sweet corn, onions for dehydration, and Bermuda grass. In fields where sugar beet are harvested, early-Sudan grass may be planted and grown till the fall (2011). Although the practice is discouraged, sugar beet farmers in the Imperial Valley may grow two consecutive crops of sugar beet. However, no more than 4 sugar beet crops can occur in a given 10 years (2011).

In general for all U.S. sugar beet crop rotations, yields and quality are highest when sugar beet follow barley or wheat in a crop rotation. Yields are also high when sugar beet follow corn, potatoes, or summer fallow in rotation; however, high levels of residual nitrogen in the soil can reduce sugar beet quality (Cattanach et al., 1991). According to the American Crystal Sugar Company, sugar beet cropping systems averaged over 2003–2007 had wheat preceding sugar beet in crop rotation for 1.75 million acres and barley was the preceding crop for 96,000 acres. Together, wheat and barley accounted for 83 percent of the total rotated acreage (Overstreet et al., 2008). Soybean (as the preceding crop) increased from 6,000 acres in 2003 to 20,400 acres in 2008 (Overstreet et al., 2008).

Table 3–6 below shows crops used in rotation after sugar beet and the percentage that are glyphosate-tolerant by State.

Key points from Table 3–6 are:

- Crops that follow sugar beet in rotation include alfalfa, barley, corn, dry beans, onions for dehydration, carrots, lettuce, sweet corn, Bermuda grass, durum wheat, oats, potato, soybean, spring wheat, sugar beet, and winter wheat.
- Other *Beta* species, such as Swiss chard and table beet, are never planted in rotation after sugar beet.
- Corn is grown in rotation after sugar beet in all five regions.
- In all states that grow sugar beet with the exception of California, there is the potential for at least one Roundup Ready® crop in rotation besides sugar beet.
    - Michigan, Minnesota, and North Dakota potentially have two other Roundup Ready® crops in their rotations besides sugar beet.
    - About 43 percent of all land cultivated to sugar beet can be followed by a Roundup Ready® crop.

Table III-6. Rotational Crops Following U.S. Sugar Beet Production and an Estimation of Rotational Crops as Glyphosate-tolerant (GT) Crops [1]

A	B	C	D	E	F	G	H
State	Sugar Beet Acres[2]	Rotational Crop	Rotational Crop Acres[3]	% Rotational Crops[4]	% GT Crop Varieties[5]	GT Rotational Crop Acres[6]	% GT Crops in Rotation[7]
California[8]	**25,000**	Sudan grass	3,750	15	0	0	0
		Alfalfa	12,500	50	0	0	0
		Durum Wheat	7,500	30	0	0	0
		Sugar Beet	1,250	5	100	1,250	5
		Dehydrated onions, carrots, lettuce, sweet corn, or Bermuda grass	3,750	15	0	0	0
		TOTAL for California	25,000			1,250	5
Colorado	**29,000**	Barley	2,900	10	0	0	0
		Corn	20,300	70	61	12,383	43
		Dry Beans	4,350	15	0	0	0
		Potato	1,450	5	0	0	0
		TOTAL for Colorado	29,000			12,383	43
Idaho	**173,000**	Alfalfa	8,650	5	50	4,325	2.5
		Barley	25,950	15	0	0	0
		Corn	5,190	3	61	3,166	1.8
		Dry Beans	3,460	2	0	0	0
		Spring Wheat	129,750	75	0	0	0
		TOTAL for Idaho	173,000			7,491	4.3
Michigan	**147,000**	Alfalfa	2270	1.5	50	1135	0.8
		Corn	53,296	65	69	65,930	25
		Cucumber	3245	2.2	0	0	
		Dry Beans	25,174	17.1	0	0	0
		Soybean	28,601	19.5	85	24,311	16.5
		Winter Wheat	34414	23.4	0	0	
		TOTAL for Michigan	147,000			62220	42.3

Table 3–6. (continued)

A	B	C	D	E	F	G	H
State	Sugar Beet Acres[2]	Rotational Crop	Rotational Crop Acres[3]	% Rotational Crops[4]	% GT Crop Varieties[5]	GT Rotational Crop Acres[6]	% GT Crops in Rotation[7]
Minnesota	**451,000**	Corn	67,650	15	74	50,061	11
		Barley	45,100	10	0	0	0
		Soybean	248,050	55	93	230,687	51
		Spring Wheat	90,200	20	0	0	0
		TOTAL for Minnesota	451,000			280,748	62
Montana	**43,000**	Barley	21,500	50	0	0	0
		Corn	10,750	25	61	6,558	15
		Dry Beans	6,450	15	0	0	0
		Spring Wheat	4,300	10	0	0	0
		TOTAL for Montana	43,000			6,558	15
North Dakota	**228,000**	Corn	34,200	15	71	24,282	11
		Durum Wheat	11,400	5	0	0	0
		Soybean	125,400	55	94	117,876	52
		Spring Wheat	57,000	25	0	0	0
		TOTAL for North Dakota	228,000			142,158	62
Nebraska	**50,000**	Corn	25,000	50	69	17,250	35
		Dry Beans	20,000	40	0	0	0
		Winter Wheat	5,000	10	0	0	0
		TOTAL for Nebraska	50,000			17,250	35
Wyoming	**3,000**	Barley	1,650	55	0	0	0
		Corn	750	25	61	458	15
		Sugar beet	300	10	100	300	10
		Dry Beans	300	10	0		0
		TOTAL for Wyoming	3,000			758	25

Table 3–6. (continued)

A	B	C	D	E	F	G	H
State	Sugar Beet Acres[2]	Rotational Crop	Rotational Crop Acres[3]	% Rotational Crops[4]	% GT Crop Varieties[5]	GT Rotational Crop Acres[6]	% GT Crops in Rotation[7]
Total	**1,177,000**	Alfalfa	23420	2.0		5460	0. 5
		Barley	97,100	9.06		0	0
		Corn	217,136	18.9		149,823	13
		Dry Beans	59,734	5.20		0	0
		Durum Wheat	18,900	1.69		0	0
		Dehydrated onions, carrots, lettuce, sweet corn, or Bermuda grass	3,750	0.48		0	0
		Potato	1,450	0.13		0	0
		Sugar beet	1,550	0.03		1,550	<0.1
		Soybean	402,050	35.00		341,743	29.7
		Spring Wheat	281,250	24.48		0	0
		Winter Wheat	39,414	3.43		0	0
		OVERALL TOTAL	**1,149,000**			**498576**	**43.4**

[1] USDA–NASS (see footnote 5 below) data included herbicide-tolerant crop acres but not specifically glyphosate-tolerant crop acres. As a conservative estimate, these data were used to represent glyphosate-tolerant crops.

[2] Sugar beet acres (Column B) obtained from the USDA–NASS (2010a).

[3] The rotational crop acres (Column D) were calculated by multiplying the % Rotational Crops (Column E) by the Sugar Beet Acres (Column B).

[4] The percentage of Rotational Crops (Column E) that follow sugar beet is based on communications from individual local experts, i.e., university agronomists, USDA–ARS and Monsanto field personnel as discussed in Table VII-13 of USDA Petition 03-323-01p (Monsanto and KWS SAAT AG, 2004)

[5] The percentage of GT Crop Varieties (Column F) was obtained from the USDA–NASS (2010d). For corn in MT, WY, CO, ID we used the average value for "other states" as individual State adoption rates were not available. For alfalfa, we used an estimated adoption rate of 50% for ID and 0% for the Imperial Valley, CA based on industry projection. (USDA–APHIS 2010b).

[6] The GT Rotational Crop Acres (Column G) was calculated by multiplying the percentage of GT Crop Varieties (Column F) by the Rotational Crop Acres (Column D).

[7] The percentage of GT Crops in Rotation (Column H) was calculated by dividing the GT Rotational Crop Acres (Column G) by the Rotational Crop Acres (Column D).

[8] In CA, sugar beet are planted in September and harvested from April to July. Sudan grass may be planted in the spring in those fields where sugar beet is harvested early (April-May) and harvested in the summer and fall. The remaining rotation crops (totaling 100%) are planted in the fall.

(5) Pest Management

Disease. Sugar beet yield loss results from a variety of causes, including seedling blights, root rots, and foliar diseases. The primary diseases that affect U.S. sugar beet production are *Cercospora* leaf spot, *Rhizoctonia* root rot, *Aphanomyces* root rot, rhizomonia, and BCTV. The level of resistance required for each disease varies by production region and the disease resistance profile is what distinguishes the regional varieties. For additional description of which diseases are associated with each region, see section III.B.1.c(1).

The most common sugar beet seedling pathogens are soil-borne fungi. Of particular concern are *Aphanomyces cochlioides* and *Rhizoctonia solani*, as well as several *Pythium* and other species (Dewar and Cooke, 2006). These fungi, particularly *A. cochliodies* and *R. solani* , are the primary fungi that cause root rots. Many of these fungi survive in the soil for extended periods of time and can cause symptoms ranging from minor lesions to complete destruction of the root by dry or wet rots (Cattanach et al., 1991). Control methods for severe root rot and seedling disease problems caused by these fungi include varietal resistance, fumigation, crop rotations, seed treatments, and fungicide application. Commercial sugar beet seed is usually pretreated with one or more protectant fungicides (Cattanach et al., 1991).

Surveys conducted by NDSU in September 2009 stated that *Rhizotonia/Aphanomyces* were consistently shown to be growers' most serious production problem at approximately 30 percent of all surveyed farms in Montana, North Dakota, and Minnesota (Stachler et al., 2009a; Stachler et al., 2009b).

Cercospora leafspot, caused by the fungus *Cercospora beticola,* is the most serious foliar disease for the sugar beet crop in the north-central United States. A moderate to severe outbreak can cause losses of recoverable sucrose per acre of 30 percent or greater (Cattanach et al., 1991). Crop rotation is one of the best methods to control the disease using at least a 3-year rotation between sugar beet crops in order to reduce the disease inoculum (Cattanach et al., 1991). Fungicides can also be applied, such as triphenyl tin hydroxide (most effective) and copper fungicides. *Cercospora* is not a problem for sugar beet crops in the Imperial Valley region (2011).

Maintaining proper crop hygiene is important to avoid or ameliorate potential disease problems. This includes eliminating overwintering sites for pests and sources of disease. In addition, the removal of infested residues of previous crops, the eradication of weed hosts between beet crops, and the removal of disease sources are important (Dewar and Cooke, 2006).

Table III-7: Fungicides Used in Sugar Beet Production

Active Ingredient	Percent Total Sugar Beet Acres Treated (%)	Number of Applications	Amount per Application (lb a.i./acre)	Amount per Year (lb a.i./acre)	U.S. Total in 2000 (lb a.i./year)	Total Acres Treated
Azoxystrobin	–	1.0	0.120	0.120	–	–
Benomyl	4	1.0	0.240	0.250	15	62,400
Mancozeb	4	1.0	1.440	1.530	99	62,400
Maneb	1	1.2	1.290	1.640	32	15,600
Sulfur	11	1.8	25.130	45.700	7,595	171,600
Thiophanate , methyl	6	1.1	0.230	0.260	25	93,600
Triadimefon	–	1.0	0.230	0.240	1	–
Triazole	55	1.6	0.100	0.160	136	858,000
Triphenyltin hydrox.	44	1.4	0.230	0.340	238	686,400

Source: (USDA-NASS, 2010d).

Table 3–7 provides a complete list of fungicides used for U.S. sugar beet root production in 2000 (the most recent year of National Agricultural Statistics Service (NASS) data). The proportion of total sugar beet acres treated (as percent of total sugar beet acres), number of applications, and amount of the fungicide active ingredient (a.i.) are also shown. Overall, fungicide options and applications vary regionally according to disease pressure and needs, but APHIS expects that they do not vary between conventional sugar beet and H7-1 sugar beet.

Insects. Insects are another pest that can reduce sugar beet yields. The sugar beet root maggot (*Tetanops myopaeformis*) is the most destructive insect pest of sugar beet in Minnesota, North Dakota, and Idaho and secondarily in Nebraska, Colorado, Montana, and Wyoming. Approximately 49 percent of U.S. sugar beet acreage is infested at economic levels (USDA-APHIS, 2011b). The organophosphates terbufos, phorate, and chlorpyrifos, and the carbamate aldicarb are the mainstay control insecticides for the root maggot and are applied at planting because the insect larvae are underground (USDA-APHIS, 2011b). Other destructive insects found in the United States include: false root knot nematodes (*Nacobbus aberrans*), beet cyst nematode (*Heterodera schachtii*), symphylids (*Scutigerella immaculata*), millipedes (*Blaniulus guttulatus* and *Brachidesmus superus*), wireworms (*Agriotes lineatus*), cutworms and other caterpillars (*Agrotis* spp., *Euxoa* spp., *Peridroma saucia*, *Crymodes devastator*, *Amathes cnigrum*, *Feltia ducens*), root aphids (*Pemphigus* spp.), and lygus bugs (*Lygus elisus*, *L. hesperus*) (Dewar and Cooke, 2006).

Table 3–8 below lists the insecticides used in sugar beet production, from the most recent (2000) NASS data. (Note that the aldicarb registrant recently agreed to a voluntary cancellation of this insecticide, 75 FR 194 (October 7, 2010)). The percentages of total sugar beet acres treated, number of applications, and amount of a.i. are also shown. Overall, insecticide options and applications can vary regionally according to insect pressure and needs, but APHIS expects that they do not vary between conventional sugar beet and H7-1 sugar beet.

Table III-8. Insecticides Used in Sugar Beet Production

Active Ingredient	Percent Total Sugar Beet Acres Treated (%)	Number of Applications	Amount per Application (lb a.i./acre)	Amount per Year (lb a.i./acre)	U.S. Total in 2000 (lb a.i./year)	Total Acres Treated
Aldicarb[1]	7	1	1.840	1.870	198	109,494
Carbofuran	–	1	0.54	0.54	4	0
Chlorpyrifos	12	1.2	0.92	1.11	204	187,704
Diazinon	2	2.4	0.73	1.78	67	31,284
Esfenvalerate	5	1.9	0.02	0.05	3	78,210
Methomyl	2	1.1	0.46	0.52	17	31,284
Phorate	2	1	1.31	1.31	45	31,284
Terbufos	41	1	1.81	1.82	1,168	641,322

Source: (USDA-NASS, 2010d).
[1] The registrant recently requested a voluntary cancellation of all products containing Aldicarb.

d. Weeds in Sugar Beet Seed and Root Crops

(1) Weed Overview

The sugar beet plant is a poor competitor against weeds, especially from emergence until sugar beet canopy closure. Emerging sugar beet are small, lack vigor, and require approximately 2 months before canopy closure. Thus, weeds have ample opportunity to become established and compete. To avoid yield loss from weed competition, weeds need to be controlled during the 8 weeks after sugar beet emerge and weed control needs to be maintained throughout the season (Cattanach et al., 1991) (California Beet Growers Association, 1999); (McDonald et al., 2003); (Mikkelson and Petrof, 1999). If the crop stands are poor or under stress from pests or lack of nutrients, sugar beet may not be able to suppress late emerging weeds, and additional weed control measures may be necessary (Wilson et al., 2001).

Some disadvantages of weeds in crops include (Hirnyck et al., 2005; Stachler and Zollinger, 2009):

- Crop yield is reduced. Uncontrolled weeds that emerge with the crop can cause from 30- to 100-percent yield losses (California Beet Growers Association, 1999; Sprague, 2007)).
- Weeds may lower the sugar content of the harvested product (Mesbah et al., 1994).
- Weed seed produced in any given year increases future weed problems.
- Root crops are subject to harvesting problems (smaller beet missed, harvesting equipment damage).
- Processors pay growers less for the harvested sugar beet crop when weeds are present.
- Weeds can act as alternate hosts for insect pests and plant diseases.
- Increased tillage may be needed for weed control.
- Weeds that make it into the beet pile after root harvest can restrict air movement through the pile, generate and trap heat, and contribute to storage rot.
- Sugar beet seed crops must be free of noxious weed seed and have limited other weed seed (e.g., 0.10 percent weed seed in stock seed and certified seed) (OSCS (Oregon Seed Certification Service), 1993). Weeds in sugar beet seed crops can cause the seed lot to not be useable for commercial sugar beet planting.

Though a detriment to the grower, weeds in agricultural fields can provide habitat and nourishment for insects and animals and in this way promote biodiversity (Strandberg et al., 2005; May and Wilson, 2006) (Graef et al., 2010). Weeds are classified as annual or perennial. An annual is a plant that completes its lifecycle in one year or less and reproduces only by seed. Perennials are plants that live for more than 2 years. Weeds are also classified as broadleaf (dicots) or grass (monocots). Weeds can reproduce by seeds, rhizomes (underground creeping stems), or other underground parts.

Some of the more important weeds in sugar beet are briefly described below (USDA-APHIS, 2011b):

- **Kochia** (*Kochia scoparia*), an annual broadleaf plant, is a member of the goosefoot family, the same family as sugar beet.
- **Pigweed** (*Amaranthus* spp.) is a broadleaf annual that is a weed problem in many crops. There are several species, with redroot pigweed being the most common (Hembree, 2005) .
- **Common lambsquarter** (*Chenopodium album*) is an annual broadleaf in the same family as sugar beet. With its rapid growth and large size, it quickly removes soil moisture (McDonald et al., 2003).
- **Nightshade** (*Solanum* spp.) is a broadleaf annual that grows 6–24 inches tall (McDonald et al., 2003).

- **Common mallow** (*Malva neglecta*) and **cocklebur** (*Xanthium strumarium*) are widespread broadleaf annuals.
- **Barnyardgrass** (*Enchinochloa crus-galli)*, **foxtail** (*Setaria*), **wild millet** (*Panicum miliaceum*), and **wild oats** (*Avena fatua*) are annual grasses.
- **Sowthistle** (*Sonchus* spp.) is a perennial plant that reaches a height of 3–7 feet and reproduces by seed and underground roots.
- **Canada thistle** (*Cirsium arvense*) is a perennial that reproduces by seeds and underground roots and grows 2–5 feet tall. The roots extend several feet deep and some distance horizontally. Canada thistle is the most prevalent and persistent nongrass weed in Minnesota and is the number one noxious weed in Colorado. It is a problem weed in all growing regions (Durgan, 1998; McDonald et al., 2003; Colorado Department of Agriculture, Undated).
- **Nutsedges** (*Cyperus* spp.) are among the most problematic weeds of agriculture in temperate to tropical zones worldwide. They are difficult to control, often form dense colonies, and can greatly reduce crop yields. Nutsedges reproduce primarily by rhizomes (Hembree, 2005).
- **Dodder** (*Cuscuta* spp.) is an annual parasitic weed that grows only by penetrating tissues of host plants to obtain water and nutrients. Each plant produces thousands of seeds that can remain dormant in the soil for years (Hembree, 2005).
- **Velvetleaf** (*Abutilon theophrasti*) is a broadleaf annual that grows 2–7 feet tall (McDonald et al., 2003).
- **Ragweed** (*Ambrosia* spp.) are annual broad leaf weeds that can be very competitive with crops.
- **Wild beet** *(Beta macrocarpa*) is an annual plant that is a problem weed only in the Imperial Valley. It is difficult to control due to its morphological and physiological resemblance to sugar beet.

An important concept in weed control is the seed bank, which is the reservoir of seeds that are in the soil and have the potential to germinate. Agricultural soils contain reservoirs of weed seeds ranging from 4,100 to 137,700 seeds per square meter of soil (May and Wilson, 2006). Climate, soil characteristics, cultivation, crop selection, and weed management practices affect the seed bank composition and size (May and Wilson, 2006).

(2) Weed Management Nonchemical Methods

In addition to crop rotation and tillage, growers of conventional sugar beet have other nonherbicide means to manage weeds, such as cover crops and hand-hoeing. Narrow row widths (22–24 inches) are commonly used for quicker canopy closure (Cattanach et al., 1991; Mikkelson and Petrof, 1999; McDonald et al., 2003). Use of weed-free seed is an important step to limit the introduction of weeds into the field. Another important management technique is to scout fields for weeds and then implement a strategy to keep the weeds from producing more seeds (Ali, 2004).

Rotation. Weed control should be considered over the entire rotation to keep weed seed banks in check year to year (May and Wilson, 2006). Although traditional fallow (land is rested for an entire year) is seldom practiced for economic reasons, inter-crop fallow (land is rested through fall and winter) is more common (May and Wilson, 2006). For inter-crop fallow, cultivation can be used to control weeds that germinate in the fall and winter.

The Southern Minnesota Sugar Beet Cooperative (SMSBC) indicates that for many years sugar beet rotation after soybean or wheat was not recommended, so sugar beet most commonly followed field corn. However, sugar beet production following soybeans has recently become more popular due to the easier management of residue following soybeans, compared to corn, and introduction of sugar beet varieties with greater rhizoctonia tolerance (pathogenic fungi). Nutrient management following soybeans is easier than corn as well. More recent data indicate that the ranking of crops to produce before sugar beet is wheat, sweetcorn, soybean, then field corn (SMBSC (Southern Minnesota Beet Sugar Cooperative), 2010b). SMSBC now recommends that, when possible, sugar beet production should follow wheat (SMBSC (Southern Minnesota Beet Sugar Cooperative), 2010b). For more information on typical rotations in the various regions, see section III.B.1.c(4).

Rotation is a biological method for controlling weeds that is often used in combination with herbicides. Rotations are useful for weed control because different crops are sensitive and resistant to different sets of herbicides, so herbicide selection can vary from year to year and therefore control a wider variety of weeds (May and Wilson, 2006). Also, crop rotation presents the opportunity to vary cultural practices between crops such as planting date, harvest date, tillage practices, etc. This variation of cultural practices leads to weed shifts which help to minimize the dominance of a particular weed species from year to year. Both corn and soybean have Roundup Ready® varieties that are in widespread use. This means that when sugar beet are in rotation with corn or soybean, that most likely the corn and soybean in rotation are also Roundup Ready®.

In general for all U.S. sugar beet crop rotations, yields and quality are highest when sugar beet follow barley or wheat in a crop rotation. Based on information from the American Crystal Sugar database of sugarbeet cropping systems averaged over years 2003-2007, wheat preceded sugarbeet in the crop rotation on 1.75 million acres and barley was the preceding crop for 96,000 acres (Overstreet et al., 2008). Of all the preceding crops represented in the database, wheat and barley accounted for 83 percent of the total acreage (Overstreet et al., 2008). So whereas as much as 2/3 of the crop that precedes sugar beet in Minnesota and North Dakota may be Roundup Ready® based on the adoption rates of Roundup Ready® crops and total acreages planted in these states (see Table 3-6), in practice a much lower percentage (<20 percent) of the preceding crop is expected to be Roundup Ready® (Overstreet et al., 2008).

Mechanical Cultivation (Tillage). Tillage in general and with respect to regional practices is discussed in section III.B.1.c(2).

One of the main purposes of tillage is weed control. One type of tillage is stale seedbed, which is a technique where a field is tilled well before the crop is sown to encourage weed seed germination and again just prior to sowing the crop (May and Wilson, 2006). Weeds may also be controlled with herbicides instead of tillage before planting. In the United States and northern Europe, sugar beet have better yield if they are sowed as early as possible, but not before the risk of cold periods that could kill seedlings or induce bolting. In countries where there is less pressure to sow early or organic farming is practiced, stale seedbed can be used to control weeds (May and Wilson, 2006).

Tractor hoes are used to control weeds between sugar beet rows. Some examples include (May and Wilson, 2006):

- Where herbicides have been sprayed in bands over the rows, and weeds between the rows still need to be controlled;
- To replace a late herbicide application, especially when weed infestations are low or some weeds are too far advanced to be properly controlled by the herbicide; and
- To control difficult weeds such as wild beet and perennials.

Hand Hoeing. Hand hoeing for weed removal is associated with higher yields (Odero et al., 2008). Stachler and Zollinger (2009) provide advantages of hand weeding:

- Hand weeding will reduce losses due to weed competition. Losses due to weed competition are proportional to weed density. At some low weed density, the value of the increase in yield from weed control will be equal to the cost of the weed control. This economic threshold is very difficult to predict because many factors impact yield loss due to weed competition. Weed density, weed species biology, date of crop and weed emergence, rainfall, soil temperature, row width, date of weed removal, previous herbicide use, and the planned method of weed control, can all affect the economic threshold for the use of hand-hoeing to control weeds in sugar beet.

- Hand weeding will prevent weed seed production and reduce weed densities in the future. Hand weeding densities of weeds that are below the economic threshold can be beneficial if the field has a relatively low level of weed seed in the soil.

- Hand weeding can prevent seed production by weeds that are resistant to the applied herbicides and slow the buildup of herbicide-resistant weeds.

- Stachler and Zollinger (Stachler and Zollinger, 2009) also provide a formula developed by Dr. Steve Miller at the University of Wyoming for calculating labor hours for hand weeding. The time for hand weeding in hours per acre equals 2 hours per acre for walking and looking plus 0.5 hour per 1,000 weeds. The formula was developed using student labor, so skilled labor might work faster. Hand weeding also results in removal of some sugar beet plants depending on weed density. For example, starting with 200 weeds and 150 sugar beet in a 100-foot row will result in 125 sugar beet plants per 100-foot row remaining after hoeing (Stachler and Zollinger, 2009). Hoeing weed populations greater than 200 weeds per 100-foot row would result in less than desirable sugar beet density (Stachler and Zollinger, 2009).

Hand weeding is used to control bolters and, in locations where they occur, wild beet (e.g., California, Europe). If plants begin setting seed, the hand-hoed plants must be carried from the field to limit the spread of weed seed (May and Wilson, 2006).

Cover Crops. In minimal or no-till crop systems with cover crops, mechanical cultivation may not be needed for weed control and herbicide spraying can be minimized. Organic mulches (green manure) form living, dying, or killed covers that hold soil, stop soil splashing, and protect crops from injury. Spraying and cultivation passes can damage the leaf cuticle (waxy covering on the leaf) and make the crop more susceptible to infection (Clark, 2007). Dusty and dirt splashed leaves can protect weeds from herbicides (Stachler, 2009).

The organic matter in cover crops stimulates soil biological activity. According to Clark (2007), soil organic matter and cover crop residues improve soil physical properties, which results in:

- greater water infiltration, due to direct effects of the residue coverage or to changes in soil structure;

- protecting the soil surface by dissipating raindrop energy and reducing the velocity of water moving over the soil;
- less surface sealing, because residue intercepts rain drops, reducing the dispersal of clay particles during a rainfall or irrigation event;
- greater soil aggregation or tilth, resulting in better nutrient and moisture management; and
- greater soil porosity, due to the macropores that are formed as roots die and decompose.

Cover crops reduce soil erosion and protect small sugar beet plants from wind damage. They compete with weeds and with the crop. Cover crops can also provide other benefits such as cutting fertilizer costs, reducing the need for herbicides and other pesticides, improving yields by enhancing soil health, preventing soil erosion, conserving soil moisture, protecting water quality, and helping safeguard personal health through reduced herbicide use (Clark, 2007).

Barley is an inexpensive, easy-to-kill companion crop that can protect sugar beet seedlings during their first 2 months while also serving as a soil protectant during drought periods (Clark, 2007). A low-density barley cover crop is easy to stunt or kill a month after planting using the combination of herbicides and crop oil that are normally used in conventional sugar beet for weed control. Alternatively, a single application of an herbicide to control grasses can kill the barley cover crop (Clark, 2007). In H7-1 sugar beet, glyphosate can be used to kill cover crops.

Stachler and Zollinger (Stachler and Zollinger, 2009) provide a summary of living cover crops for North Dakota and Minnesota. Winter rye is more winter hardy than winter wheat, so it is a better choice for fall seeding cover crops in northern areas. Spring-seeded cover crops such as barley and oats are seeded within a few hours to days of the sugar beet crop. Winter rye growing near the sugar beet row needs to be removed (e.g., by band application of glyphosate) to prevent yield losses in sugar beet. However, winter rye growing between the rows can be left until the sugar beet plants are large enough to withstand wind without being damaged. Spring-seeded barley growing near the sugar beet rows should be controlled by the time barley has three leaves. In addition, barley between rows should be removed by the time sugar beet have four leaves and the barley has four or five leaves. Postemergence grass herbicides or cultivation (tillage) can be used to remove winter rye or barley between rows (Stachler and Zollinger, 2009).

In Michigan, red clover frost-seeded into winter wheat suppressed common ragweed growth through wheat harvest and into the summer. The red clover did not provide complete ragweed control, but there was no adverse effect on wheat yield. A grain crop plus red clover cover crop combination often follows corn, but also can follow sugar beet (Clark, 2007).

Rye, a winter annual grain, is perhaps the most versatile cover crop used in the continental United States. For much of the continental United States, cereal rye is the best choice for catching nutrients after a summer crop (Clark, 2007) .Rye is cold tolerant so it continues to grow in late fall or where winters are mild, through the winter months. Rye can put down roots to a depth of 3 feet or more. Conventional management of rye involves removal by disk or broad-spectrum herbicides such as paraquat or glyphosate. Rye can also be killed with a roller, providing an acceptable level of weed control for the subsequent crop. When properly managed under conservation tillage, rye has the ability to reduce soil-borne diseases, nematodes, and weeds. Rye is also not a host for root-knot nematodes or soil-borne diseases. It produces significant biomass that smothers weeds when it is left on the surface and also controls weeds allelopathically through natural weed-suppressing compounds. Fall-planted rye works well in reducing broadleaf weeds in all cash crops that follow. Rye does not control weedy grasses (Clark, 2007) Because sugar beet are a broadleaf crop, weedy grasses are easier to control than broadleaf weeds.

Trap crops are specially bred varieties of radish (*Raphanus sativus*) and mustard (*Sinapsis alba*), which have the potential for controlling the sugar beet cyst nematode (*Heterodera schachtii*). Trap crops, like a true host, stimulate eggs of the sugar beet cyst nematode to hatch, but do not allow them to reproduce. With proper use and management, trap crops can reduce soil populations of the sugar beet cyst nematode and reduce or eliminate nematicide use (Koch et al., 1996)

Cover crops are not typically used in California sugar beet farming (2011).

(3) Weed Management Using Non-Glyphosate Herbicides

Herbicides are used by virtually all sugar beet growers. In 2000, approximately 98 percent of planted acres received one or more herbicide applications (Ali, 2004). Prior to adoption of H7-1 sugar beet, growers regularly used multiple chemical herbicides to control weeds (Cole, 2010); (Kniss, 2010a; Wilson, 2010). Herbicides can be applied before the crop emerges from the ground (preemergence) or after (postemergence). Preplant incorporated (PPI) herbicides are those that are mixed in with the soil before planting. In selecting an herbicide and application method, a grower must consider, among other factors, whether an herbicide may be used on the crop because it has been registered by the EPA, the potential adverse effects on the crop, residual effects that can limit crops that can be grown in rotation, effectiveness on expected weeds, and cost. Herbicide use is not regulated by APHIS but regulated by the U.S. Environmental Protection Agency (EPA) under the Federal Insecticide, Fungicide, and

Rodenticide Act (FIFRA) and its amendments (Monsanto and KWS SAAT AG, 2004).

In conventional sugar beet cropping systems, herbicide applications in early season have been reported to reduce sugar beet vigor by 17 to 22 percent and cause a 6- to 8-percent reduction in sugar beet root yield at harvest (Wilson, 2010). Several factors can influence a crop's tolerance to herbicides. Individually each factor might have little effect, but when two or more occur at the same time, crops can suffer stress that is more noticeable. Factors that influence herbicide injury to crops include:

- Crop plant stage; sugar beet cotyledon to two-leaf stage is less resistant than the mid-four-leaf stage and later (Stachler and Zollinger, 2009). Herbicide labels include information on plant stage for safe application;
- Use after other herbicides; it is not always possible to predict the interactions that could occur (Bayer CropScience, 2004);
- Nutrient deficiency (e.g., manganese) (Bayer CropScience, 2004);
- Soil acidity/lime deficiency (Bayer CropScience, 2004));
- Substantial day-to-night temperature fluctuations (Bayer CropScience, 2004);
- Sudden change from cool and cloudy to hot and sunny (Stachler and Zollinger, 2009);
- Periods of low temperature or frost (Bayer CropScience, 2004);
- High light intensity (e.g., full sunlight – May to June) (Bayer CropScience, 2004);
- Wind or hail damage including damage from blown soil particles (Bayer CropScience, 2004);
- Recent flooding (Stachler and Zollinger, 2009);
- Insect or fungal attack (Bayer CropScience, 2004);
- Rolling or harrowing carried out within 7 days of application (Bayer CropScience, 2004); and
- Temperature above 21 °C (70 °F) on the day of spraying; applications should be made after 5 p.m. (Bayer CropScience, 2004).).

Some examples of herbicide injury symptoms in sugar beet include leaf tip and leaf margin necrosis, necrotic spots (Betamix®), leaf malformation (Eptam®, Ro-Neet™), leaf chlorosis (Pyramin®), leaf petiole elongation and distorted leaf growth (Stinger®), and girdling at the root crown and stunting (Treflan® HFP) (Morishita and Downard, Undated). In most cases the injury is not lethal, and the sugar beet recover, but yield can be reduced.

Table 3–9 summarizes the effectiveness of herbicides on important sugar beet weeds based on observations in three sugar beet growing regions: the Great Lakes (Michigan Sugar Company, 2009; Sprague and Everman, 2011), the Midwest (Stachler and Zollinger, 2009), and the Northwest (Morishita, 2009). Herbicide effectiveness was scored as N=no control, P= poor (40-65% control), F=fair (65-80% control) , G=good (80-90% control), or E=excellent (90-99% control) (North Dakota State University, 2011). As the table shows, no single herbicide is effective on all weeds. Applying multiple herbicides, often at the same time in a tank mix, can result in effective control of annual broadleaf and grass weeds. In general, none of the non-glyphosate herbicides gives effective control of perennial weeds. Furthermore, the combination of non-glyphosate herbicides frequently causes severe crop injury which results in yield losses (Sprague and Everman, 2011) in contrast to glyphosate, which manages a wide spectrum of weeds without causing crop injury. In considering the herbicide management program, growers attempt to balance the yield losses from weeds with the yield losses from herbicide injury.

Current practices for weed control in conventional sugar beet include tillage, rotations, cover crops (see section III.B.1.d(2)), preplant incorporation of grass and broadleaf herbicides, and in-crop use of herbicide tank mixtures (Dexter and Luecke, 2003; Dexter and Zollinger, 2003; WSSA, 2007). Each practice has limitations. Tillage, preplant incorporation of herbicides, and in-crop use of herbicides are associated with narrow windows of application, which is based on a specific weed size or crop stage (Baker and Johnson, 1979; Baker et al., 1982; Campbell and Janzen, 1995). Additionally, herbicide effectiveness is influenced heavily by soil pH, target weed size, crop size, air temperature, and irrigation practices. Moreover, many of the currently applied herbicides leave soil residues, the persistence of which can impact crop rotation options in subsequent seasons (Dexter and Zollinger, 2003; WSSA, 2007).

Conventional weed control options are complex due to the need for several applications of multiple tank-mixed herbicides to achieve long-term, broad-spectrum weed control. As an example, a common practice in sugar beet production is to use “micro-rates” (Dexter and Zollinger, 2003) by tank mixing multiple herbicides at reduced rates in combination with an oil additive. The components of the tank mixture can include Betanex® (desmedipham), Betamix® (phenmedipham + desmedipham), Nortron® (ethofumesate), Upbeet® (triflusulfuron-methyl), Stinger® (clopyralid), and also Select® (clethodim) if grasses are present. A minimum of three applications is recommended, beginning at the cotyledon growth stage and followed by weekly applications. The intent of the micro-rate program is to lower overall herbicide costs and reduce the potential for crop injury.

Table III-9. Effectiveness of Herbicides on Major Weeds in Sugar Beet

Herbicide	Broadleaves											Grasses			Perennials			Parasites
	Cocklebur	Kochia	Lambsquarter	Mallow (common)	Nightshade	Pigweed	Ragweed (common)	Smartweed	Velvetleaf	Wild Mustard	Wild Buckwheat	Barnyard-grass	Foxtail	Wild Oats	Canada thistle	Nutsedge	Sow-thistle	Dodder
Preplant incorporated																		
Ro-Neet™																		
GL	P	P	F	-	F	G	F	P	G	P	F	G	G	-	N	G	N	-
MW	P	P	F/G	F/G	F/G	F/G	F	P	-	P	P-F	G	G/E	F/G	N	-	-	-
NW	P	P	E	P	G	E	-	P	-	P	P	G	G	F	P	F	P	P
Preemergence																		
Nortron®																		
GL	F	F	G		G	G	P	G	F	G	G	P	F	-	N	P	N	-
MW	P	F/G	P/F	P	F/G	G/E	P	G	-	P/F	F/G	P	F/G	F/G	N	-	-	-
NW	P	F/G	G/E	P	F/G	G/E	-	F/G	-	G	F/G	G	G	F	P	P	G	P
Pyramin®																		
GL	P	P	E		G	G	G	G	F	G	G	P	P	-	N	N	N	-
NW	P	P	G	P	F/G	G/E	-	G	-	G	P	P	P	P	P	P	P	P
Eptam®																		
MW	P	F	F/G	F/G	F/G	F/G	F	P	-	P	P/F	G/E	G/E	G	N	-	-	-
NW	P	F	G	P	F/P	F/G	-	P	-	P	F	G	G	F/G	P	F	F	P

Table 3-9. (continued)

Herbicide	Broadleaves											Grasses			Perennials			Parasites
	Cocklebur	Kochia	Lambsquarter	Mallow (common)	Nightshade	Pigweed	Ragweed (common)	Smartweed	Velvetleaf	Wild Mustard	Wild Buckwheat	Barnyard-grass	Foxtail	Wild Oats	Canada thistle	Nutsedge	Sow-thistle	Dodder
Postemergence																		
Nortron®																		
GL	P	-	F	-	G	F	P	G	P	G	G	P	F	-	N	N	N	-
Pyramin®																		
GL	P	-	F	-	F	F	F	F	F	F	F	N	N	-	P	N	P	-
Betamix®																		
GL	F	F	E	-	F	G	G	F	P	G	F	P	F	-	N	N	N	-
MW	P/F	F	G	P	F/G	G	F	P	-	G/E	F	P	F	N	N	-	-	-
NW	F	P/F	E	P	F/G	G/E	-	P	-	G	F/G	P/F	F	P	P	P	E	P
Betanex®																		
GL	F	-	F	-	F	E	F	F	P	G	P	P	P	-	N	N	N	-
MW	P	P/F	G	P	F/G	G/E	F	P	-	G/E	P/F	P	P	N	N	-	-	-
Upbeet®																		
GL	F	-	P	-	F	F	F	F	G	E	F	P	P	-	P	N	N	-
MW	N	P/E	P	G	F	F	F	F	-	G/E	F	N	F/G	N	N	-	-	-
NW	F	G	G	F	G	G/E	-	G	-	G	G	P	P	P	P	P	G	P
Stinger®																		
GL	E	N	P	-	F	P	E	F	P	P	F	N	N	-	G	N	G	-
MW	E	N	P/F	P	F/G	P	F	F	-	P	F/G	P	P	N	G/E	-	-	-
NW	E	P	F	P	F/G	P	-	G	-	P	E	P	P	P	E	P	G	P

Table 3-9. (continued)

Herbicide	Broadleaves											Grasses			Perennials			Parasites
	Cocklebur	Kochia	Lambsquarter	Mallow (common)	Nightshade	Pigweed	Ragweed (common)	Smartweed	Velvetleaf	Wild Mustard	Wild Buckwheat	Barnyard-grass	Foxtail	Wild Oats	Canada thistle	Nutsedge	Sow-thistle	Dodder
Progress (a mixture of Betamix® plus Nortron®)																		
GL	F	F	E	-	G	G	G	G	P	G	G	P	F		N	N	N	-
MW	F	F/G	G/E	P	G	G	F/G	F/G	-	G	F/G	P	F/G	N	N	-	-	-
Assure® II/Select® (Assure® II only for U of ID)																		
GL	N	N	N	-	N	N	N	N	N	N	N	G	E	-	N	N	N	-
MW	N	N	N	N	N	N	N	N	-	N	N	E	E	E	N	-	-	-
NW	P	P	P	P	P	P	-	P	-	P	P	E	E	G/E	P	P	P	P
Poast®																		
GL	N	N	N	-	N	N	N	N	N	N	N	E	E	-	N	N	N	-
NW	P	P	P	P	P	P	-	P	-	P	P	E	E	G/E	-	P	P	P
Glyphosate																		
GL	E	G	G	-	G	E	G	G	G	G	E	E	E	-	G	F	G	G
MW	E	F/E	P/E	P/G	P/G	E	G/E	P/E	-	G/E	G/E	E	E	G/E	G/E	-	-	-
Select®																		
NW	P	P	P	P	P	P	-	P	-	P	P	E	E	G–E	P	P	P	P
Treflan® HFP																		
NW	P	F	F/G	P	P	G	-	P/F	-	P	F	G	G	F	P	P	P	P

Sources:

GL: (Michigan Sugar Company, 2009), (Sprague and Everman, 2011); **MW:** (Stachler and Zollinger, 2009)**; NW:** Morishita, 2009

E=excellent; **G**=good; **F**=fair; **P**=poor; **N**=no effect; **GL**=Great Lakes; **MW**=Midwest; **NW**= Northwest

A member of the Minn-Dak Farmers Cooperative, who farms about 1,100 acres of sugar beet annually, described his conventional weed control system (Mauch, 2010):

> "Prior to planting Roundup Ready® sugar beet, my herbicide regimen for conventional beet seed was very complicated and labor intensive. Preemergence, I used a combination of Eptam® (which is very toxic to the sugar beet) and Ro-Neet™ (which is very expensive). Approximately 2 weeks after the beet plants emerged, I started spraying a mix of BetaMix®, Betanex®, Upbeet®, Nortron® and Stinger® and adjuvants to make the herbicides stick better. This would be sprayed four times (approximately once per week). Even after spraying several times, there were still weeds and I then needed to hire manual labor to hoe and pull out the weeds."

This description of the complexity of conventional weed control is similar to that provided by researchers evaluating weed management in sugar beet (Odero et al., 2008). Odero et al. (2008) evaluated 20 different weed treatment alternatives for conventional sugar beet and found that the following treatment yielded the highest net economic return: PPI treatment with Nortron® (ethofumesate), followed by three postemergence micro-rate treatments of a tank mixture of Betamix® (phenmedipham + desmedipham) and Nortron® (ethofumesate), followed by Outlook® (dimethenamid-P); with hand-hoeing following each herbicide application.

Herbicide application is further complicated because oil adjuvants[4] used in herbicides combined with some fungicides or insecticides can increase crop injury (Stachler and Zollinger, 2009). In addition, broadleaf herbicides antagonize[5] grass herbicides. Therefore, grass herbicides should be applied 24 hours before broadleaf herbicides or 3–5 days after broadleaf herbicide (Stachler and Zollinger, 2009).

A combination of herbicides plus hand-hoeing is sometimes required to effectively control weeds in conventional sugar beet (Dexter and Luecke, 2003). In 2000, 25 percent of sugar beet acres in Minnesota and eastern North Dakota were hand weeded (Dexter and Luecke, 2001). Hand-weeding is necessary in many situations but it is cost-prohibitive as a replacement for herbicides. USDA data show that in 2000, conventional

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[4] For pesticide regulation, adjuvants are chemicals added to a pesticide by users to improve the pesticide's efficacy. Agricultural chemical adjuvants are grouped according to their intended purpose in a tank mix (U.S. EPA, 2011c).

Herbicide antagonism is defined as the reduction of control of certain weeds as the result of applying mixtures of two or more herbicides B.V. Ottis, J.D. Mattice and R.E. Talbert, "Determination of Antagonism between Cyhalofop-Butyl and Other Rice (*Oryza Sativa*) Herbicides in Barnyardgrass (*Echinochloa Crus-Galli*)," Journal of Agricultural and Food Chemistry 53.10 (2005).

sugar beet growers spent an average of USD 94.28 per acre for all chemicals (insecticides, herbicides, fungicides, etc.) (Ali, 2004). Five-year studies of the cost of hand-weeding sugar beet at the University of California-Davis, as reported by the California Beet Growers Association, found that the cost of hand weeding was between USD 260 to over USD 650 per acre (California Beet Growers Association, 1999). Using the midyear of 1996 as the base year, this is equivalent to approximately USD 373 to USD 914 per acre in 2010 dollars, or approximately three to seven times what sugar beet growers spent on all chemicals. More recently, scientists in Wyoming have found that net returns for optimal herbicide application combined with hand weeding are more than twice the net returns for hand weeding alone (Odero et al., 2008).

Mapping weed infestations in a field can help farmers make weed management decisions. Perennial weeds like Canada thistle and quackgrass often occur in patches, and so can be spot treated with an herbicide or rogued or cultivated (Wilson et al., 2001). Because of the overwintering parts of perennial weeds, proper timing is required to control perennials and application timing is critical for effectiveness. Field scouting immediately after the crop begins to emerge helps with early identification of weeds and the selection of an appropriate postemergence herbicide (Wilson et al., 2001).

Herbicide labels include information on rotation restrictions following herbicide applications (Table 3–10). As can be seen in Table 3–10, glyphosate and Betanex® have the advantage over all the other sugar beet herbicides in that no time restrictions are needed for planting any of the listed rotation crops. Crop injury or failure can result if rotation restrictions are not followed. Because Betanex® fails to control most sugar beet weeds, glyphosate is unique in its effectiveness on a wide number of weed species and lack of crop rotation restrictions.

Table III-10. Herbicide Crop Rotation Restrictions (in months)[1]

	Soybeans	Field Corn	Seed Corn	Wheat	Oats	Barley	Rye	Alfalfa	Dry Beans	Sugar Beet	Potatoes	Cucumbers	Tomatoes
Assure® II	0	4	4	4	4	4	4	4	0	0	4	4	4
Betamix®	0	4	4	4	4	4	4	0	0	0	0	0	0
Betanex®	0	0	0	0	0	0	0	0	0	0	0	0	0
Eptam®	10	1	10	3	10	10	3	0	0	10	10	10	10
Glyphosate	0	0	0	0	0	0	0	0	0	0	0	0	0
Nortron®[1]	6/12	6/12	6/12	6/12	6/12	6/12	6/12	6/12	6/12	0	6/12	6/12	6/12
Poast®[2]	0	1	1	1	1	1	1	0	0	0	0	0	0
Pyramin®[1]	10	10	10	10	10	10	10	10	10	0	10	10	10
Ro-Neet™	–	–	–	–	–	–	–	–	–	–	–	–	–
Select®	0	1	1	1	1	1	1	0	0	0	0	0	0
Stinger®[2]	10.5	0	0	0	0	0	0	10.5	0	18	18	18	18
Treflan® HFP	0	5	5	5	5	5	5	5	0	12	5	5	5
Upbeet®	0.5	0.75	0.75	0.5	0.5	0.5	0.5	0.5	0.5	0	0.5	0.5	0.5

Source: (Michigan State University Extension, 2003).

[1] **Crop rotation restrictions may vary from State to State. Due to primacy of the State law, the label can only be more stringent than federal law.**

[2] **Consult the Remarks and Limitations section on the herbicide label for further information.**

Note that – means no information was given on this label.

Herbicide application methods include:

- Spot treatment – the application of herbicide to just specific plants or areas of the field, usually done by hand with a backpack sprayer.

- Ground broadcast – the application of herbicide using a tractor with spray nozzles. The nozzle height and spray width can be adjusted. Broadcast application can cover the crop and in between the rows.

- Band – the application of herbicide that is sprayed over the crop row and later the space between the rows is cultivated (Donald and Nelson, 2004). Zone herbicide application is a banding method where herbicide rates vary. For example, a preemergence herbicide can be applied at greater rates between rows (Donald and Nelson, 2004). Lay-by treatments are applied at last cultivation to provide an extended period of weed control (UNL, 2011).

- Irrigation – the application of herbicides by incorporating or metering into an irrigation system (Morishita, 2003). For example, Ro-Neet™ can be applied through sprinkler irrigation systems, such as center pivot, lateral move, end tow, wheel line, traveling big gun, solid set, or hand moved lines.

- Aerial broadcast – the application of herbicide using an airplane. This type of application is commonly used in forestry applications but is more seldom used over cropland (USDA-FS, 2006).

Dexter and Luecke (Dexter and Luecke, 2001)report that broadcast methods dominate the application of herbicides on conventional sugar beet. Based on acres treated averaged across all herbicides, these authors report that in 2000 approximately 54 percent were ground broadcast, 9 percent were aerial broadcast, and 37 percent were band applied.

On conventional sugar beet, glyphosate can be used in the fall to prepare for the next growing season, in the spring preemergence, postemergence for spot treatment, or by wiper application (Stachler and Zollinger, 2009); (Hirnyck et al., 2005). Wiper application ("Roundup® wick") of glyphosate involves wiping a cotton wick saturated with glyphosate on weeds that protrude above the sugar beet canopy (Hirnyck et al., 2005). Other height-selective application methods include recirculating sprayers, rotating rollers, and pressure pads controlled by electronic sensors (May and Wilson, 2006). Glyphosate can also be used to remove winter wheat or winter rye seeded as a cover crop prior to conventional sugar beet emergence (Stachler and Zollinger, 2009).

Table 3–11 lists the 13 herbicides used in sugar beet that are included in the NASS Agricultural Chemical Use Database. It also identifies the application method, whether the herbicide is used preemergence (PRE), postemergence (POST), or PPI, and what the general weed targets are for the 13 herbicides with the best documented use in sugar beet (USDA-NASS, 2008). There are an additional 10 herbicides for use in sugar beet that are mentioned in various extension agency guides. This EIS evaluates the impacts for the 13 herbicides listed by NASS. The additional herbicides shown in Table 3–12 may also be used in sugar beet, but data on their usage are not available

(4) Weed Management for H7-1 Sugar Beet Varieties – Chemical Methods

H7-1 sugar beet, assigned the Organisation for Economic Co-operation and Development (OECD) unique identifier KM-000H71-4, have been genetically modified to tolerate application of glyphosate herbicide formulations (Monsanto and KWS SAAT AG, 2004). The following sections provide an introduction to glyphosate and then describe how it is used on H7-1 sugar beet.

Glyphosate. Glyphosate (N-phosphonomethyl-glycine) (CAS Registry Number 1071-83-6), a nonselective herbicide, was first introduced under the trade name of Roundup® by Monsanto in 1974. Glyphosate is a systemic, herbicide used on both agricultural and nonagricultural sites (Cerdeira and Duke, 2006). It may be used premergent, preplant incorporated, or post-emergent with Roundup Ready® crops.

Glyphosate is an aminophosphonic analog of the amino acid glycine. The glyphosate molecule has a methylphosphono group bonded to the nitrogen atom of the amino group of glycine, as denoted in Fig. 3–9 below.

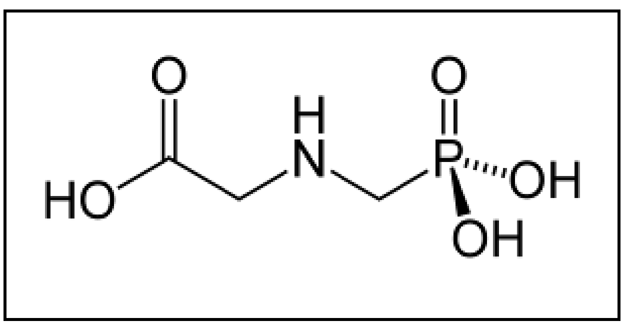

Figure 3- 9. Molecular Structure of Glyphosate

Table III-11. Application Methods for 13 Sugar Beet Herbicides

Agricultural Chemical (Herbicide)	Trade Name (Typical)	Application Method	Context (How is it used)	General Target
Clethodim	Select®	7-inch band, broadcast, or micro-rate (with Betamix® or Progress)	POST	Annual grasses
Clopyralid	Stinger®	7-inch band, broadcast, or micro-rate (with Betamix®, Progress, or Poast®)	POST	Cocklebur, sunflower, marshleder, wild buckwheat, ragweed, Canadian thistle
Cycloate	Ro-Neet™	7-inch band or broadcast, lay-by, or sprinkler irrigation (apply at end of irrigation cycle to penetrate 3–4 inches, or mechanically incorporate to depth of 3–4 inches)	PPI or fall when temperature is below 50 °F before freeze or snow	Annual grasses and some broadleaf weeds
Desmedipham	Betanex®	Broadcast or micro-rate	POST	Annual broadleaf weeds
EPTC	Eptam®	7-inch band or broadcast, or lay-by (may be incorporated or metered into sprinkler irrigation lines or injected on each side of beet row)	PPI or fall after Oct 15 before freeze or snow	Annual grasses and some broadleaf weeds; temporary stunting of sugar beet
Ethofumesate	Nortron®	7-inch band or broadcast (requires moisture – sprinkler irrigation or furrow irrigation, no mechanical incorporation)	PPI or PRE (high levels) POST (lower levels) - in combination with Progress, Betanex®, Betamix®, or Roundup® (GT varieties only)	Annual broadleaf weeds
Glyphosate	Several including Roundup®	7-inch band or broadcast	Preplant or any time prior to crop emergence (can work on emerged weeds), POST only in GT varieties	Grasses and broadleaf weeds

Table 3–11 (continued)

Agricultural Chemical (Herbicide)	Trade Name (typical)	Application Method	Context (how is it used)	General Target
Phenmedipham + Desmedipham	Betamix®	7-inch band, broadcast, or micro-rate (do not apply when dew is present, do not apply through irrigation system, do not add wetting agents or spray adjuvants)	POST	Annual broadleaf weeds
Pyrazon	Pyramin®	7-inch band or broadcast (requires moisture – sprinkler irrigation or furrow irrigation)	PRE or POST	Annual broadleaf weeds
Quizalofop-p-ethyl	Assure® II	7-inch band, broadcast, or micro-rate (with Betamix® or Progress[1])	POST	Annual grasses
Sethoxydim	Poast®	7-inch band, broadcast, or micro-rate	POST	Annual grasses
Trifluralin	Treflan® HFP	7-inch band, broadcast, or lay-by (does not need irrigation to activate)	POST	Late emerging annual grasses and some broadleaf weeds
Triflusulfuron-methyl	Upbeet®	7-inch band, broadcast, or micro-rate (with Betamix® or Progress)	POST	Annual broadleaf weeds (kochia, redroot pigweed, common lambsquarters, nightshades, and mustards)

Sources: (Khan, 2011a); (Morishita and Downard, Undated); (Sprague and Everman, 2011)

[1] **Progress is phenmedipham, desmedipham, and ethofumesate. It is applied at micro-rates three to five times at 5-day intervals and at low rates two to three times at 7-day intervals**.

Table III-12. Additional Herbicides that May Be Used in Sugar Beet But Are Not Included in NASS Database

Agricultural Chemical (Herbicide)	Trade Name (Typical)	Context (How is It Used)	General Target
Phenmedipham + Desmedipham + Ethofumesate	Progress (Betamix® + Nortron®)	POST	Annual broadleaf weeds
Flumioxaxin	Valor	PRE	Broadleaf weeds (e.g., preemergence of Amaranthus)
Dimethenamid-P	Outlook	POST	Late emerging annual grasses and some broadleaf weeds
2,4-Dichlorophenoxyacetic acid	2, 4-D	PRE	Broadleaf weeds (e.g., preemergence of Amaranthus)
Alochlor	INTRRO	PRE	Broadleaf weeds (e.g., preemergence of Amaranthus)
Triallate	Far-Go	Spring PPI or fall incorporated after Oct 15 before freeze or snow	Wild oat
S-metolachlor	Dual Magnum	POST	Late emerging annual grasses and some broadleaf weeds
Paraquat	Gramoxone Inteon	Preplant or any time prior to crop emergence (works on emerged weeds)	Nonselective, nonresidual, contact, foliar herbicide
Glufosinate	Ignite 280 (others)	Preplant or any time prior to crop emergence (can work on emerged weeds)	Nonselective, nonresidual, contact, foliar herbicide
Thifensulfuron	Harmony	45 days prior to planting (works on emerged annual broadleaf weeds)	Broadleaf selective, nonresidual, systemic, foliar herbicide

Sources: (Khan, 2011a; Zollinger et al., 2011; Morishita and Downard, Undated)

Table III-13. Maximum Glyphosate Application Rates on H7-1 Sugar Beet

	Acid Equivalent per Acre per Season (lb a.e.)	Active Ingredient per Acre per Season (lb a.i.)	Acid Equivalent per Acre per Application (lb a.e.)	Active Ingredient per Acre per Application (lb a.i.)
Combined Total per Year for All Applications	6	7.32	–	–
Total Preemergence Applications	3.7	4.51	–	–
Total of All Applications Made from Emergence to 8-leaf Stage	2	2.44	1.125	1.37
Total of All Applications Made between 8-leaf Stage and Canopy Closure	1.55	1.89	0.77	0.94

Source: (Monsanto, 2007b; USDA-APHIS, 2011b).

At normal temperatures, glyphosate is a white crystalline substance that is not volatile (is not likely to vaporize at atmospheric pressure) and is highly soluble in water. Glyphosate salts serve as the source of the a.i. *N*-(phosphonomethyl) glycine. To improve handling, performance, and concentration, the glyphosate acid is formulated as a salt compound. Several salts of glyphosate are currently marketed. The term acid equivalent (a.e.) refers to the weight of the glyphosate acid, which is herbicidally active, while a.i. is the weight of the glyphosate acid plus the salt.

Herbicide formulations in liquid form are generally considered trade secret. Surfactants (surface action agents that are soluble in organic solvents and water), such as polyethoxylated tallowamine (POEA), are added to the herbicide formulations to increase leaf penetration.

As listed on the Roundup® herbicide label, Roundup® Original MAX®, Roundup® WeatherMAX®, and Roundup® Ultra MAX II® products contain 48.8 percent of the potassium salt of glyphosate, equivalent to 4.5 lb of glyphosate a.e. per gallon (540 g glyphosate per L). The product is to be applied over-the-top (e.g., spot treatment, broadcast ground application) for preplant, preemergence, and postemergence weed control.

On sugar beet, according to the Roundup® herbicide label, no more than 6 pounds of glyphosate a.e., or 7.32 pounds a.i. per acre may be legally applied per year (see Table 3–13). Of those 6 pounds a.e., no more than 3.7 pounds a.e. (4.51 pounds a.i.) per acre can be applied preemergence, no more than 2 pounds a.e. (2.44 pounds a.i.) per acre can be applied from emergence to the 8-leaf stage, and no more than 1.55 pounds a.e. (1.89 pounds a.i.) can be applied between the 8-leaf stage and canopy closure. No glyphosate applications may be made after 30 days prior to harvest. For post-emergent applications, up to four sequential applications of glyphosate can be made with 10 days between applications. For each application, no more than 1.125 pounds a.e. (1.37 pounds a.i.) per acre may be applied postemergence prior to the 8-leaf stage and no more than 0.77 pound a.e. (0.94 pound a.i.) per acre may be applied after the 8-leaf stage (Table 3–13). According to one report, most H7-1 sugar beet growers typically use two applications of glyphosate per year (Khan, 2010). In the herbicide usage surveys conducted by Stachler et al. (Stachler et al., 2011), the most common herbicide treatment for sugar beet growers (conventional and H7-1) was 0.75 pound a.e. per acre (0.91 pound a.i. per acre). The average total rate of glyphosate applied in 2011 (the average amount applied per acre for the season) by growers of H7-1 sugar beet in Minnesota and Eastern North Dakota was 2.21 lb a.e. per acre (2.70 lb. a.i. per acre).[6] The range of total glyphosate applied per acre by growers of H7-1 sugar beet in 2011 was between 1.80 lb a.e. per acre (2.20 lb a.i. per acre) and 2.67 lb a.e. per acre (3.26 lb a.i. per acre) (Stachler et al., 2011). All of the application rates reported by Stachler et al. (Stachler et al., 2011) and Khan (2010) are within the range of the maximum application rates for glyphosate per application and per season.

Use of Glyphosate with H7-1 Sugar Beet. Glyphosate offers growers several advantages over non-glyphosate herbicides. First, it results in minimal crop injury. Second, it effectively controls most sugar beet weeds including some perennials such as bindweed, Canada thistle, perennial sowthistle, and quackgrass which are not controlled singly or in combination by non-glyphosate herbicides (Sprague and Everman, 2011). Third, it does not necessitate crop rotation restrictions. Fourth., it is more cost effective than using nonglyphosate herbicides (Table 3–38, Table 3–39). Fifth, it offers growers an herbicide with an additional mechanism of action, which as discussed in section 3.C.3.a.(3) is helpful in managing herbicide-resistant weeds. Overall, weed management is considerably simplified because fewer herbicides and herbicide applications are needed, the timing of applications are less critical so weather related application

[6] The average total rate of glyphosate applied per acre is calculated by multiplying the percentage of acres applied at a particular glyphosate rate by the total acres in Table 1, from J. Stachler, A.L. Carlson, M.A. Boetel and M.F.R. Khan, "Survey of Weed Control and Production Practices on Sugarbeet in Minnesota and Eastern North Dakota in 2011," (North Dakota State University Extension, 2012a), vol., by that glyphosate rate. Repeat that procedure for each glyphosate rate, add the pounds applied for each rate, and then divide by the total RR sugarbeet acreage in table 4, from Stachler, Carlson, Boetel and Khan, "Survey of Weed Control and Production Practices on Sugarbeet in Minnesota and Eastern North Dakota in 2011," vol..

delays are less problematic, crop injury from the herbicide application is rarely a problem, and the crop rotation schedule has more flexibility (Kemp et al., 2009). In field trials, an 18-percent increase in sucrose yield was observed in H7-1 sugar beet treated with glyphosate when compared with conventional sugar beet treated with a varied mixture of herbicides (Wilson, 2010). This is consistent with other studies showing a 16-percent increase in yield over conventional treatment (Kniss et al., 2004).

With H7-1 sugar beet, growers may replace the previous practice of disking, plowing, packing, and two cultivations with one strip tillage (Wilson, 2010). Because H7-1 sugar beet crops may not require in-crop tillage, H7-1 sugar beet growers can switch to narrow-row production. With narrower rows, H7-1 sugar beet may achieve canopy closure earlier in the growing season, which can deprive weeds of sunlight and therefore impact late-season weed growth (Wilson, 2010). Regardless of row width, initial glyphosate applications should be made before weeds reach 10 cm in height to maximize yield and minimize weed competition with sugar beet (Armstrong and Sprague, 2010).

Glyphosate can be mixed with recommended fungicides, which may reduce application costs (Khan, 2010).

Other herbicides can be used in conjunction with glyphosate to improve control of glyphosate-resistant weeds. For example, NDSU recommends adding Stinger® (or generic equivalent) to improve control of volunteer soybean, ragweed, and wild buckwheat; Nortron® to improve control of kochia, lambsquarters, pigweed species, and waterhemp; and Upbeet® + methylated seed oil to improve control of lambsquarters, common mallow, redroot pigweed, and velvetleaf (Zollinger et al., 2011). Preliminary research shows possible antagonism when glyphosate is applied with Betamix®, Betanex®, and Progress (Zollinger et al., 2011). Stachler et al. (2011) reported that the most frequently reported herbicide combinations used by RR sugarbeet growers in 2010 in Minnesota and eastern North Dakota were glyphosate plus Stinger® (8.4%) and glyphosate plus Select® (2.0%), the latter used primarily to control RR corn volunteers. In 2011, the most frequent combinations were also glyphosate plus Stinger® (6.4%) and glyphosate plus Select® (2.3%) (Stachler et al., 2012a). For discussion of herbicide resistance, see section III.C.3.a.

As mentioned above in section III.B.1.d(3) in 2000, based on acres treated averaged across all herbicides, approximately 54 percent were ground broadcast, 9 percent were aerial broadcast, and 37 percent were band applied (Dexter and Luecke, 2001). Stachler et al. (Stachler et al., 2011) report that broadcast methods dominate the post- emergent application of herbicides on H7-1 sugar beet. Based on acres treated averaged across all herbicides, these authors report that in 2011 approximately 94 percent were ground broadcast, 4 percent were aerial broadcast, and 2 percent were band applied (Stachler et al., 2012a).

e. Volunteer Control

Volunteers are plants from a previous crop that are found in subsequent crops. Volunteers are often considered a type of weed, not because the volunteer plants have any other inherent weedy characteristics, but simply because the volunteer plants are growing in an area where they are not wanted and might interfere or compete with other planting activities. For many cropping situations, growers often choose to apply herbicide to fields when rotating from one crop to another to avoid competition from both weeds and volunteer plants. In most crops, volunteers grow from seeds left or carried into the field during harvest.

(1) Sugar Beet as Volunteers

If sugar beet bolters are unmanaged and allowed to go to seed, these mature seeds could shatter and disperse in the crop field. Sugar beet seed may survive and germinate in the following year. These plants are called volunteers and theoretically can act as weeds in the following year's planted crop. However, sugar beet bolters rarely produced seed, volunteers do not compete well with crops used in rotation with sugar beet (CFIA, 2002) and sugar beet are "rarely" observed as weeds in cropland (Beckie and Owen, 2007).

Additionally, groundkeepers are a type of volunteer derived from vegetative tissue (small roots) left in the field after harvest, which can grow in the next season if not controlled. In most parts of the United States where sugar beet are grown, beet roots are not expected to survive the winter, so groundkeepers are of little concern (Cattanach et al., 1991; Panella, 2003). In the Imperial Valley, groundkeepers could not survive the intense heat from soil solarization of the late summer (2011). Hence, volunteers are not a problem from the sugar beet root crop in any regions of the U.S..

Because sugar beet seed plants release seed in the field during seed harvest, control of volunteers in seed production fields has been an essential component of production practices developed to maximize seed purity. Most seed left in the upper five centimeters of soil would germinate if the conditions are favorable. Seed that is ploughed deeper may remain dormant until the conditions are optimal for germination. It is known that seed may remain dormant for up to 10 years or longer and still retain part of its germination capacity (Beet Sugar Development Foundation et al., 2011). WCBS has detailed requirements in its protocol for postharvest field management. After harvest, the fields are shallow tilled and irrigated to promote sprouting of shattered seeds. Fall plowing is not allowed by WCBS. Any remaining seed that sprouts is destroyed by herbicides or other means. All equipment is cleaned according to WCBS procedures before it can leave the fields. Fields used for growing H7-1 are inspected by WCBS "for a minimum of five years or until no volunteers are noted." Betaseed has similar requirements (Lehner, 2010). After sugar beet seed production, volunteer sugar beet are very rarely observed in other crops, ditches, or on road sides. If volunteer sugar beet were to occur in the following crop, they could be controlled by broadleaf herbicides or by other agricultural practices, such as tillage during seed bed preparation

(2) Volunteers in Sugar Beet

Volunteer crops from previous rotations can sometimes act as weeds in sugar beet. The many crops that can be used in rotation with sugar beet, for example, wheat, barley, potato, and edible beans, that are not cultivated as Roundup Ready®varieties, can be controlled with glyphosate in H7-1 sugar beet (Khan, 2010). However, surveys of sugar beet growers in Minnesota and North Dakota have determined that volunteer Roundup Ready® corn and soybeans have been identified among the top glyphosate-resistant weeds in glyphosate-tolerant sugar beet fields (Stachler and Luecke, 2009; Stachler et al., 2009b). Volunteer Roundup Ready® corn and soybean in H7-1 sugar beet can be effectively controlled with clethodim and clopyralid, respectively (Bloomquist, 2010; Khan, 2010).

Monsanto Technology Use Guide (TUG) (Monsanto, 2011a) provides specific weed control recommendations for H7-1 sugar beet. The TUG recommends the use of "mechanical weed control/cultivation and/or residual herbicides" with H7-1 sugar beet, where appropriate, and "additional herbicide mechanisms of action/residual herbicides and/or mechanical weed control in other Roundup Ready® crops" rotated with H7-1. See section III.C.3.a for more information on weeds with herbicide resistance.

f. Herbicide Quantity Estimate

This section presents an estimate of herbicide quantities used in conventional and H7-1 sugar beet for 2011 in Minnesota and Eastern North Dakota. The 2000 data are also included to provide an indicator of regional differences as this is the most recent year that national and State-level herbicide application statistics are available for sugar beet root production. The estimate of herbicide use in sugar beet production for 2011 assumes that 90 percent of the Minnesota-Eastern North Dakota acreage is planted with H7-1 sugar beet and 10 percent is planted with conventional sugar beet based on (Stachler et al., 2012a).

(1) Herbicide Usage for Conventional Sugar Beet, 2000

A regional summary of herbicide usage and acres planted for the five sugar beet root production regions is presented in Table 3–14, below.

Table III-14. Summary of Herbicide Applications by Sugar Beet Growing Region in 2000

Agricultural Chemical (Herbicide)	Trade Name (Typical)	Midwest Total Applied per Year (lbs ai)	Great Plains Total Applied per Year (lbs ai)	Northwest Total Applied per Year (lbs ai)	Great Lakes Total Applied per Year (lbs ai)	Imperial Valley Total Applied per Year (lbs ai)	Total
Clethodim	Select®	62,000	11,000	3,000	NR[1]	ND[2]	76,000
Clopyralid	Stinger®	68,000	14,000	10,000	10,000	NR	102,000
Cycloate	Ro-Neet™	ND	37,000	79,000	16,000	NR	132,000
Desmedipham	Betanex®	175,000	28,000	35,000	21,000	11,000	270,000
EPTC	Eptam®	NR	15,000	156,000	NR	NR	171,000
Ethofumesate	Nortron®	18,000	27,000	31,000	3,000	3,000	82,000
Glyphosate	(Several)	26,000	17,000	23,000	NR	9,000	75,000
Phenmedipham	Betamix®	80,000	25,000	35,000	19,000	11,000	170,000
Pyrazon	Pyramin®	NR	NR	NR	66,000	NR	66,000
Quizalofop-p-ethyl	Assure® II	4,000	ND	3,000	2,000	NR	9,000
Sethoxydim	Poast®	23,000	ND	7,000	NR	25,000	55,000
Trifluralin	Treflan® HFP	23,000	NR	12,000	NR	7,000	42,000
Triflusulfuron-methyl	Upbeet®	14,000	4,000	8,000	2,000	ND	28,000
Total herbicides applied in 2000 (lbs ai.)		**493,000**	**178,000**	**402,000**	**139,000**	**66,000**	1,278,000
Acres planted in 2000[3,4]		748,000	271,400	256,600	189,000	98,000	
Pounds of herbicide per total acres planted		0.66	0.6	1.55	0.74	0.67	

Pesticide Usage Source: (USDA-NASS, 2008).

[1] NR = None Reported, No use of the herbicide was reported in the region.

[2] ND = No Data were reported for total herbicide applied per year (lb), although the available data indicated that the herbicide was applied in the region; see [tables G1 through G11] in appendix G.

[3] Note that 15,600 acres in western North Dakota are grouped with the Midwest for this table because the herbicide data are grouped in this manner. Note this is why the acres for 2000 are different for the Midwest and Great Plains by 15,600 acres compared to Table 3–5.

[4] Data on acres planted are from the USDA 2000 Crop Production Survey (USDA-NASS, 2001). Data on plantings were reported for Ohio (1,200 acres), but no herbicide data were reported in the Agricultural Chemical Use Database for Ohio, so the acreage was omitted from this table.

Table III-15. Relative Herbicide Use [1]

Herbicide	Midwest	Great Plains	Northwest	Great Lakes	Imperial Valley
Clethodim	7.1	3.5	1.0	nr	nd
Clopyralid	2.3	1.3	1.0	1.4	nr
Cycloate	nd	1.6	3.6	1.0	nr
Desmedipham	2.1	0.9	1.2	1.0	1.0
EPTC	nr	1.0	11.0	nr	nr
Ethofumesate	1.0	4.1	5.0	0.7	1.3
Glyphosate	1.0	1.8	2.6	nr	2.6
Phenmedipham	1.2	1.0	1.5	1.1	1.2
Pyrazon	nr	nr	nr	OR[2]	nr
Quizalofop-p-ethyl	1.0	nd	2.2	2.0	nr
Sethoxydim	1.1	nd	1.0	nd	9.4
Trifluralin	1.0	NR	1.5	nr	2.3
Triflusulfuron-methyl	1.8	1.4	2.9	1.0	nd

1Pounds of herbicide applied per region divided by acres planted. For each herbicide, data was normalized to the region with the lowest rate

2OR-only region reporting use of this herbicide

The sugar beet growing regions, listed in order of most acres planted, are: Midwest (Minnesota and North Dakota), Great Plains (Colorado, Montana, Nebraska, Wyoming), Northwest (Idaho, Oregon, Washington), California (at this time production still occurred in the Central Valley), and Great Lakes (Michigan). Herbicide usage statistics in Table 3–14 are based on 2000 data from the USDA–NASS Agricultural Chemical Use Database (USDA-NASS, 2008), and data for total acreage planted in each region are based on the USDA 2000 Crop Production Survey (USDA-NASS, 2001). Though the USDA Agricultural Chemical Use Database was last updated in 2008, the most recent data for herbicide use are from 2000. Tables containing the usage data for the individual States in each growing region are presented in appendix G (see tables G–1 through G–11), and are based on the same USDA data for 2000 (USDA-NASS, 2008). These data show the relative application amounts for each of the herbicides used in sugar beet for that year, and give a national-level overview of sugar beet herbicide use before H7-1 sugar beet was commercially available. These data are useful for a comparison of differences in regional practices before the availability of H7-1 sugar beet.

Data were reported on sugar beet acres planted in Ohio in 2000, but no herbicide usage statistics were available for Ohio from USDA–NASS (2008a). For this reason, Ohio has not been included in this analysis. The

Midwest Region (Minnesota and North Dakota) planted the greatest number of sugar beet acres in 2000, nearly 100,000 acres more than the second largest region, the Northwest Region (Idaho, Oregon, Washington). The Northwest Region had the highest total herbicide application per acre, at a rate nearly double that of the Great Lakes Region, which had the second-highest rate per acre. The high poundage in the Northwest is attributable in part to the much greater use of preplant incorporated herbicides such as ethofumesate, EPTC, and cycloate which are applied at much higher application rates (Table 3–15, Table 3-16). Relatively high amounts of ethofumesate were also used in the Great Plains Region. In the Great Lakes region, the predominant PPI herbicide was pyrazon and this herbicide did not seem to be used in the other regions. The Midwest and Great Plains Regions used more clethodim for grass control while in California, much more sethoxydim was used relative to other regions.

Table III-16. Herbicide Applications to Conventional Sugar Beet Acres[1] in the United States, 2000

Agricultural Chemical (Herbicide)	Trade Name (Typical)	WSSA Mechanism of Action Group No.[2]	Acreage Treated (%)	No. of Applica-tions per Year	Rate per Application (lb/app./acre)	Rate per Acre (lb/acre)	Total Applied per Year (lb)
Clethodim	Select®	1	46	2.5	0.04	0.11	76,000
Clopyralid	Stinger®	4	74	2.8	0.03	0.09	102,000
Cycloate	Ro-Neet™	8	5	1	1.84	1.84	132,000
Desmedipham	Betanex®	5	94	2.8	0.07	0.18	270,000
EPTC	Eptam®	8	6	1	2.61	2.61	171,000
Ethofumesate	Nortron®	8	37	2.1	0.06	0.14	82,000
Glyphosate	(Several)	9	13	1.1	0.39	0.43	75,000
Phenmedipham	Betamix®	5	80	2.6	0.05	0.14	170,000
Pyrazon	Pyramin®	5	6	1	0.82	0.82	66,000
Quizalofop-p-ethyl	Assure® II	1	10	1.6	0.04	0.06	9,000
Sethoxydim	Poast®	1	11	1.7	0.19	0.33	55,000
Trifluralin	Treflan® HFP	3	5	1	0.65	0.66	42,000
Triflusulfuron-methyl	Upbeet®	2	83	2.7	0.008	0.02	28,000
Total							**1,278,000**

Pesticide usage source: (USDA-NASS, 2008).
[1] **1.565 million acres were planted in the United States in 2000. All values are averages.**
[2] **Source: (WSSA, 2007).**

(2) Herbicide Usage for H7-1 and Conventional Sugar Beet, 2011

An annual survey conducted in Minnesota and Eastern North Dakota, where about half the U.S. sugar beet are produced, was used to compare herbicide use on conventional and H7-1 sugar beet from the 2011 growing season (Stachler et al., 2012a). No national data is available that makes this herbicide use comparison. The most recent national herbicide use data was collected in 2000 before H7-1 sugar beet was grown. Therefore,data limitations prevent a national analysis. Nevertheless the data set reflects the most current herbicide use rates capturing changes that might be occurring over time due to weed shifts and allows a comparison of data on the two types of beet from the same year that minimizes seasonal differences in herbicide use rates.

Herbicide use estimates for conventional and H7-1 sugar beet based on 2011 herbicide use rates are shown in Table 3–17A and B, respectively. The assumptions made for estimating herbicide usage are:

- The 2011 acreage for conventional sugar beet in this region was determined by consultation with Todd Geselius, Vice President of Agriculture at Southern Minnesota Beet Sugar Cooperative, Daniel Bernhardson, Director of Agriculture at American Crystal Sugar, and Tom Knudsen, Vice President of Agriculture at Minn-Dak Farmers Cooperative (Bernhardson et al., 2012). According to these sources, a total of 72,900 acres of conventional sugar beet were produced out of a total of 693,740 acres. The percentage of acreage used to grow conventional sugar beet was about 10.5%. H7-1 sugar beet was grown on 620,840 acres consisting of about 89.5% of the total sugar beet acreage.

- The percentage of acres treated with each herbicide were based on Table 1 in (Stachler et al., 2012a). Total acres treated were calculated by multiplying the percentage of acres treated by 693,740 acres.

- Amounts of herbicide applied by banding or broadcast were estimated from Table 33 in (Stachler et al., 2012a). Where applied by banding, the herbicide rate was assumed to be 1/2 the broadcast rate (i.e the banded application is applied to an 11” band as opposed to a 21” row) (Bernhardson et al., 2012).

- The conversion for glyphosate from pounds a.e. to pounds a.i. was based on a ratio of 4.5 pounds a.e. to 5.5 lb. a.i. according to the ratios listed by (Hartzler et al., 2006). These values are typical of glyphosate products labeled for use on sugar beet including Roundup® Original MAX®, Roundup® WeatherMAX®, and Roundup® Ultra MAX II®, which all contain 48.8 percent of the potassium salt of glyphosate.

- The following herbicide use rate assumptions were made based on discussions with Jeff Stachler, Todd Geselius, Daniel Bernhardson, and Tom Knudsen, (Bernhardson et al., 2012),:
    - 1) single rate application rates, as indicated in column 5 of Table 3-17, for clethodim, clopyralid, dimethenamid-p, ethofumesate (preplanting), ethofumesate (postplanting), glyphosate preplanting, quizalofop, and trisulfuron-methyl;
    - 2) seasonal applications rates for desmedipham and phenmedipham as indicated in column 9 of Table 3-17.
- The 2011 seasonal glyphosate use rate on H7-1 sugar beet was estimated to be 2.21 lb. a.e./acre (Stachler et al., 2012a). This rate corresponds to 2.7 lb. a.i./acre.
- Herbicide pounds a.i. applied regionally was calculated as either:
    - (total acres x fraction broadcast x single applicate rate broadcast) + (total acres x fraction banded x single application rate banded) or
    - by multiplying the seasonal rate by the seasonal acres.
- The last column in Table 3-17 normalizes the data assuming sugar beet production is either 100% conventional or 100% H7-1. For the data in A. values were divided by 0.105 (the fraction of conventional beet planted in 2011; for the data in B, values were divided by 0.895 (the fraction of H7-1 beet planted in 2011).

Table III-17. Estimated Herbicide Use on A. Conventional Sugar Beet and B. H7-1 Sugar Beet in Minnesota and Eastern North Dakota in 2011.

Herbicide Active Ingredient	% Acres Treated[1]	Total Acres[2]	Fraction Broadcast[3]	Single Application Rate Broadcast[4]	Fraction Banded[5]	Single Application Rate Banded[6]	Seasonal Acres[7]	Seasonal Application Rate[8]	Actual # ai Applied[9]	Theoretical #ai for 100%[10]
A. Conventional Sugar Beet										
Clethodim	44.5	308714	1	0.09375	0	0.0469			28,942	275,638
Clopyralid	49.5	343401	0.91	0.046875	0.09	0.0234			15,373	146,405
Desmedipham	57.1	396126	0.91		0.09		72,900	0.38	27,702	263,829
Dimethenamid-P	0.9	6244	0.75	0.98	0.25	0.4900			5,354	50,990
Ethofumesate (Pre)	5.3	36768	0.11	3.75	0.89	1.8750			76,524	728,799
Ethofumesate (Post)	40.2	278883	0.91	0.125	0.09	0.0625			33,292	317,064
Glyphosate (Pre)	3.4	23587	1.00	1.22	0.00	0.6100			28,776	274,060
Phenmedipham	57.1	396126	0.91		0.09		72,900	0.38	27,702	263,829
Quizalofop	1.8	12487	1	0.04125	0	0.0206			515	4906
Trisulfuron-Methyl	52.6	364907	0.91	0.0078125	0.09	0.0039			2,723	25,929
Total Conventional										2,351,448
B. H7-1 Sugar Beet										
Clethodim	8.9	61743	1	0.09375	0	0.0469			5,788	6,467
Clopyralid	9.6	66599	0.96	0.046875	0.04	0.0234			3,059	3,,418
Ethofumesate (Pre)	1	6937	1.00	3.75	0.00	1.8750			26,015	29,067
Glyphosate							620,840	2.7	1,676,268	1,872,925
Quizalofop	1	6937	1	0.04125	0	0.0206			286	318
Total H7-1										1,912,196

[1]Source: Table 1 in (Stachler et al., 2012a); [2]Assumes total acres planted=693,740 (Stachler et al., 2012a). Calculated as % acres x 693,740
[3]Source: Table 33 in (Stachler et al., 2012a); [4]Source: consultation with J. Stachler and Coop Agronomists. [5]Source: Table 33 in (Stachler et al., 2012a).
[6]Assumes rate is 1/2 broadcast based on 11" band vs 21" row; [7]Seasonal acres determined by consultation with Coop Agronomists.
[8]Source:seasonal rates: desmedipham and phenmedipham determined by consultation with Jeff Stachler and Coop Agronomist; glyphosate (Stachler et al., 2012a)
[9]Calculated as (total acres X fraction broadcast x single application rate broadcast) + (total acres x fraction banded x single application rate banded) or seasonal acres x seasonal application rate; [10]Calculated by dividing pounds ai applied by 0.105 for conventional beet and 0.895 for H7-1 beet.

The purpose of the herbicide usage estimate discussed in this section is to a compare the herbicide use on conventional and H7-1 sugar beet to illustrate the change in herbicide production practices with the introduction of H7-1 sugar beet. Differences in herbicide use are summarized in Table 3-18. These changes in herbicide use are discussed further in other sections of this document to evaluate potential impacts of the adoption of H7-1 sugar beet.

Table III-18. Estimated Differences in Herbicide Use on Conventional and H7-1 Sugar Beet in Minnesota and Eastern North Dakot in 2011[1]

Herbicide Active Ingredient	#ai Applied Assuming only Conventional Sugar Beet	#ai Applied Assuming only H7-1 Sugar Beet	Difference (H7-1 - Conventional)	Fold Change
Clethodim	275,638	6,467	-269,171	-43
Clopyralid	146,405	3,418	-142,987	-43
Desmedipham	263,829	0	-263,829	nc*
Dimethenamid-P	50,990	0	-50,990	nc*
Ethofumesate (Pre)	728,799	29,067	-699,732	-25
Ethofumesate (Post)	317,064	0	-317,064	nc*
Glyphosate	274,060	1,872,925	1,598,865	7
Phenmedipham	263,829	0	-263,829	nc*
Quizalofop	4,906	318	-4,588	-15
Trisulfuron-Methyl	25,929	0	-25,929	nc*
Total	**2,351,449**	**1,912,195**	**-439,254**	**-1.22**

[1]Calculated from Table 3-17; nc*=not calculated because this herbicide was not applied to H7-1 sugar beet in 2011

As can be seen in Table 3-18, glyphosate is the only herbicide that shows an increase in use in H7-1 sugar beet where it increases 7 fold relative to conventional sugar beet correcting for planting frequency. In terms of pounds of herbicide applied, glyphosate represents nearly 12% of the herbicide applied to conventional sugar beet where it is used as a preplant herbicide. In H7-1 sugar beet, it is rarely used for this purpose. In terms of pounds of herbicide applied, it represents 98% of the herbicide applied to H7-1 sugar beet.

Eight other herbicides were used on conventional sugar beet in 2011. All decreased markedly on H7-1 sugar beet. The dominant herbicide applied to conventional sugar beet is ethofumesate where it comprised 44% of the pounds of herbicide applied. Its use on H7-1 sugar beet decreased about

25 fold as a preplant herbicide and it was no longer used as a post-emergent herbicide. Ethofumesate shows promise as a residual herbicide to help manage glyphosate-resistant weeds (Kniss et al., 2010; Stachler and Luecke, 2011; Wilson Jr and Sbatella, 2011) so its use on H7-1 sugar beet is likely to increase in the future. Four herbicides, desmedipham, dimethenamid-p, phenmedipham, and trisulfuron-methyl were used on conventional beet in 2011 but were not used on H7-1 sugar beet. Clethodim and clopyralid use decreased about 43 fold on H7-1 compared to conventional beet. Clopyralid also shows promise to help manage glyphosate-resistant weeds (Fisher et al., 2009; Stachler et al., 2009c) so its use is likely to increase in the future, too . Overall pounds of herbicide decreased about 20% on H7-1 sugar beet relative to conventional sugar beet. As glyphosate-resistant weeds become more prevalent, more non-glyphosate herbicides are likely to be used and overall pounds of herbicide applied to H7-1 is expected to increase. . The impacts of these changes in herbicide use are discussed further in chapter IV of this document. Trends in herbicide use are discussed in the cumulative impacts section.

2. Swiss Chard

As stated above in section III.B.1, Swiss chard (*Beta vulgaris* ssp. *cicla*), sugar beet, table beet, and fodder beet are all the same species meaning that they are all sexually compatible and can interbreed with each other (OECD). In the United States, varieties of chard are commonly referred to as Swiss chard, but they are also called silverbeet, perpetual spinach, spinach beet, crab beet, and seakale beet. For simplicity, this crop is referred to as Swiss chard throughout the EIS. Swiss chard is grown both for seed and for food in the United States.

Like all *Beta* crops, Swiss chard is a hardy biennial and requires 2 years to complete its lifecycle. Swiss chard seed is produced by both commercial producers and home gardeners. Similar to sugar beet, the majority of commercial Swiss chard seed production occurs in the Northwest. Seeds can be produced in other parts of the country if roots are dug up before the ground freezes and then replanted in the spring. The steckling method is described above in section III.B.1.b(14). Commercial Swiss chard seed is not usually hybrid and is produced through open, wind pollination. Home gardeners also produce seed though open pollination.

Swiss chard grown for vegetable production occurs throughout the United States by both commercial producers and home gardeners. Swiss chard differs from sugar beet and table beet in that it lacks a fleshy root. It is grown for its foliage, or large leafy greens, in a manner similar to spinach or lettuce (Desai, 2004). The Swiss chard plant grows until it's growth is stopped by a hard freeze. The plant can be harvested all at once or leaves can be collected over the course of a season.

a. Seed Production

(1) Location

In the United States in 2011, APHIS is aware of commercial Swiss chard seed production occurring on approximately 600[7] acres in Arizona, California, Oregon, and Washington. Table 3–19 lists counties and shows the State acreage of commercial Swiss chard seed production in 2011. Commercial Swiss chard seed acreage was determined through publications from the Washington State Extension Office (McMoran et al., 2010) and personal communications with State Extension Officers in Oregon and Washington and commercial seed producers (Dorsing, 2011; Falconer, 2011; Mcmoran, 2011a; McReynolds, 2011). Swiss chard seed acreage reported in the Willamette Valley represents all of the commercial Swiss chard seed being produced by members of the WVSSA in 2011. Any non-members of the WVSSA who are growing Swiss chard seed in the Willamette Valley in 2011 are not captured in the above acreage.

Table III-19. 2011 Acreage of Swiss Chard Seed Production in the United States

State	County	Acreage	References
AZ	Yuma	20	(Dorsing, 2011)
CA	Butte, Colusa, Glenn, Monterey	1–125[1]	(McReynolds, 2011), (Falconer, 2011)
OR	Benton, Clackamas, Jackson, Linn, Marion, Polk, Washington, Yamhill	300[2]	(McReynolds, 2011), (Dorsing, 2011)
WA[3]	Skagit, Snohomish	150	(Mcmoran, 2011a)
Total U.S. Acres		**<605**	

[1] **Unknown combination of acreage growing Swiss chard & table beet seed.**
[2] **Including 8 acres of Certified Organic acres.**
[3] **Although Swiss chard seed has been historically grown in Whatcom and Lewis Counties, WA, the last available data were for 2007 (McMoran et al., 2010). Swiss chard was not identified as having been grown in those counties in 2011, and therefore, those counties are not represented here.**

Based on this information, APHIS determined that in 2011, commercial Swiss chard is being grown in the following counties: western Washington

[7] The information APHIS received on acreage of Swiss chard production in California for Glenn, Colusa, and Butte Counties was aggregate data with combined acreage for both Swiss chard and table beet. Therefore,actual acreage of Swiss chard and table beet in each of the individual counties is not known. For the purposes of the EIS, APHIS will assume the highest possible acreage for both of the crops by estimating that the acreage of each is up to 125 acres. (See Table 3–20.)

(Skagit and Snohomish), Arizona (Yuma), California (Monterey, Glenn, Colusa, and Butte), and Oregon (Marion, Polk, Yamhill, Washington, Benton, Linn, Clackamas and Jackson). The commercial Swiss chard seed production acreage in Benton and Jackson counties in Oregon is being produced following organic standards. The acreage and location of Swiss chard seed being produced by home gardeners is unknown.

Fig. 3–10 shows a map of all known commercial Swiss chard seed-producing counties from 2007 to 2011. Fig. 3–10 includes all of the counties listed in Table 3–19 above and additionally includes Whatcom and Lewis counties in Washington. While Whatcom and Lewis counties were not identified as counties in which commercial Swiss chard seed was produced in 2011, they are included here as they have historically produced Swiss chard seed (McMoran et al., 2010).

It is entirely possible that not all commercial Swiss chard seed production in 2011 has been captured through the aforementioned research efforts. However, information on Swiss chard acreage and areas of production from previous years indicates that the major areas of U.S. Swiss chard seed production are represented above (Loberg, 2010b; McMoran et al., 2010). The acreage of commercial Swiss chard production in each area varies from year to year due to changes in demand for seed and crop rotation cycles (Loberg, 2010b; McReynolds, 2011).

Based on the information above, in 2011 approximately half of commercial Swiss chard seed was produced in Oregon, a quarter of Swiss chard seed was produced in Washington, slightly less than a quarter was produced in California, and the remainder was produced in Arizona.

> As mentioned in III.B.1.b(1), Willamette Valley, Oregon is the major commercial vegetable seed producing region in the United States. In addition to other types of vegetable seeds, seed production for sugar beet, Swiss chard, and table beet all occur in Willamette Valley. Approximately 98 percent of known commercial Swiss chard seed production in Oregon, (equaling about half of U.S commercial Swiss chard seed production) in 2011 is being grown in Willamette Valley. Willamette Valley is the only known commercial Swiss chard seed production area where gene flow could occur between Swiss chard and H7-1 sugar beet as both types of *Beta* species are grown for seed production in the same counties. For a map showing the counties where H7-1 sugar beet are grown see Fig. 3–1. For a map showing the counties where Swiss chard are grown see Fig. 3–10. Vegetable beet seed production (Swiss chard and table beet) and sugar beet seed production both occur in six counties in the Willamette Valley of Oregon (Marion, Clackamas, Polk, Washington, Benton, and Linn) and one county in Southern Oregon, (Jackson), shown in brown in Fig. 3–12. For more

information on gene flow and a map of sugar beet and Swiss chard seed production see section III.B.5 and Fig. 3-12.

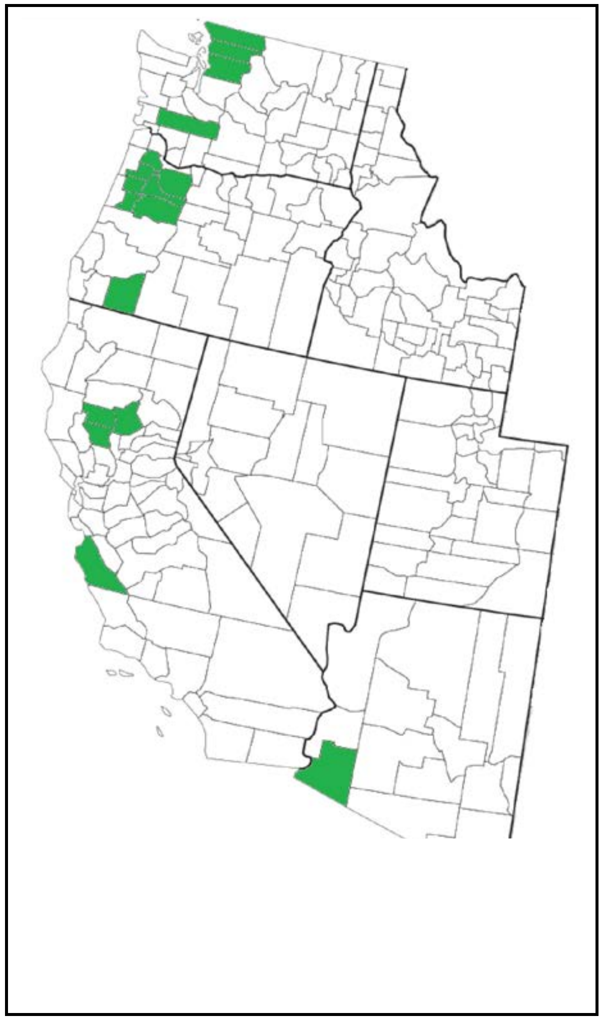

Figure 3-10. Map of known counties in which commercial Swiss chard seed is, or was historically, produced

Counties shown on the map have been identified as Swiss Chard Seed producing between 2007 and 2011. (Sources: (Dorsing, 2011)

(2) Breeding

Swiss chard has had the least systematic breeding efforts for crop improvement as compared to sugar beet and table beet. Mass selection and collection of seed from open-pollinated plants have been the principal methods for developing new varieties with the desired characteristics (Desai, 2004).

(3) Seed Crop Producers

Swiss chard seed production, much like sugar beet seed production, consists of developing, growing, and processing the seed that Swiss chard growers use to plant their crop. Unlike sugar beet seed production, both commercial growers and home gardeners produce Swiss chard seed.

Commercial Swiss Chard Seed Production. Most commercial Swiss chard seed production is typically conducted under bailment contracts, whereby a seed company (bailor) provides a grower with the seed necessary to produce a crop. The seed company retains ownership of the seed, the growing crop, and the resulting harvested seed. The growers (bailees) produce and harvest the crop and are paid the contract price for the resulting seed. Seed contracts typically specify quality criteria that a grower must meet to be paid for the crop. These criteria include germination percentage and purity. Most seed crops must meet an 85 percent germination rate and must be cleaned to 99 percent purity (du Toit et al., 2007).

Market seed is produced and used for vegetable production, while stock seed is grown specifically for use in planting seed crops. APHIS is aware of 8 acres of organic Swiss chard seed being produced in 2011 (equaling ~ 1 percent of the known commercial seed production for Swiss chard) all of which is occurring in Oregon (McReynolds, 2011). This may be an under-representation of organic commercial Swiss chard seed production acreage, as one of the commercial Swiss chard and table beet growers indicated that on average, 5 to 10 percent of their combined Swiss chard and table beet acreage was organic (Lyons, 2011c). The commercial Swiss chard seed grown in the United States, whether grown following organic or conventional methods, is primarily grown for GE-sensitive markets (McReynolds, 2011).

While the size of seed markets vary based on market demand, estimates from seed producers indicate that up to 50 percent of Swiss chard seed grown in the United States is exported annually (McReynolds, 2011) (Lyons, 2011c).

Home Gardener Swiss Chard Seed Production. By definition, home gardeners grow Swiss chard seed for their own personal use and do not grow seed under contract. Home gardeners may or may not use organic methods and may or may not be GE-sensitive.

Non-U.S. Swiss Chard Seed Production. In addition to growing Swiss chard seed domestically, many of the commercial Swiss chard seed producing companies also produce seed overseas. The main foreign countries where Swiss chard seed is grown are New Zealand, Australia, and China (McReynolds, 2011). There are two main reasons as to why commercial seed companies grow Swiss chard seed overseas:

- **Doubling the growing seasons.** The growing seasons in New Zealand and Australia are opposite of those in the United States. By growing seed in both areas, seed producers can essentially double the rate of breeding and seed production by doubling the number of growing seasons per year.

- **Increasing the amount of land available**. There is a limited amount of land for seed production, especially in Willamette Valley, Oregon. The isolation distances currently being used between *Beta* species in Willamette Valley limits the number of growers who can produce *Beta* seed (McReynolds, 2011). For more information on isolation distances in Willamette Valley see section III.B.1.b(10).

(4) Planting and Lifecycle

As stated above, Swiss chard is a biennial plant that requires 2 years to produce seeds. In the second year, after exposure to vernalizing temperatures, the plant produces a tall seed stalk completing the lifecycle.

Seeds are harvested after the base of the flowering stalk has turned brown. At harvest plants are cut, windrowed, and dried in the field for 10-14 days. While the crop is drying, it is hand turned to prevent molding. Seed is taken to a conditioning plant where it is cleaned to 99 percent purity (McMoran et al., 2010).

Weed seed that cannot be sorted out from the harvested Swiss chard seed can reduce the market value of the seed crop or cause it to be unmarketable (McMoran et al., 2010).

Swiss chard seed can be produced using either the direct-seeded method or the steckling method. Both of these methods can be used by commercial producers and home gardeners and are described in greater detail below.

(5) Direct-Seeded Method

The direct-seeded method, also called the 'over wintering method' involves planting the desired variety of Swiss chard seed in the field in the late summer to early fall and harvesting the seed the next fall. The direct-seeded method is only suitable for mild climates, such as those found in the Northwest, which is why the majority of commercial Swiss chard seed production occurs in this area.

Commercial Swiss Chard Seed Production. For commercial production in the Northwest, seed is typically planted in August to September, depending on the variety and the specific location (Desai, 2004; McMoran et al., 2010). Slower growing varieties are planted earlier than faster growing varieties. Recommended spacing is 16 inches between plants and 35 inches between rows (Desai, 2004). As the weather becomes colder, the plants become dormant and are vernalized in the ground. Plants begin to bolt to form a flowering stalk in the spring, produce pollen during the late spring-early summer, and seeds in the late-summer. The exact timing for bolting, flowering and seed setting are highly dependent on the specific variety of Swiss chard and the growing conditions.

For an example of timing, the OrCa Seed Production Inc. production schedule from 2010 shows that commercial Swiss chard seeds are direct-seed planted in August, the estimated bloom date is in May–June and the estimated harvest date is August to September (OrCa Seed Production Inc., 2010b). Note that the production schedule does not indicate the location of the Swiss chard seed production. OrCa Seed Production Inc. produces seed in both Oregon and California (OrCa Seed Production Inc., 2010a).

The advantages of the direct seeded method are reduced labor and expenses and that no storage is required compared to the steckling method. The major disadvantages of the direct seeding method are that it can only be used in appropriate climates and it requires more seed,

Home Gardener Swiss Chard Seed Production. Home gardeners producing Swiss chard seed in the Northwest could also use the direct seeded method and would likely follow similar production methods to those of commercial producers. Home gardeners producing Swiss chard seed in other regions with more severe winters would need to use the steckling method described below.

(6) Steckling Method

Stecklings are Swiss chard roots that are grown from seed for less than a full season and are dug up in the spring for replanting after either vernalization in the ground in milder climates or refrigerated storage in colder climates.

Commercial Swiss Chard Seed Production. For commercial production in the Northwest, seeds are typically planted in mid-June to August, depending on the variety and the specific location (Desai, 2004); (McMoran et al., 2010). Slower growing varieties are planted earlier than faster growing varieties. Seeds can be planted either with two rows per bed or as a single row. Row spacing varies from 16 to 35 inches. Depending on method used, 1 acre of stecklings can be used to plant 10 to 20 acres for seed production (Desai, 2004). Plants are rogued for off-types in the fall. In Washington, plants are allowed to overwinter in the field (McMoran et al., 2010).

For an example of timing, in Skagit County, Washington under ideal weather conditions, Alf Christenson Seed Company typically plants Swiss chard stecklings into seed production fields around April 15th, and the estimated bloom date is early June to July (Lyons, 2011a). A harvest time of August is typical for the State of Washington (McMoran et al., 2010).

The major advantage of the steckling method is that it utilizes less seed and provides flexibility in production. For example, young seedlings which are more sensitive to disease can be grown in a disease free region and then transplanted into another where isolation distances can be met. The major disadvantages of the steckling method is that it requires additional labor and expenses and storage is required if roots are not overwintered in the field (Desai, 2004).

Home Gardener Swiss Chard Seed Production. Home gardeners producing Swiss chard seed in the Northwest could also use the steckling method and would likely follow similar production methods to those of commercial producers.

Home gardeners producing Swiss chard seed in other regions would need to modify the production method according to their specific environmental conditions. Swiss chard seeds are planted as early in the season as possible; Swiss chard can be direct seeded mid-spring after danger of frost has passed through mid-summer and into fall in warmer regions (High Mowing Organic Seeds, 2011b). Stecklings are dug up in the fall and any leaves an inch or more above the crown are cut off. In colder climates the stecklings are stored for the winter at temperatures between 32 to 34 °F under conditions of high humidity. In the spring, stecklings are planted outside at a spacing of 6 to 10 inches between plants and 16 to 24 inches between rows. Based on the specific variety and local environmental conditions, plants bolt and flower at varying times during the summer and set seed in the fall.

(7) Isolation Distances

Production of high quality Swiss chard seed requires that the “correct” seed parent be fertilized by the “correct” pollen source. Swiss chard seeds will not meet the quality criteria demanded by purchasers if the percentage of off-type seeds, resulting from unwanted cross-pollination, exceeds contractual thresholds.

Off-type seeds can result from a variety of sources. These sources include gene flow between different Swiss chard varieties, between Swiss chard and table beet and between Swiss chard and sugar beet. Open pollinated varieties usually produce more pollen than do the pollen parents used in hybrid production. Furthermore, in open pollinated fields, every plant produces pollen whereas in hybrid production less than one in four plants produces pollen. As a result, Swiss chard seed production, which most often uses open pollination, generates more than four times as much pollen/acre as hybrid seed production (Westgate, 2010). This means that gene flow from Swiss chard pollen into a hybrid seed crop such as sugar beet seed is more likely than gene flow from sugar beet pollen into Swiss chard. For more on pollen competition see section III.B.5. If detectable levels of gene flow were to occur from H7-1 sugar beet into Swiss chard seed fields, the Swiss chard seed producer may not be able to sell the seed to GE-sensitive purchasers, depending on the level of gene flow and the tolerance level for the presence of a GE trait such as H7-1. For more on gene flow see section III.B.5.

The main process through which Swiss chard seed producers ensure that the desired pollen fertilizes the desired seed donor is to use isolation distances. As described in section III.B.5 below, pollination rates, or gene flow, decreases rapidly as distance from the pollen source increases (Eastham et al., 2002; Darmency et al., 2009). Therefore, just like sugar beet seed producers, Swiss chard seed producers follow strict isolation distances when producing Swiss chard seed, as described below.

APHIS is aware of three major regions in the United States that grow multiple *Beta* species for commercial seed production. See Fig. 3–12. These regions are: (1) Willamette Valley, Oregon (Swiss chard, table beet, and sugar beet seed production), (2) Skagit and Snohomish Counties in western Washington (table beet and Swiss chard) and (3) Butte, Colusa, and Glenn Counties in California (table beet and Swiss chard). Commercial *Beta* species producers in each of these regions are known to have either formal or informal isolation distances in place to ensure contractual levels of seed purity.

As mentioned in III.B.1.b(10), all growers of commercial specialty seed in the Willamette Valley, including all commercial companies producing Swiss chard, table beet and sugar beet, are members of the WVSSA. WVSSA has strict (although not mandatory) isolation distances and pinning guidelines for growers to follow. As shown in Table 3–3 the isolation distances between *Beta* species range from 1 to 4 miles depending on the specific species, variety and type of pollination used. The minimum isolation distance between Swiss chard and H7-1 sugar beet is 3 miles (WVSSA, 2008). Note that the sugar beet seed producer Betaseed uses a minimum of a 4 mile isolation distance between H7-1 sugar beet seed production and other *Beta* species. For more information see section III.B.1.b(11).

In western Washington, the WSU Northwest Washington Research & Extension Center (NWREC) at Mount Vernon houses a pinning map that covers Skagit, Snohomish, Whatcom, and Island Counties. Isolation distances for *Beta* species (Swiss chard and table beet) used by the WSU NWREC are similar to those used by the WVSSA (McMoran, 2011b). In addition to the WSU NWREC pinning rules, most commercial Swiss chard seed producers maintain an isolation distance of at least 5 miles between *Beta* species (Mcmoran, 2011a). H7-1 sugar beet seed is not produced in this region.

California has the California Seed Growers Isolation Pin Map System. The membership-only, online pinning system is hosted by University of California at Davis. However, the map does not include *Beta* species (CCIA, 2011). While APHIS is not aware of any formal pinning schemes being used in this region, *Beta* seed producers work cooperatively on an informal basis and use isolation distances to minimize gene flow (Wahlert, 2011). H7-1 sugar beet seed is not produced in this region.

In many of the counties listed above, increased urbanization and the presence of home gardeners (who do not participate in pinning) have made it more difficult to control pollen flow and ensure that adequate isolation distances are maintained (McMoran et al., 2010; Wahlert, 2011).

(8) Fertilization

For optimum growth and quality seed production, Swiss chard needs to be fertilized, especially during the bolting and flowering phase. Soil tests should be done to determine the amount of nitrogen in the soil. As a general rule, a ratio of 5:10:5 of nitrogen:phosphorus:potassium fertilizer is recommended (Desai, 2004). Producers growing organic Swiss chard seed can only apply fertilizers that are in compliance with the National Organic Program Standards (NOP) (7 CFR § 205.203). Home growers may or may not apply fertilizers.

(9) Crop Rotation

To prevent buildup of pathogens in the soil, to reduce disease and weed pressure, and to manage volunteers, Swiss chard is generally grown on a 3 to 5 year crop rotation (McMoran et al., 2010).

(10) Swiss Chard Pests and Control Measures

Weeds. In Washington State, vegetable seed crops are not considered to be grown for food or feed, and thus categorized differently in terms of pesticide use. On these sites, pesticide use may include chemicals and amounts of chemicals not permitted on food and or feed crops (McMoran et al., 2010).

Similar to sugar beet, Swiss chard does not compete well with weeds. Seed fields are hoed to control weeds and herbicides are applied to control weeds as needed (McMoran et al., 2010).

The main weeds that compete with Swiss chard seed production in the Northwest include: Shepherds purse, mustards, lambs quarter, pigweeds, smartweed, henbit, groundsel, chickweed, wild turnip, quackgrass, wild oat, Canada thistle, bolt thistle, vetch, nightshades, bed straw, and pineapple weed. Weeds that are related to crops can be difficult to control due to similarities in biology. As a result, lambsquarters, also a member of the Chenopodiaceae family is especially difficult to control in Swiss chard. Spin-Aid, Ro-Neet® and Poast® are commonly used for weed control (McMoran et al., 2010). Producers growing organic Swiss chard seed can only use weed control methods that are in compliance with the National Organic Program (NOP) (7 CFR § 205.206). Home gardeners may or may not use herbicides.

In addition to reducing yield and viability of Swiss chard plants, weeds can also act as host for insects and diseases.

Pest Management. Pest management in the production of Swiss chard seeds focuses on two major types of pests: fungi and insects.

The primary disease problems in Swiss chard seed production are caused by two species of fungus: powdery mildew and downy mildew. Mefenoxam and cymoxanil are used to control downy mildew which can be very severe in some parent lines. Powdery mildew is controlled with a diversity of fungicides including sulfur, azoxystrobin, and pyraclostrobin. Chlorothalonil and mancozeb are used for general disease control and to help prevent resistance to fungicides developing in the pathogen populations (McMoran et al., 2010). Producers growing organic Swiss chard seed can only use fungal control methods that are in compliance with the NOP (7 CFR § 205.206). Home gardeners may or may not use fungicides.

The most critical insect pests are cabbage aphid and turnip aphid. Other insect pests include armyworms, wireworms, cutworms, thrips, and leafminers. Because aphid infestations are spotty and difficult to detect, fields are inspected regularly for aphid outbreaks. Pirimor is used to control aphids. Diazinon is used to control armyworms and cutworms and thrips (McMoran et al., 2010). Producers growing organic Swiss chard seed can only use insect control methods that are in compliance with the NOP (7 CFR § 205.206). Home gardeners may or may not use insecticides.

(11) Testing for Seed Purity and LLP

Similar to sugar beet producers, Swiss chard seed producers have a strong economic incentive to maintain genetically pure seed in both their breeder and commercial seed. Maintaining high levels of seed purity is important because impure seed lots may not have the desired variety attributes, growth rates, and other traits as demanded by customers. As described in III.B.1.b(19), LLP is the presence of undesired seeds or traits in a seed lot. LLP is the result of unintended pollen movement between flowering fields of compatible *Beta* species and/or through admixtures of seeds (accidental mixing of seeds) if equipment is shared or if seeds are not properly isolated from each other during the post harvesting process. As stated above in III.B.2.a., whether grown under conventional or organic methods, the commercial Swiss chard seed produced in the United States is primarily for GE-sensitive markets (McReynolds, 2011). Swiss chard seed producers may test for the presence of the H7-1 trait in their seed if their customers request the test (Loberg, 2011; McReynolds, 2011) (Lyons, 2011c).

The LLP testing described above is done either through molecular means (testing for DNA and proteins) or through grow-outs. Grow-outs (planting of a representative sample of seeds, followed by visual selection) are used to evaluate the frequency of LLP in different seed crops. Morphological traits can be visually identified to detect the presence of table beet or sugar beet LLP, and help identify the potential source(s) of LLP, as well as determine the percent of LLP in the seed lot. For more information on testing methods and grow-outs see section III.B.5.e.

b. Vegetable Production

As stated above, Swiss chard grown for vegetable production occurs throughout the United States. Swiss chard is grown for its foliage, or large leafy greens (Desai, 2004).

(1) Areas of Production

Like other *Beta* crops, Swiss chard is a temperate-cool climate crop that can be grown in much of the United States. Unlike for Swiss chard seed production, producers of the Swiss chard for greens want to avoid bolting. Therefore, unlike Swiss chard seed production, commercial Swiss chard grown for greens is not highly concentrated in the Northwest. Swiss chard is grown for its greens by both commercial producers and home gardeners.

(2) Planting/Harvesting/Bolting Cycle

Planting dates for Swiss chard are highly dependent on the local environment in which it is planted. Swiss chard seeds are typically planted as early in the season as possible; the earlier the Swiss chard is planted, the earlier it will begin to produce leaves. Swiss chard can be direct seeded mid-spring (after danger of frost has passed) in colder climates, through mid-summer in mid-range climates, and into fall in warmer regions (High Mowing Organic Seeds, 2011b). Transplants can be started indoors and transplanted outdoors after danger of frost has passed (Drost, 2010) Different regions may grow different varieties of Swiss chard that are best suited to their specific environmental conditions.

The optimal germination temperature for Swiss chard is 55 to 75° F and it generally requires 7 to 14 days for the plant to emerge (Drost, 2010) Once it has emerged, the optimal growing temperatures are 60 to 75° F during the day and 40 to 45 °F at night, depending on the variety (Masabni and Lillard, 2010b)a).

Swiss chard grows well on well-drained, clay loam. However Swiss chard will tolerate a wide range of loamy soils with a pH range of 6.5 to 7.5 (Masabni and Lillard, 2010b).

Production practices used to grow Swiss chard vary depending on the desired product (i.e., baby greens or mature greens) and the local environment. In general for commercial production of mature greens, seed are planted 0.25–0.5 inch deep in the soil, in double-planted rows on 38–40 inch beds with 3–6 inch in row spacing (Western Growers Association, 2001; Masabni and Lillard, 2010b); . Depending on the local conditions, fields may be pre-irrigated, tilled, and disked (Western Growers Association, 2001). Furrow irrigation may be used to keep plants watered at a low to moderate level. Overhead sprinkler irrigation is not advisable as it increases the incidence of foliar diseases (Masabni and

Lillard, 2010b). Baby Swiss chard is grown on 80 inch beds with 12 rows per bed (Western Growers Association, 2001).

Swiss chard can be harvested anywhere from 20–60 days after planting, depending on the variety, the local environmental conditions and type of desired product (i.e., baby leaves or mature greens) (Cornell University, 2011b). However, typical harvest dates for commercial production are 50–60 days after planting as Swiss chard leaves have the best flavor during this period (Western Growers Association, 2001; Masabni and Lillard, 2010b).

Swiss chard is harvested by hand and the plant can continue to be harvested as long as the mature leaves are removed and there is not a hard frost. When harvesting for fresh markets, the plants are trimmed, cleaned and tied into bunches in the field. One or two dozen Swiss chard are packed into wax cardboard boxes and shipped to the coolers (Western Growers Association, 2001; Masabni and Lillard, 2010b). Baby Swiss chard is shipped in bulk to packing houses and used in packaged salads.

Because of their perishability, Swiss chard greens should be held as close to 32 °F as possible. At this temperature, they can be held for 10 to 14 days. Relative humidity of at least 95 percent is desirable to prevent wilting (Western Growers Association, 2001; OSU Production Guides, 2004).

Swiss chard grown for greens is primarily for fresh market use which presumably is GE sensitive (OSU Production Guides, 2004). According to the most recent National Organic Farmer's (NOF) Survey (2004), in 2001, 13 producers reported growing certified organic Swiss chard on a total of 33 acres nationwide (Walz, 2004). APHIS is not aware of any national production acreage for non-organic Swiss chard. According to the NOF Survey, organic Swiss chard producers reported that 100 percent of their harvest in 2001 was sold in fresh markets (Walz, 2004).

Much like sugar beet, Swiss chard can bolt during the first season. Bolting can be induced by long days (14 plus hours) following cold temperatures (Masabni and Lillard, 2010b) Bolting is undesirable for growers producing fresh green as bolts deplete the energy going into the leaves and reduce the quality of the greens. Additionally, seed from annual bolters is not desirable for home gardeners who save their own seed because bolter seed is also likely to produce plants that would also bolt during the first season, resulting in poor quality Swiss chard for fresh greens production.

(3) Fertilization

Much like sugar beet, Swiss chard generally requires nitrogen, phosphorus, and potassium for optimum growth. Soil tests are the best way to determine how much fertilizer should be applied (OSU Production Guides, 2004). The generalized rate of fertilizer used for commercial Swiss chard production (in pounds per acre) is 120 nitrogen, 75 phosphorus, and 80 potassium. These amounts may vary depending on the type of soil, the variety grown and production practices used (OSU Production Guides, 2004; Masabni and Lillard, 2010b). In some regions sulfur, boron and magnesium are also applied (OSU Production Guides, 2004). Lime applications may also be applied when the soil pH is 5.8 or below (OSU Production Guides, 2004). Producers growing organic Swiss chard can only use fertilizers that are in compliance with the National Organic Program Standards (7 CFR § 205.203). Home gardeners may or may not use fertilizers.

(4) Crop Rotation

For commercial production, crops are destroyed upon crop termination to reduce the potential build-up of fungi and other pests. A 3- to 5- year rotation is used to reduce fungal levels in the soil (Masabni and Lillard, 2010b).

(5) Swiss Chard Pests and Control Measures

Weeds. As stated above, Swiss chard does not compete well with weeds. The specific weeds that compete with Swiss chard are dependent on the region in which the Swiss chard is grown. Commercial Swiss chard growers use cultural controls such as tillage, rotary hoeing, hand weeding and in-crop cultivation to control weeds in addition to the use of herbicides (Dimson, 2001). Different regions may recommend different herbicide regimens (Peachey, 2009; Zandstra, 2010; New England Vegetable Management Guide, 2011). Glyphosate is approved for some applications to control weeds in Swiss chard (Western Growers Association, 2001; Nichino America Inc, 2009; Peachey, 2009; New England Vegetable Management Guide, 2011). Again, organic growers can only use weed control methods approved by the National Organic Program Standards (7 CFR § 205.206), and home gardeners may or may not follow commercial production weed control methods.

In addition to reducing yield and viability of Swiss chard plants, weeds can also act as host for insects and diseases.

Pest Management. Similar to the production of sugar beet for roots, pest management in the production of Swiss chard for greens focuses on fungi and insects.

The specific fungi that infect Swiss chard depend on the region in which the Swiss chard is grown. Different regions report different fungi as the main cause of disease in growing Swiss chard for greens; therefore, methods to control fungi may vary by region (Dimson, 2001; Kovatch, 2003; Masabni and Lillard, 2010b; New England Vegetable Management Guide, 2011). Organic growers can only use fungal control methods approved by the National Organic Program Standards (7 CFR § 205.206). Home gardeners may or may not use fungicides to control fungi.

The specific insects that attack Swiss chard also depend on the region in which the Swiss chard is grown. However, aphids are a problem when growing Swiss chard for seed in most, if not all, regions. Control measures for insects may vary by region (Dimson, 2001; Masabni and Lillard, 2010b; Pacific Northwest Insect Management Handbook, 2011). Organic growers can only use insect control methods approved by the National Organic Program Standards (7 CFR § 205.206). Home gardeners may or may not use insecticides to control insects.

3. Table Beet

The table beet (*Beta vulgaris* var. *vulgaris)* has a long history of cultivation. It is a minor crop in North America and Europe, although popularity has increased in the U.S over the past 30 years (Navazio et al., 2010). As stated above in section III.B.1, table beet is the same species as sugar beet, Swiss chard and fodder beet (OECD). Therefore, table beet are sexually compatible with other *Beta* crops and represent a potential gene flow source or sink. For more information on gene flow see section III.B.5. Table beet is grown for seed, leafy greens, and roots in the United States. For simplicity, in this EIS the term “table beet” includes red, white, yellow, and striped table beet cultivars.

Like all *Beta* crops, table beet is a hardy biennial and requires 2 years to complete its lifecycle. Table beet seed is produced by both commercial producers and home gardeners. Similar to sugar beet and Swiss chard, the majority of commercial table beet seed production occurs in the Northwest. However, like Swiss chard, table beet seed can be produced almost anywhere in the United States when the steckling method is used. The steckling method is described above in section III.B.2.a(6), and below in section III.B.3a(6). Commercial table beet seed is usually open pollinated, but breeding lines to produce commercial table beet seeds may be inbreds used for hybrid seed production (Goldman and Navazio, 2008). Home gardeners produce seed though open pollination. Beet grown for seed are not used for human or animal consumption as, after bolting, roots become woody and leaves become unpalatable (du Toit et al., 2007).

Table beet grown for its leafy greens and/or roots occurs throughout the United States. Table beet has a large fleshy root, which can vary in size, shape and color depending on the variety (Desai, 2004). It also produces foliage, or leafy greens, which can be eaten in a manner similar to spinach or lettuce (Navazio et al., 2010). The two main markets for table beet are: 1) leaves and roots for fresh markets; and 2) roots for canning. The table beet plant grows until it is harvested or growth is stopped by a hard freeze (Desai, 2004). Table beet is grown by both commercial producers and home gardeners.

a. Seed Production

(1) Location

In the United States in 2011, APHIS is aware of commercial table beet seed production occurring on around 550[8] acres in California, Washington, and Oregon. Table 3–20 shows the acreage of known commercial table beet seed production in each of the table beet seed producing states in 2011. Commercial table beet seed acreage was determined through publications from the Washington State Extension Office (du Toit et al., 2007), personal communications with State Extension Officers in Oregon and Washington, and commercial seed producers (McMoran, 2009; Mcmoran, 2011a; McReynolds, 2011).

Table III-20. 2011 Acreage of Commercial Table Beet Seed Production in the United States

State	County	Acreage	References
CA Total	Butte, Colusa, Glenn	<125[1]	(McReynolds, 2011)
OR Total	Polk, Yamhill	27	(McReynolds, 2011)
WA Total	Island, Skagit, Snohomish	405	(McMoran, 2009; Mcmoran, 2011a)
Total U.S. Acres		**557**	

[1] **Unknown combination of acreage growing Swiss chard & table beet seed. The combined acreage totals 125.**

[2] **Acreage in Island County is for stecklings that are relocated to Snohomish and Skagit counties for seed production (i.e., acreage is double-counted, and therefore not included in WA total acreage).**

[3] **Most recent data available for Skagit County is 2009.**

[8] The information APHIS received on acreage of Swiss chard production in California for Glenn, Colusa, and Butte Counties was aggregate data with combined acreage for Swiss chard and table beet. Therefore,actual acreage of Swiss chard and table beet in each of the individual counties is not known. For the purposes of the EIS, APHIS will assume the highest possible acreage for both of the crops by estimating that the acreage of each is up to 125 acres.

The information in Table 3-20 reflects all commercial table beet seed being produced by members of the WVSSA in 2011 and may not capture production by non-members.

Based on this information, APHIS determined that in 2011, commercial table beet is being grown in the following states in the listed counties: western Washington (Island,[9] Skagit, and Snohomish), California (Glenn, Colusa, and Butte), and Oregon (Polk and Yamhill). The acreage and location of table beet seed being produced by home gardeners is unknown.

Fig. 3–11 is a map of all known commercial table beet seed producing counties in 2009 and 2011. Fig. 3–11 includes all of the counties listed in Table 3–20 above.

Based on the information above, in 2011 approximately five percent of commercial table beet seed is being produced in Oregon, 73 percent is being produced in Washington, and 22 percent is being produced in California.

It is entirely possible that not all commercial table beet seed production in 2011 has been captured through the aforementioned research efforts.

However, information on table beet seed acreage and areas of production from previous years indicates that the major areas of U.S. table beet seed production are represented above (du Toit et al., 2007; Loberg, 2011). The acreage of commercial table beet seed production in each area varies from year to year due to changes in demand for seed and crop rotation cycles (Loberg, 2011; McReynolds, 2011). The acreage and location of table beet seed being produced by home gardeners is unknown.

As discussed previously in III.B.1.b(1) and III.B.2.a(1), commercial sugar beet, Swiss chard and table beet seed are all produced in Willamette Valley, Oregon, making Willamette Valley the only known commercial table beet seed production area where gene flow could occur between table beet and H7-1 sugar beet. In 2011, Table beet and H7-1 sugar beet were both grown in a single county of Oregon, Polk County. For a map showing the counties where both table beet and H7-1 sugar beet are grown see Fig. 4–2. For a map that shows the counties where both vegetable beet seed production (Swiss chard and table beet) and sugar beet seed production occur, see Fig. 3–12. For more information on gene flow see section III.B.5.

(2) Breeding

[9] While Island County, Washington, is listed as a table beet seed producing county, only stecklings are grown on the island. The stecklings are then re-located to Snohomish and Skagit Counties for seed production.

Mass selection and collection of seed from open-pollinated plants has traditionally been the principal method for developing new varieties with the desired characteristics (Desai, 2004). However, innovative breeding strategies have been developed for table beet and some table beet breeders are now producing inbred breeding lines (Desai, 2004; Goldman and Navazio, 2008). For example, similar to sugar beet seed breeding, sterile inbred lines and Cytoplasmic Male Sterility (CMS) are used in some table beet breeding programs (Goldman and Navazio, 2008). CMS is described in greater detail in section III.B.1.b(8).

Figure 3-11. Map of known counties in which commercial table beet seed is produced

Counties in map have been identified as table beet seed producing in 2009 and 2011. Source:(McMoran, 2009; Mcmoran, 2011a)

(3) Seed Crop Producers

Table beet seed production, much like sugar beet production, consists of developing, growing, and processing the seed that table beet growers use to plant their crop. Like Swiss chard seed production, both commercial growers and home gardeners produce table beet seed.

Commercial Table Beet Seed Production. Similar to seed production with Swiss chard, commercial table beet seed production is conducted under bailment contracts. The seed companies provide growers with the stecklings necessary to produce a beet seed crop (du Toit et al., 2007). Stecklings are described above in section III.B.2.a(6) and below in section III.B.3.a(6). It is common practice under bailment contracts for the seed companies to retain ownership of the seed, the growing crop, and the harvested seed (du Toit et al., 2007). Growers are only paid the contracted price if the resulting seed meets quality criteria stated in the bailment contract, typically an 85 percent seed germination rate and 99 percent purity. As weed seed is similar in size and shape to table beet seed, making it difficult to remove during post-harvest processing of seeds, elevated levels of weed seed may cause a seed company to reject a seed crop (du Toit et al., 2007).

Like for other *Beta* species, table beet seed is produced and used for vegetable production, while stock seed is grown specifically for use in planting seed crops (du Toit et al., 2007). APHIS estimates that 5-10 percent of vegetable beet seed production is organic based on an an interview with Alf Christenson Seed Company, one of the major vegetable beet seed producers. (Lyons, 2011c).

While the size of seed markets vary based on market demand, estimates from seed producers indicate that up to 50 percent of table beet seed grown in the United States is exported annually (Lyons, 2011c; McReynolds, 2011).

Home Gardener Table Beet Seed Production. By definition, home gardeners grow table beet seed for their own personal use and do not grow seed under contract.

Non-U.S. Table Beet Seed Production. Just like Swiss chard seed production, table beet seed production also occurs in other countries for the same reasons stated above in III.B.2.a(3). The main foreign countries in which table beet seed is grown are the same as those in which Swiss chard seed is grown: New Zealand, Australia, and China (McReynolds, 2011). For more information on non-U.S. table beet seed production see section III.B.2.a(3) above.

(4) Planting and Lifecycle

During its 2-year seed-producing lifecycle, table beet plants grow a rosette of numerous above ground leaves and develop a fleshy root the first year (Desai, 2004). In the second year, after exposure to vernalizing temperatures, the plant produces a tall seed stalk completing the lifecycle.

In the Northwest, commercial table beet seed producers can produce a seed crop in a 14- to 16-month period by sowing seeds in the late summer to generate young plants that are vernalized over the winter, and produce a seed crop the following summer (Desai, 2004; du Toit et al., 2007; Navazio et al., 2010).

For both the direct-seeded and steckling seeded methods, seeds are harvested after the base of the flowering stalk has turned brown (Desai, 2004). At harvest plants are cut, windrowed, and dried in the field for 10–14 days. While the crop is drying, it is hand-turned to prevent molding. Seed is taken to a conditioning plant where it is cleaned to 99 percent purity (du Toit et al., 2007).

Table beet seed can be produced using either the direct-seeded method or the steckling method, and both of these methods can be used by commercial producers and home gardeners as described below. It should be noted, however, that 100 percent of table beet seeds grown in western Washington are grown using the steckling method. This method is used in this region because it was determined that beet that over-wintered using direct-seeded method were contributing to the spread of the beet mosaic virus which resulted in drastically reduced table beet seed yields (Navazio et al., 2010).

(5) Direct-Seeded Method

The direct-seeded method, also called the "over wintering method" involves planting the desired variety of table beet seeds in the field in the mid-summer and harvesting the seeds the next fall. The direct-seeded method is only suitable for mild climates, such as those found in the Northwest, which is why the majority of commercial table beet seed production occurs in this area.

Commercial Table Beet Seed Production. For commercial production in the Northwest, seeds are typically planted between mid-June to early September, depending on the variety and the specific location (Desai, 2004; Navazio et al., 2010). Slower growing varieties are planted earlier than later growing varieties. Recommended spacing is 16–22 inches between plants with two rows on top of a 30- to 40-inch seed bed (Navazio et al., 2010). As the weather becomes colder, the plants become dormant and are vernalized in the ground. Plants begin to bolt to form a flowering stalk in the spring, produce pollen during the mid-summer, and seeds in the late-summer. The exact timing for bolting, flowering and seed setting is highly dependent on the specific variety of table beet and the growing conditions (Lyons, 2011b).

For an example of timing, the OrCa Seed Production Inc. production schedule from 2010 shows that when commercial table beet seeds are direct-seed planted in June, the estimated bloom date is the following June to August and the estimated harvest date is September to October (OrCa Seed Production Inc., 2010b). Note that the production schedule does not indicate the location of the table beet seed production. OrCa Seed Production Inc. produces seed in both Oregon and California (OrCa Seed Production Inc., 2010a).

The advantages and disadvantages of using the direct-seed method to produce table beet seeds are identical to those of Swiss chard (Desai, 2004; Navazio et al., 2010). See section III.B.2.a(5) for more information.

Home Gardener Table Beet Seed Production. Home gardeners producing table beet seed in the Northwest could also use the direct-seeded method and would likely follow similar production methods to those of commercial producers. Home gardeners producing table beet seed in other regions with more severe winters would need to use the steckling method.

(6) Steckling Method. Stecklings are table beet roots that are grown from seed for less than a full season and are vernalized either in the ground or are dug up and stored (depending on climate conditions), and will be replanted in the spring for seed production.

Commercial Table Beet Seed Production. For commercial production in the Northwest, seeds are typically planted in mid-June to August, depending on the variety and the specific location (Navazio et al., 2010); (Desai, 2004; du Toit et al., 2007). In Washington, all commercial table beet seeds for steckling production are planted in Island County to avoid damage to the young seedlings from beet mosaic virus (du Toit et al., 2007; Navazio et al., 2010). Slower growing varieties are planted earlier than faster growing varieties. Recommended spacing is the same as for the direct-seeded method: 16–35 inches between plants with 1 to 2 rows on top of a 30- to 40-inch seed bed (Desai, 2004; Navazio et al., 2010). As with Swiss chard, depending on seeding method used, 1 acre of stecklings can be used to plant 10–20 acres for seed production (Desai, 2004).

In October, when the beet roots have reached a size of 3 to 3.75 inches in diameter, their green tops are removed mechanically, they are dug up and placed in windrows (four to six rows of beet roots covered with about one foot of soil to keep roots from freezing in the winter) (du Toit et al., 2007; Goldman and Navazio, 2008; Navazio et al., 2010). Plants are rogued for off-types before being put in windrows.

The next spring, in March or early April, the stecklings are removed from the windrows, graded for shape, prominence of taproot, absence of disease, and trueness-to-type, and brought to Skagit and Snohomish counties for transplanting into production fields (du Toit et al., 2007); (Goldman and Navazio, 2008). Stecklings are mechanically dropped into furrows in an upright position and then covered in soil, approximately 15–25 inches apart in 30- to 36-inch rows (Goldman and Navazio, 2008).

Table beet plants flower in the summer and seeds are collected in the fall. For an example of timing, in Skagit County under ideal weather conditions, Alf Christenson Seed Company typically plants table beet stecklings around April 15 with an estimated bloom date of late June to late July, depending on the variety (Lyons, 2011a). A harvest time of August to September is typical for the State of Washington (du Toit et al., 2007).

The major advantages and disadvantages of using the steckling method to produce table beet seeds are identical to those of Swiss chard (Desai, 2004; Navazio et al., 2010). See section III.B.2.a(6) for more information.

Home Gardener Table Beet Seed Production. Home gardeners producing table beet seed in the Northwest could also use the steckling method and would likely follow similar production methods to those of commercial producers.

Home gardeners producing table beet seed in other regions would need to modify the production method according to their specific environmental conditions. Table beet seeds can be planted as soon as the soil can be worked and after the threat of a hard frost as passed. Table beet seeds can be direct seeded mid-spring through mid-summer and into the fall in warmer regions. Optimal germination temperature is 55–75 °F, but seeds will germinate in temperatures as low as 45°F (High Mowing Organic Seeds, 2011a). Stecklings are dug up in the fall when roots are 3–3.75 inches in diameter and any leaves an inch or more above the crown are cut off (Navazio et al., 2010). In colder climates the stecklings are stored for the winter at temperatures between 34–37 °F under conditions of high humidity (Navazio et al., 2010). In the spring, stecklings are planted outside at a spacing of 8 to 12 inches between plants and 18 to 36 inches between rows. Based on the specific variety and local environmental conditions, plants bolt and flower at varying times during the summer and set seed in the fall (High Mowing Organic Seeds, 2011a).

(7) Isolation Distances

As described above for Swiss chard seed, production of high quality table beet seed requires that the “correct” seed parent be fertilized by the “correct” pollen source. Table beet seed will not meet the quality criteria demanded by purchasers if the percentage of off-type seed exceeds contractual thresholds.

As described for Swiss chard, open-pollination is used for the majority of commercial table beet seed production, and open-pollinated fields generate more than four times the pollen as hybrid seed production. This means that gene flow from table beet pollen into sugar beet seed is more likely than gene flow from sugar beet pollen into table beet seed.

As described in section III.B.2.a(7), isolation distances are used to maintain seed quality. Much like for Swiss chard seed production, increased urbanization and the presence of home gardeners who do not participate in pinning have made it more difficult to control pollen flow and ensure that adequate isolation distances are maintained for table beet seed production (du Toit et al., 2007; Wahlert, 2011).

(8) Fertilization

Fertilization of table beet is similar to that described for Swiss chard in section III.B.2.a(8).

(9) Crop Rotation

For commercial production, table beet plants grown for seed are typically grown in a 4- to 5-year rotation to mitigate disease problems (du Toit et al., 2007) and to manage volunteers.

(10) Table Beet Pests and Control Measures

a. Weeds

Similar to sugar beet, table beet does not compete well with weeds. Weed competition can reduce the yield by up to 75 percent if weeds are not controlled. Therefore, mechanical cultivation, herbicides, and hand-hoeing are all used to help control weeds in table beet seed production fields (du Toit et al., 2007).

The main weeds that compete with table beet seed production in the Northwest include: nightshade, henbit, pigweed, shepherds purse, lambsquarters, mustard, chickweed, wild buckwheat, pale smartweed, common groundsel, curly dock, wild radish, Canada thistle, pineapple-weed, annual grasses (including annual bluegrass, *Poa annua*, and others), volunteer grain (such as barley, *Hordeum vulgare*, and wheat, *Triticum aestivum*), and seedling perennial grasses (such as quackgrass, *Elytrigia repens*, and perennial ryegrass, *Lolium perenne*). Weeds that are related to crops can be difficult to control due to similarities in biology. As a result, lambsquarters, also a member of the Chenopodiaceae family, is especially difficult to control in table beet. Cycloate (Ro-Neet™), phenmedipham + desmedipham (Betamix®), ethofumesate (Nortron® SC), chloridazon (= pyrazon) (Pyramin®), Fluazifop-P-butyl (Fusilade® DX), and clopyralid (Stinger®) are commonly used for weed control in table beet seed production (du Toit et al., 2007). Producers growing organic table beet seed can only use insect control methods that are in compliance with the National Organic Program Standards (7 CFR § 205.206). Home gardeners may or may not follow commercial production practices for weed control. In addition to reducing yield and viability of table beet plants, weeds can also act as host for insects and diseases.

Pest Management. Pest management in the production of table beet seeds focuses on the control of viruses and fungi, as well as insects. The primary fungal disease problems in commercial table beet seed production in the Northwest are damping-off, black root rot, downy mildew, powdery mildew, and black leg. The disease-causing fungi can be controlled through a combination of cultural means and chemicals. Cultural controls include selecting resistant seed varieties, not over-fertilizing, increasing air circulation, avoiding damp soil and pre-treating or cleaning seed before planting (du Toit et al., 2007). Additionally, fungi can be controlled through the use of chemicals. Fludioxonil, Thiram, Azoxystrobin, and Mefenoxam are commonly used to control damping-off and black root rot. Mefenoxam and cymoxanil and copper hydroxide are used to control downy mildew. Powdery mildew is controlled with a diversity of fungicides including sulfur, azoxystrobin, and pyraclostrobin. Black leg is controlled with thiram (du Toit et al., 2007). Producers growing organic table beet seed can only use fungal control methods that are in compliance with the National Organic Program Standards (7 CFR § 205.206). Home gardeners may or may not use fungicides.

Table beet are also susceptible to beet mosaic virus, beet western yellows virus and BCTV. Most of these viruses are controlled through cultural means (planting stecklings in Island County and transplanting vernalized stecklings onto the mainland in the spring) in western Washington and chemical control is not typically used (du Toit et al., 2007).

The significant insect pests of table beet include three types of aphids, armyworms, and cutworms (larvae), and thrips. Aphids can also spread the beet western yellows virus (although the virus is not transmitted to the seed). Aphids are typically controlled by pymetrozine (Fulfill®). Armyworms and cutworms are controlled by methomyl (Lannate®) and diazinon, which can also be used to control thrips (du Toit et al., 2007). Producers growing organic table beet seed can only use insect control methods that are in compliance with the National Organic Program Standards (7 CFR § 205.206).

(11) Testing for Seed Purity and LLP

Similar to sugar beet and Swiss chard seed producers, table seed producers have a strong economic incentive to maintain genetically pure seed in both their breeder and commercial seed. Growers must maintain high levels of seed purity to ensure seeds produce the desired variety attributes, growth rates, and other traits as demanded by customers. Most producers rogue off-types during seed production and perform grow-outs to look for off-types. Some table beet seed producers test for the presence of the H7-1 trait in their seed (Loberg, 2010b) (Lyons, 2011c; McReynolds, 2011). These testing methods are described in more detail above in III.B.2.a(11) and below in III.B.5(e).

b. Vegetable Production

As stated above, table beet vegetable production occurs throughout the United States. The table beet plant grows until it is harvested or growth is stopped by a hard freeze.

In addition to being grown for food, table beet roots are a source of betanin (2,6-pyridinedicarboxylic acid), which is used in a variety of industrial food colorants (Harmer, 1980; Grubben and Denton, 2004). Betanin is a red glycosidic food dye, usually extracted from red table beet where the betanin concentration can reach between 300 and 600 mg per kg. Red beet dyes can be used in cosmetics, candy, ice cream, meat products, yogurt, and powdered drink mixes (Goldman and Navazio, 2008).

(1) Areas of Production

Like other *Beta* crops, table beet can be grown in many regions within the United States. The best growing regions for beet have cool, wet spring weather, followed by cool and relatively dry summer weather. Table beet are grown for their roots and greens, for fresh markets or for canning, by both commercial producers and home gardeners. Unlike table beet seed production, producers of table beet for roots and greens do not want to induce bolting as it ruins the quality of both the roots and the greens (du Toit et al., 2007).

The majority of table beet grown in the United States are grown for the canning industry (Nolte, 2010) which is largely not a GE sensitive market. In 2007 (the most recent year for which data are available), Wisconsin grew the most acres (2784 acres harvested) followed by New York (2,173 acres harvested) (NASS, 2010). Total U.S. acreage of beet harvested in 2007 was 8412 acres. In 2002 9,902 acres were harvested and in 1997, 11,303 acres were harvested. In 1997 the harvest had a total yield of 122,180 tons (average yield = 16.38 tons per acre), and a total value of USD 8,153,000 (NASS, 2010).

In addition, table beet are grown for fresh markets. According to the Fourth National Organic Farmer’s Survey, in 2001, 27 producers reported growing table beet on a total of 42 certified organic acres in the United States (Walz, 2004).

The acreage of table beet grown for roots and greens does not normally exceed 10,000 acres annually (Nolte, 2010). In 2009, the United States produced beet for roots and leaves on roughly 7,000 acres, not including production for microgreens which has increased over the past decade (Nolte, 2010).

(2) Planting/Harvesting/Bolting Cycle

Planting dates for table beet are highly dependent on the local environment in which it is planted. Table beet seed is typically planted as early in the season as possible, usually when soil seed zone has reached a temperature greater than 45°F (Masabni and Lillard, 2010a). Table beet can be direct-seeded in mid-spring (after danger of frost has passed) in colder climates, through mid-summer in mid-range climates and into fall in warmer regions (High Mowing Organic Seeds, 2011a). Transplants can be started indoors and transplanted outdoors after danger of frost has passed. The earlier the table beet is planted, the earlier it will begin to produce leaves. Different regions may grow different varieties of table beet that are best suited to their specific environmental conditions.

Optimal germination temperature for table beet is 55 to 75 °F, but beet will germinate in temperatures as low as 45 °F (High Mowing Organic Seeds, 2011a). The optimal growing temperatures for table beet are 60–75 °F during the day and 45–55°F at night. Beet are fairly cold-tolerant, but do not tolerate heat well (Masabni and Lillard, 2010a).

Table beet grows well on well-drained, sandy or silt loams or muck soils with a pH range of 6.5 to 8.0 (Masabni and Lillard, 2010a). Beet may be grown on heavier soil types, but heavier soils make root harvesting more difficult and may impair root growth (Hemphill and Mansour, 2011)

Production practices used to grow table beet vary depending on the desired product (i.e., microgreens or beet roots) and the local environment. In general, for commercial production of beet roots, seed are planted 0.5–0.75 inch deep in the soil, a little over an inch apart in 18 to 24 inch rows (Hemphill and Mansour, 2011; High Mowing Organic Seeds, 2011a). Seeds should be planted at different densities depending on harvest date; for early harvest, 15–20 seeds per foot, for mid-season harvest, 20–25 seeds per foot, and for late-season harvest 15–20 seeds per foot. For fresh market beet, plants should be 2–3 inches apart. For baby beet, 30–35 seeds are planted per foot and rows are reduced to 10–15 inches (Hemphill and Mansour, 2011).

When irrigation is used, table beet should be irrigated uniformly. The critical irrigation stages are during stand establishment and early growth. Beet do not tolerate water-logged or over-irrigated soils, which can turn beet leaves red, can cause plants to stop growing and may increase diseases (Masabni and Lillard, 2010a; Hemphill and Mansour, 2011).

Beet grown for root are typically harvested at 42–56 days for table beet, 60–70 days for round beet and 70–80 days for cylindrical beet (Schrader and Mayberry, 2006; Hemphill and Mansour, 2011). Harvest dates can depend on specific planting date, the desired size of the beet and the season in which the beet is grown (Masabni and Lillard, 2010a; Hemphill and Mansour, 2011). Beet for processing may be harvested by machine. Beet for fresh market are normally hand harvested and bunched (Masabni and Lillard, 2010a).

Harvested beet roots should be stored at 32 °F with high levels of humidity. Topped beet can be stored for up to 4 to 6 months under suitable conditions. Beet greens are far more perishable. They can be stored at 32 °F for up to 10–14 days (Hemphill and Mansour, 2011).

Much like sugar beet, table beet can bolt in the first season. However because beet are typically harvested anywhere from 6–12 weeks and vernalization typically takes place for 12 weeks at temperatures of approximately 2–5 °C. (Goldman and Navazio, 2008), the beet root crop is usually harvested before bolting has time to occur.

(3) Fertilization

Table beet generally requires nitrogen, phosphorus and potassium for optimum growth (Schrader and Mayberry, 2006). Soil tests are the best way to determine how much fertilizer should be applied (OSU Production Guides, 2004). The generalized rate of fertilizer used for commercial table beet production (in pounds per acre) is 80 nitrogen, 80 phosphorus, and 90 potassium (Masabni and Lillard, 2010a). These amounts may vary depending on the type of soil, the variety grown and production practices used (Schrader and Mayberry, 2006; Masabni and Lillard, 2010a). In some regions sulfur, boron and magnesium are also applied (Schrader and Mayberry, 2006). Lime applications may also be applied when the soil pH is 5.8 or below (Schrader and Mayberry, 2006). Producers growing organic table beet can only use fertilizers that are in compliance with the National Organic Program Standards (7 CFR § 205.203).

(4) Crop Rotation

Like other *Beta* species, table beet should be rotated with other crops to reduce weed and other pest pressures (Binning et al., 2011).

(5) Table Beet Pests and Control Measures

In the United States, table beet growth and survival is vulnerable to several pests, including insects, diseases, and weeds. Each of these pests is managed by different practices, either through cultural or chemical means.

Weeds. Like all *Beta* species, table beet does not compete well with weeds. The specific weeds that compete with table beet are dependent on the region in which the table beet is grown. Commercial table beet growers use cultural controls such as tillage, rotary hoeing, hand weeding and in-crop cultivation to control weeds in addition to the use of herbicides (Sanders, 2001; Peachey, 2009). Different regions may recommend different herbicide regimens (Peachey, 2009; Zandstra, 2010; Binning et al., 2011; New England Vegetable Management Guide, 2011). Glyphosate is approved for preplant and pre-emergent applications to control weeds in table beet (Nichino America Inc, 2009; Zandstra, 2010; New England Vegetable Management Guide, 2011; Pacific Northwest Weed Management Handbook, 2011). Home growers may or may not follow commercial production weed control methods. Organic growers can only use weed control methods approved by the National Organic Program Standards (7 CFR § 205.206).

In addition to reducing yield and viability of table beet plants, weeds can also act as host for insects and diseases.

Pest management. The specific fungi that infect table beet are dependent on the region in which the table beet is grown; therefore, control measures for fungi may vary by region. Different regions report different fungi as the main cause of disease in growing table beet for roots and greens (Masabni and Lillard, 2010a; Ocamb and Pscheidt, 2010; Binning et al., 2011; New England Vegetable Management Guide, 2011). Producers growing organic table beet for roots or greens can only use fungal control methods that are in compliance with the National Organic Program Standards (7 CFR § 205.206). Home growers may or may not use fungicides.

The specific insects that attack table beet also depend on the region in which the table beet is grown, and control measures for insects may vary by region as well. However, aphids appear to be a problem when growing table beet for vegetables in most, if not all, regions (Masabni and Lillard, 2010a; Binning et al., 2011; Pacific Northwest Insect Management Handbook, 2011). Producers growing organic table beet for roots or greens can only use insect control methods that are in compliance with the National Organic Program Standards (7 CFR § 205.206). Home growers may or may not use insecticides.

4. Fodder beet

Fodder beet (*Beta vulgaris* var. *crassa*) are the same species as sugar beet, Swiss chard and table beet and as such they are all sexually compatible with each other (OECD). Before the Second World War, fodder beet was commonly grown as a high yielding forage crop (Draycott and Hollies, 2001; Henry, 2008; Roth et al., 2008; DLF Trifolium, 2010). While no longer as popular, they are still grown for fodder on 150,000 acres in Europe and New Zealand and may be used for ethanol production (Gibbons and Westby, 1988). Fodder beet are rarely grown in the United States.

Like other *Beta* species, fodder beet is a hearty biennial and requires 2 years to complete its lifecycle. Commercial fodder beet seed is grown by a few seed producers in Europe. Fodder beet seed can either be hybrid or open pollinated, self-fertilizing, or self-incompatible. Seed can be produced using the direct-seeded or the steckling method (Henry, 2008). APHIS is not aware of any fodder beet seed production in the United States (Wahlert, 2011).

Fodder beet grown for its greens and roots occurs across Europe and in New Zealand. Like sugar beet, fodder beet produces a fleshy root in the first year. The root color, size, and shape vary by variety. Both the root and the greens may be eaten for animal feed (Henry, 2008). As farmers only use the vegetative phase for fodder, bolting resistant varieties have been developed as bolting greatly reduces the yield and quality of the fodder (Henry, 2008). APHIS is not aware of any commercial fodder beet vegetable production in the United States.

While there is currently no commercial fodder beet seed or vegetable production in the United States, fodder beet may be grown in limited University plots for ethanol research purposes (Gibbons and Westby, 1988). A limited discussion on fodder beet seed production practices is presented in this EIS due to the sexual compatibility of fodder beet, sugar beet, Swiss chard and table beet. The following discussion is based largely on information relevant to European countries where fodder beet are currently being grown for root and seed.

a. Areas of production

(1) Seed Production

The principal fodder beet seed production occurs in the southwest of France near where sugar beet seed is produced (Henry, 2008).

(2) Forage Production

Fodder beet is currently not a major crop for animal feed in terms of production or area cultivated. Based on the most recent global production data available (Henry, 2008), fodder beet production occurs in: France (32,100 acres), the United Kingdom (24,700 acres), Belarus (19,800–24,700 acres), Denmark (19800 acres), Ireland (18,800 acres), New Zealand (17,300 acres), Belgium (9,900 acres), Germany (9,900 acres), and Switzerland (2,500–3,700 acres).

b. Production/Planting/Harvesting

(1) Seed

Most fodder beet seed sold on the market today is monogerm, triploid seed. Hybrid fodder beet seed breeding and production is modeled on hybrid sugar beet seed breeding and production and involves a complex series of maintaining CMS females and pollinators (Henry, 2008). For more on sugar beet breeding and the use of CMS in hybrid seed production see sections III.B.1.b(6) through III.B.1.b(9).

The steckling method is the most common method used to produce hybrid commercial fodder beet seed. Seed is typically planted in nurseries in August after the basic seed is provided by the breeder to the producer. The plants are grown until November when the stecklings are harvested and vernalized at 40–45°F. Stecklings are transplanted into production fields in March in the desired ratio of male to female plants. After stalk elongation in early summer, females may be topped in order to synchronize flowering. Male pollinators are removed in July with harvest following shortly thereafter, depending on varieties used and the environmental conditions. Stalks are dried in the fields for approximately 10 days after which they are harvested and sent to factories for processing and cleaning (Henry, 2008).

Plants are rigorously checked for off-types from other fodder beet crosses and weedy beet as incorrect crosses will lower the quality and potentially the value of the seed produced (Henry, 2008).

According to the OECD Schemes for the varietal certification of fodder beet seed in international trade (OECD) all seed crops for basic seed production must be at least 3280 feet (1 km) from other *Beta* species, and all seed crops used to produce certified fodder beet seed must be a minimum of 980 to 3280 feet away from other *Beta* pollen sources depending on the specific *Beta* source and the type of seed being produced (OECD). Additionally, certified seed (not including basic seed) must have a minimum of 97 percent analytical purity (excluding any additives) and a minimum germination percentage of 68, depending on the type of seed being produced (OECD).

(2) Forage Production

Fodder beet grown for forage production grows best on well-drained soil with a pH of at least 6.5 to limit fungal growth. When grown on sandy soils, irrigation may be required. Fields can be plowed in the autumn or the spring (DLF Trifolium, 2010).

Seed is planted in spring, after soils are warm enough. Planting occurs around the 5–20 of April in Denmark. Seeds are planted at a depth of 0.2 in and then covered with 0.8–1.2 in of soil. An optimal final germination rate is 70,000 to 75,000 plants per hectar. Germination rates are dependent on the variety but are usually 60–65 percent for triploid varieties and 70–75 percent for diploid varieties. As with other *Beta* species, fodder beet require fertilizer. A typical amount of fertilizer used is 397 lb per hectare nitrogen, 88 lb per hectare phosphorus and 441 lb per hectare potassium, depending on the local soil conditions. (DLF Trifolium, 2010)

At harvest, beet are carefully topped to ensure minimal damage to the beet. Tops may be ensiled for animal fodder. Beet are lifted from the soil and stored at 37–41 °C over the winter. (DLF Trifolium, 2010)

Much like other *Beta* species, fodder beet can bolt the first year. Bolting in fodder beet fields can be due to vernalization of fodder beet, or the presence of weed beet. Some of the fodder beet varieties bolt more easily than others. In either case, bolters are removed as fodder beet bolters reduce the quality of the beet, impede topping and harvesting and weed beet bolters that are allowed to seed will result in the spread of weed beet. Fodder beet cannot be grown successfully in areas with high levels of wild beet. (DLF Trifolium, 2010).

Similar to other *Beta* species, fodder beet are poor competitors with weeds. Weed control management can include machine and hand-hoeing in addition to herbicide use. Much like sugar beet, Swiss chard, and table beet, fodder beet are susceptible to pests and diseases. These can be controlled through chemical and other means. (DLF Trifolium, 2010).

5. Gene Flow in Beta Species

a. Overview of Gene Flow

(1) Gene Flow

Gene flow is a natural biological process necessary for the evolution of plant species and the production of fruits and seeds by most crop species. Gene flow describes the process by which genes move from one plant population (source) to another (sink) genetically distinct population. Gene flow itself does not pose any particular risk (Bartsch et al., 2003; Ellstrand, 2006); unless it results in the movement of specific genes or traits with undesired effects into cultivated or weedy plant species.

The movement of genes from one plant population to another requires dispersal of the pollen or seed to a new location followed by either sexual or asexual reproduction. Gene flow as a result of sexual reproduction occurs via transfer of pollen or seeds. Pollen-mediated gene flow (often called cross-pollination or outcrossing) is a term used to describe the movement of plant genes from one plant to another genetically distinct plant via successful pollen movement to produce hybrid seeds(Mallory-Smith and Zapiola, 2008). Seed-mediated gene flow describes the movement of genes via seeds into new populations. In this case, seed from one population disperses to another in a new location and establishes, introducing new gene or genes into the plant population (Mallory-Smith and Zapiola, 2008).

(2) Hybridization

In plant biology, hybridization occurs when plants from two different populations exchange genes and produce seed with the genetic combination of the two parental plants. For natural hybridization to occur between plant populations, the two plant populations need to overlap in flowering time and physical proximity such that pollen can be carried between the male and female parents. Additionally, the pollen must successfully compete with the pollen produced by the sink population, fertilization must occur, and the resulting hybrid seed must be viable. If the hybrid seed is viable, germinates, and grows into a hybrid plant, gene flow and hybridization has successfully occurred (Ellstrand, 2003). Hybridization is most common between the same or closely related species but can sometimes occur when distantly related species are brought into contact in a new environment or when hybrids are deliberately created by crop breeding.

(3) Introgression

A single case of hybridization between plant populations may not result in lasting genetic changes in the sink population. For example, hybrid plants may be less fertile than parental plants or have other altered traits, reducing their fitness. However, if repeated hybridization events occur, either through hybrid plants exchanging genes with neighboring plants, or if source and sink populations continue to exchange genes over time, then introgression has occurred. Repeated hybridization between hybrid plants and parental plants (backcrossing) must occur in order for the genes of the source population to permanently integrate into the sink population. Introgression tends to be rarer than hybridization because hybridization between distantly related species may not produce viable seeds or fertile hybrid plants. For example, in studies done with canola and a weedy relative, backcrossing occurred at one-hundredth to one-thousandth the rate of the original hybridization (Stewart Jr., 2008). Nevertheless, when a species is introduced to a new area, there is the potential that the introduced plants may hybridize with other closely related species. New hybrid plants therefore may be created with new or modified traits. For example, hybridization events may contribute to the rise of invasive weeds, genetic assimilation, or local extinction of sink population as genetic mixing between previously isolated plant populations can produce a wide array of genetic and phenotypic variation. Some of these new hybrid genotypes may exhibit increased invasive properties (USDA-ARS, 2008).

Many plant species are believed to have been derived from gene flow, hybridization, and introgression between closely related species (Grant, 1981; Soltis and Soltis, 1993; Rieseberg, 1997; Hegde et al., 2006). In addition, the occurrence of gene flow in the evolutionary history of crop species is reported to be widespread (Rieseberg et al., 1993; Ellstrand, 2003). Plant breeders frequently make controlled crosses to move desirable traits between cultivars (different versions of the same crop species) or to introduce traits from wild species into domesticated crops to develop new cultivars. Conversely, gene flow from domesticated crops such as rice, sorghum, and sunflower into wild relatives can result in undesired effects, such as potentially contributing to enhanced weediness of the wild relatives (Ellstrand et al., 1999). Gene flow varies greatly between different species of plants and between different populations of plants of the same species (Ellstrand, 2003).

The rate of gene flow between plant populations varies depending on numerous external factors in addition to the mechanism of gene flow (Mallory-Smith and Zapiola, 2008). Persistence of genes from the source population in the sink community through pollen transfer or self seeding is required to maintain detectable levels of gene flow.

- The rate of pollen-mediated gene flow between populations depends on numerous factors:
  - The species and population of plants involved;
  - Pollination method (e.g., wind pollination or insect pollination);
  - Abundance of pollinator (e.g., high winds, numerous insects);
  - Biology and quantity of pollen produced;
  - Pollen cloud density;
  - Flowering phenology and synchrony (the timing of flowering of both source and sink populations);
  - Distance between source and sink populations;
  - Relative sizes of source and sink populations; and
  - Weather conditions, including temperature, wind, and humidity.
- Seed-mediated gene flow (dispersal) also depends on many factors:
  - Natural dispersal from wind, water, or animals
  - Persistence in the seed bank; and
  - Human-mediated dispersal from field harvesting technology, transportation, or storage.

Gene flow can also result from the dispersal and regeneration of vegetative plant propagules (e.g., stem cuttings). Whether a plant can successfully reproduce asexually depends on the specific clonal nature of a plant species. For example, many plants can regenerate new adult plants from fragments of vegetative tissue. If a plant species can reproduce in this fashion, natural- and human-mediated dispersal mechanisms can lead to gene flow.

Another potential mechanism for the movement of genes between species includes the biological process known as horizontal gene transfer (HGT). Briefly, HGT is a process whereby genes move between species that are not sexually compatible (e.g., plant to bacteria). Relative to the rates of natural gene flow between sexually compatible species, HGT is extremely rare. For a more detailed description of HGT see section III.C.5 of this EIS.

b. Mechanisms of Gene Flow for Sugar Beet Cultivars

Sugar beet (*Beta vulgaris* ssp. *vulgaris*) are a member of the genus *Beta* (Chenopodiaceae) and are cultivated worldwide. The species *B. vulgaris* includes many different crop varieties including sugar beet, fodder beet, Swiss chard, and table beet. The potential mechanisms for hybridization in the United States between sugar beet and the following other crop and wild beet are discussed below: (*Beta vulgaris*) fodder beet, table beet, Swiss chard, ruderal or feral beet (beet that have escaped cultivation), and wild beet species (*B. vulgaris ssp. maritima* , *B. macrocarpa*). The biological and physical mechanisms that contribute to gene flow between sugar beet and any sexually compatible relative are the same regardless of the agronomic production method: conventional, organic, or GE. Thus, the following sections describe how gene flow processes would affect all three types of agronomic production.

The cultivation of sugar beet can be summarized by two general categories: sugar beet cultivated for the production of a root crop, and sugar beet cultivated for the production of sugar beet seed.

Sugar beet is grown primarily as a root crop and is harvested for its belowground structures (root). Sugar beet is a biennial species, producing a sugary tap root in the first year, and a flowering stalk in the second. Selection has been against annual bolting tendency in sugar beet and vegetable beet varieties. As described in section III.B.1.c., sugar beet require a vernalization period (cold period) to induce flowering. This trait in sugar beet is controlled by a single genetic locus (B locus) (Desplanque et al., 2002). Wild beet species typically carry the dominant allele (genetic sequence) for bolting (flowering in the first year), while cultivated sugar beet carry the recessive allele. Thus, hybrids between wild beet and cultivated sugar beet carry the trait for first year bolting (Boudry et al., 1993). Production of the inflorescence (bolting) in the second year of growth consumes the large taproot formed during the first year of growth. Thus, sugar beet grown for sugar production are grown as annual plants, planted in the spring, and harvested in the fall of the first year without producing flowers. If sufficiently cold weather, 4–7 °C (39–44 °F), occurs in the spring and satisfies the vernalization period (Van Dijk et al., 1997), bolting can occur in sugar beet production fields. In this case, some level of flowering can occur in production fields though intense breeding of modern varieties of sugar beet have reduced the frequency of bolting to 0.01 percent, or 4 plants per acre (Ingram, 2000; OECD; Darmency et al., 2009). Sugar beet root production in California is different from cultivation in the other states. Because of mild winters, California production involves planting sugar beet in the fall and the growing season can extend for 10-11 months. As a result, cool winter weather can vernalize sugar beet and lead to first-year bolting prior to root harvest (Bartsch et al., 2003)(see section III.B.1.c).

In contrast to sugar beet grown for the root, the production of sugar beet seeds for use in root crop production requires flowering and the production and movement of pollen. The potential mechanisms for gene flow in sugar beet seed production are described below.

(1) Pollen-Mediated Gene Flow

Movement of pollen from one *Beta spp*. seed field into another seed production field is the primary mechanism for outcrossing between different sugar beet cultivars and between sugar beet and other sexually compatible varieties/species. Sugar beet are predominantly wind-pollinated. Sugar beet are a highly self-incompatible species that require the movement of pollen between individual plants for the production of sugar beet seed. Self-incompatibility in sugar beet is controlled by a number of different genetic loci although temperature-induced breakdown of incompatibility can occur. Genetic incompatibility is further reinforced by asynchronous flower maturation as pollen is released from the flowers before the female structures are receptive (Bosemark, 2006). Production areas for sugar beet seed are discussed in section III.B.1.b.

Beet produce extremely high numbers of pollen per plant (almost 1 billion grains per plant) and a 1-hectare (2.47 acres) seed field can produce an estimated 25 trillion pollen grains (OECD). Because of the large amount of pollen produced by beet, the pollen is often referred to as a “pollen cloud” (OECD). Because of the great numbers of pollen grains produced by a beet field, competition is very high within the cloud for successful pollination of an ovule (female part of the flower). Pollen survivability in the environment is typically limited to 24 hours and is influenced by humidity and other environmental conditions (OECD). Beet flowers are not showy or attractive to insect pollinators. Some studies, however, have reported limited insect pollination by bee, fly, and thrips species (Free et al., 1975; OECD; Desplanque et al., 2002).

In seed production areas, sugar beet seed is produced by hybridizing very specific genetic lines of sugar beet. The female plant line is genetically described as being CMS and typically cannot produce viable pollen. The desired cross pollination can be achieved by planting alternating blocks of CMS female plants with the desired male fertile plants. CMS lines are typically diploid (2N) where its ovules (which become the seeds) are haploid and possess one copy of the sugar beet genome (N) (Campbell, 2002). The male plant line or pollen parent can be diploid (2N) or tetraploid (4N) producing haploid or diploid pollen and the resulting F_1 hybrid sugar beet seed will be diploid (2N) or triploid (3N), respectively

(Campbell, 2002). Diploid F_1 hybrids of sugar beet can be fully fertile if the pollen parent carries the proper restorer genes. In contrast, the triploid hybrids are either sterile or have very limited fertility (Desplanque et al., 2002) and therefore would not be an effective pollinator.

An important factor regarding the use of CMS hybrid production methods for the production of H7-1 seed production is the preferential use of CMS plants (male sterile) that carry the H7-1 trait. The best available data for 2011 suggest that ~85 percent of H7-1 seed production fields in the Willamette Valley use CMS plants (male sterile) that carry the H7-1 trait (APHIS proprietary data). The male pollinator plants in these fields produce all non-H7-1 pollen. Thus the only potential source of H7-1 pollen in these fields arises from the extremely low level of spontaneous fertility in female (CMS) plants (approx. 1 in 16,000 plants) (Lehner, 2010). Because seed purity is important to seed producers, every field is walked to identify and destroy these rare events Because of the lack of fertile H7-1 pollen from these sources, the potential for H7-1 pollen movement in the environment is primarily due to the remaining ~15 percent of H7-1 seed production that utilizes male fertile H7-1 pollinator lines. Details regarding the specifics of CMS plant breeding in sugar beet are presented in section III.B.1.b(8).

Because sugar beet seed production requires pollen movement and sugar beet pollen can travel long distances, large isolation distances are standard practice in seed production for all *Beta* seed crops to ensure pollination by the desired pollinator and not from neighboring fields (OSCS (Oregon Seed Certification Service), 1993); see section III.B.1.b(10) for discussion on isolation distances in *Beta* seed production. It should be noted that isolation distances do not guarantee 100% seed purity. Undesired cross pollination can always occur due to interacting factors between the environment, biology, and human error. As a result, seed producers have established isolation distances with the aim of reducing the occurrence of gene flow and cross pollination to a minimum. Seed producers are fully aware that the potential for small amounts of unintended gene flow are possible, but that expanding isolation distances beyond those currently used in seed producing regions (e.g., Willamette Valley of Oregon) would be economically or logistically prohibitive (OSA (Organic Seed Alliance), 2010). For very little tangible benefit, namely the reduction in gene flow would decrease only slightly if at all, it would greatly restrict the number of *Beta* seed growers.

To maximize the recovery of sugar beet seed produced using CMS hybrid production (currently all commercial sugar beet seed is produced using CMS), fields are typically planted with a 3- to 4-fold excess of CMS lines over the pollen parent. Use of the CMS breeding method for the production of sugar beet hybrid seed naturally reduces the number of plants producing pollen in a given field by a factor of 3 or 4. As such, the pollen clouds created by CMS sugar beet production fields are expected to be smaller than a pollen cloud produced by an identical-sized field of open-pollinated *Beta* crop. Another potential factor influencing the potential risk of pollen-mediated gene flow could arise through the use of tetraploid (4N) male lines in CMS sugar beet seed production. Tetraploid male lines can have delayed pollen release, relative to diploid lines. Additionally, beet pollen derived from tetraploid lines has been found to be less competitive compared to pollen from diploid lines (Campbell, 2002). Thus, female CMS plants are expected to be at greater risk of incoming pollen flow from diploid *Beta* crops or weeds for a short period of time before tetraploid lines release pollen (OECD).

As discussed in section III.B.1.b, APHIS-issued permits for H7-1 sugar beet seed production in Eastern Washington (Franklin, Adams, Grant, and Yakima counties), Idaho (Canyon, Cassia, Gooding, Jerome, Minidoka, Payette, Twin Falls, and Washington counties), and Oregon (Benton, Clackamas, Crook, Deschutes, Douglas, Jackson, Josephine, Lane, Linn, Malheur, Marion, Polk, Washington, and Yamhill counties) (APHIS proprietary data). Based on planting records supplied to APHIS , planting occurred in all these counties with the exceptions of Yakima, WA, Jerome and Minidoka, ID, and Crook and Yamhill, OR. (see section III.B.1.a(2), Fig. 3–1).

Many factors can affect the distance over which cross pollination can occur including wind direction, wind speed, humidity, and surrounding vegetation. Additionally, pollen travelling from a source population is faced with pollen competition within the pollen cloud produced by the sink population and can act to reduce the likelihood of long-distance pollen successfully pollinating plants within a given field (Hoffman, 2010). As long-distance pollen will naturally be in lower abundance than local pollen, the likelihood of successful long-distance pollination decreases with increasing distance and the size of the receptor field. Because CMS fields produce less total pollen, gene flow out of CMS fields will be lower than from similarly sized non-CMS fields. Conversely, because the pollen cloud is smaller in hybrid production fields, competition is also less than in similarly sized open pollinated fields and hence rates of long-distance gene flow are expected to be higher into hybrid production fields.

Many studies have been conducted to qualitatively and quantitatively measure pollen-mediated gene flow between sugar beet and other *Beta* crops. Studies have indicated that sugar beet pollen can travel a substantial distance depending on wind conditions. Wind-borne sugar beet pollen has been measured to travel up to 5.0 miles (Archimowitsch, 1949; OECD), though the viability of the pollen at this distance was not determined.

Many different studies have been conducted to measure the distances over which cross-pollination between *Beta* crops may occur (Archimowitsch, 1949; Saeglitz et al., 2000; Bartsch et al., 2003; Alibert et al., 2005; Darmency et al., 2007; Fénart et al., 2007; Darmency et al., 2009). Some of the earliest studies of viable pollen and hybridization indicate that most sugar beet pollen is deposited at short distances (<656 feet) from crop fields (Archimowitsch, 1949). Similarly, in studies comparing gene flow from transgenic sugar beet to non-transgenic ruderal beet and CMS beet, gene flow rates were observed to decrease rapidly with distance. In a study where CMS plants (more susceptible to gene flow due to male sterility) were used as bait plants to measure gene flow, gene flow was highest close to pollen donor plants and was as high as 40 percent at 656 feet. In a second study, gene flow rates to ruderal beet occurred at a level of 0.55 percent at 656 feet, while the more receptive (due to male sterility) CMS plants received 1.46-percent gene flow (Alibert et al., 2005). At greater distances (3,280 feet), CMS plants received less gene flow, 0.15 to 0.26 percent. Due to the use of only male sterile plants, gene flow rates would be expected to be higher than rates to fully fertile plants due to lack of competing local pollen (Saeglitz et al., 2000).

Darmency et al. (2009) summarized these studies and noted that comparisons between these experiments are difficult due to the many different parameters unique to each study (Table 3–21). However, Darmency et al. (2009) also noted that the dispersal pattern of pollen movement from sugar beet fields is best described by a leptokurtic curve (power-law distribution) with a fat-tail. That is, gene flow decreases rapidly with approximately 40 percent at the source, dropping to 1 percent at around 1,000 feet and < 0.1 percent around 3,280 feet. Using this model, Darmency et al. (2009) predicted that rare instances of gene flow at great distances can occur. The pattern of pollen movement described by Darmency et al. (2009) suggests that while isolation distances reduce gene flow between *Beta* populations, increases in isolation distance beyond 3,280 feet do not greatly alter the likelihood of successful gene flow and offer little additional practical value.

Table III-21. Summary of Gene Flow Studies for Beta vulgaris

Study	Maximum Distance[1]	Gene Flow
(Archimowitsch, 1949)	2,000 ft	0.30%
(Alibert et al., 2005)	660 ft / 3,280 ft	2.10% / 0.15–0.26%
(Vigouroux et al., 1999)	50 ft	1.20%
(Darmency et al., 2007)	920 ft	1.30%
Madsen, 1994	250 ft	0.31%
Brants et al., 1992	250 ft	8%
(Saeglitz et al., 2000)	660 ft	40%

Bateman, 1947	62 ft	0.07%
Dark, 1971	100 ft	0.10%
Stewart and Cambell, 1952	50 ft	10%
(Fénart et al., 2007)	3 miles	Detected
(Arnaud et al., 2003)	1 mile	Inferred seed dispersal

Source: (Darmency et al., 2009).
[1] **Measures of greatest distance have been converted from meters to feet or miles.**

(2) Seed Dispersal Leading to Gene Flow

Another mechanism for the movement of genes between sugar beet populations includes the natural or human-mediated dispersal of sugar beet seeds outside of cultivation. Sugar beet seed exhibits a shattering phenotype (release and dispersal of seed) and many seeds can remain in the field after harvest and must be managed to control volunteers. Seeds that drop to the ground do not all germinate in the same season due to germination inhibitors within the seed ball and also due to minimal contact with the soil (OECD). Seeds that do disperse from mature plants could be buried and sugar beet seed can exhibit substantial seed dormancy leading to the production of a seed bank. Sugar beet seed has been found to be viable in soil seed banks after 4 years (Desplanque et al., 2002). Seeds that do successfully disperse within sugar beet seed production fields and also germinate can also be identifiable due to position within the field. As planting for sugar beet is highly controlled, plants not in the planting pattern can be identified and removed (Desplanque et al., 2002). Additionally, sugar beet seed production practices include rotational crop species that are easily identifiable from sugar beet. Management practices used by sugar beet seed producers specifically address sugar beet volunteers to limit gene flow from seed dispersal. WCBS has detailed requirements in its protocol for post-harvest field management. After harvesting, the fields are shallow tilled and irrigated to promote sprouting of shattered seeds. Fall plowing is not allowed, and any remaining seed that sprout are destroyed by herbicides or other means. All equipment is cleaned according to WCBS procedures before it can leave the fields. Fields used for growing H7-1 are inspected by WCBS “for a minimum of 5 years or until no volunteers are noted.” Betaseed has similar requirements (Lehner, 2010).

Sugar beet are not considered a particularly competitive plant species and are ecologically limited due to susceptibility to plant pathogens and herbivores and are not typically described as weeds outside of agricultural fields (Bartsch et al., 2001). Sugar beet seed (and other *B. vulgaris* crops) are encased in a specialized woody tissue that can float and disperse via water movement (Fievet et al., 2007). As such, flooding of fields following seed production and harvest could result in dispersal of sugar beet seed beyond field boundaries. Following dispersal, sugar beet seed would need to successfully compete with local weed and pathogen pressure. Sugar beet seed could also be a source of food for small animals and insects. If sugar beet seeds are consumed and survive digestion, sugar beet seeds could disperse with animal vectors. However, no studies could be identified that have examined the viability of consumed sugar beet seed. Feral populations of sugar beet have not been identified (Mallory-Smith and Zapiola, 2008) in the seed production regions of the United States, further suggesting that sugar beet are not a particularly successful weed species in the United States. However, feral populations of *B. vulgaris* have been identified in California (discussed further in section III.B.5.d(2)), potentially arising from escaped Swiss chard, indicating that the potential for persistence of *B. vulgaris* in some geographic regions is possible.

Another mechanism that could contribute to the unintended dispersal and movement of sugar beet seed is non adherence to best management practices for seed harvesting and processing. If the same equipment and processing facilities are used for harvesting both sugar beet and vegetable beet seed, if mislabeling and improper storage of seeds occurs, or if crop refuse containing seed or steckling materials are distributed into fields, seed-mediated gene flow could occur. However, the use of established BMP (discussed in section III.B.1.b(11)) designed to limit the potential for seed mixing specifically address each of these issues and can greatly reduce this potential mechanism for seed-mediated gene flow.

(3) Vegetative Reproduction

Sugar beet also have a limited ability to propagate from vegetative tissue but this ability is likely limited in scope to sugar beet production fields or laboratories. If small roots are left behind in sugar beet fields after harvest, these roots could theoretically overwinter and flower in the next growing season. These small plants are called groundkeepers. However, as sugar beet will be destroyed if they or the ground freezes (23 °F), most winter climates where the sugar beet root crop is grown will kill groundkeepers. Groundkeepers will also be killed in the Imperial Valley due to high summer soil temperatures. Another reason groundkeepers are unlikely to survive the winter is that sugar beet roots are a very attractive food source for foraging mammals and are likely to be eaten (see section III.C.1.b.). Under laboratory conditions, sugar beet can be propagated from root cuttings, crown cuttings, or leaf cuttings (Miedema et al., 1980; Miedema, 1982). When sugar beet are harvested, the crown is sometimes removed which renders the beet non viable.

c. Gene Flow Between Sugar Beet and Vegetable Beet

Gene flow to or from sugar beet and vegetable beet (table beet and Swiss chard) is driven by the same processes and at the same likelihoods as those discussed above for pollen-mediated gene flow between sugar beet cultivars or seed dispersal. All varieties of *Beta vulgaris* grown for vegetable products are interfertile with sugar beet if they flower. As such, the properties of pollen and seed dispersal between populations are equivalent. Successful pollination between vegetable beet varieties and sugar beet would result in the production of seed that would produce hybrid plants sharing morphological traits intermediate to, or a mix of, the two parental varieties. As such, hybrid plants can easily be identified and removed if so desired.

Specific studies examining gene flow between sugar beet and vegetable beet demonstrate the same decrease in pollen-mediated gene flow with distance from source fields. Studies examining gene flow from red table beet into sugar beet have demonstrated that gene flow rates decrease with distance to 0.3-percent gene flow at > 656 feet (Archimowitsch, 1949). The potential for gene flow is equivalent between the crop types with the exception of field size. It has been demonstrated that gene flow in other crop species can be greater from large-scale farming compared with small experimental plots or private gardens (Rieger et al., 2002). The cultivation of vegetable beet can be summarized by three broad categories: commercial vegetable beet production, vegetable beet seed production, and home gardens.

Vegetable beet cultivars (e.g., table beet and Swiss chard) are the same species as sugar beet (*B. vulgaris*) and share the biennial characteristics of sugar beet. Thus, commercial fields cultivated for the production of vegetable crops are harvested before flowering, precluding any possibility of gene flow (Bartsch and Ellstrand, 1999). The exception is that some low level of first-year bolters could occur due to vernalization in the spring (Ingram, 2000) and any fields that are abandoned would flower and be receptive in the second year. As the flowering stalk is undesirable to farmers, a standard practice of farmers is to either remove the bolting inflorescence or the entire plant. Gene flow into bolting plants would only present a problem if plants that have gone to seed are not managed. These bolters could then contribute to weed problems by dispersing seed within the field. However, as the presence of bolters would reduce the quality of the crop harvest, they are typically removed. Hand harvesting of Swiss chard or fresh market table beet would allow harvesters to identify, remove, and discard bolting plants as well as low-quality (off-types) plants. The woody roots that result from bolters can damage harvesting and processing equipment (Ellstrand, 2003) utilized in the harvest of table beet for canning. For these reasons, growers remove bolters.

Because bolters are rare and require several weeks to develop flowers, stewardship can be very successful in eliminating any small probability of pollen shed. As such, the potential for pollen-mediated gene flow into or out of vegetable beet fields grown for vegetable production is zero for the vegetable crop, and can only occur as a result of neglect to remove bolters or harvest the crop in areas where the beet could overwinter. If a field of vegetable beet was abandoned and winter conditions were sufficiently mild to allow overwintering, flowering could occur in the second year and represent a significant source of *B. vulgaris* pollen in the environment that could lead to undesirable offtypes in the neighbors fields. Similarly, abandoned vegetable beet fields could also represent potential pollen sink populations. However because they are abandoned cross pollination into that field would not be noticed by the owner. As cultivated beet are not particularly competitive, the persistence of an abandoned field of vegetable beet is unlikely.

Similar to the production of sugar beet seed; the production of vegetable beet seed can be influenced by pollen-mediated gene flow due to the requirement for flowering to produce seeds. Usually vegetable beet seeds are produced using open pollination. As a result, large isolation distances are utilized between seed production fields (0.5–4 miles) to reduce the chance of pollen flow from other varieties independent of H7-1 seed production (OSCS (Oregon Seed Certification Service), 1993).

Available data for sugar beet seed production (H7-1 seeds, non-H7-1 seeds, and organic seeds) are discussed in section III.B.1.b and root production is discussed in section III.B.1.c. From these available data, APHIS determined where sugar beet and vegetable beet seed production (Swiss chard and table beet) are produced in the same county. These counties include six in the Willamette Valley of Oregon (Marion, Clackamas, Polk, Washington, Benton, and Linn counties), and Jackson county in Southern Oregon, shown in brown in Fig. 3–12. This region represents the area where gene flow between vegetable beet and sugar beet might occur if precautions are not followed or do to unsual conditions.

Small scale farms and home gardens of Swiss chard and table beet are less likely to participate in or take note of isolation distances or pinning maps. For example, in western Washington (Skagit Co.), increases in urbanization and home gardeners and farmers who save seed and sell the vegetable crop have made isolation distances difficult to enforce and maintain high-quality hybrid seed production (du Toit et al., 2007). Different households might grow table beet or Swiss chard for personal use and cultivate plants for seed saving. If the goal of private vegetable gardens is to harvest the vegetative parts in the same year as they were planted, gene flow from sugar beet into home gardens cannot occur and is therefore not a concern. Similarly, such plants will not act as a pollen source. However, home gardens could serve as pollen sources or sinks for gene flow especially if the garden is left unmanaged and vegetable beet bolt or survive the winter and flower, or the vegetable beet are purposely

carried over between years to produce a personal stock of seeds. Den Nijs et al., (2004) inferred that home gardeners and farmers who save seed could play a role in the movement of vegetable beet traits and genes into wild beet populations in Europe.
Home gardens have also been implicated in successful unintended gene flow into sugar beet. As noted by Anfinrud (2010), sugar beet farmers have detected the presence of Swiss chard and table beet off-types in sugar beet seed grow-outs despite extensive isolation from pinned vegetable beet production. As the nearest vegetable production field was in excess of eight miles from the sugar beet fields, it was inferred that local pollen sources, likely from local home gardens, contributed the unintended pollen.

Though home gardens and small farms are likely to be much smaller than seed production fields, they are difficult to identify and coordinate with and can represent a source of pollen if near a seed field and can result in off-types being present in the seed sold for sugar beet root crop production. Gene flow of sugar beet into home gardens that have been abandoned or into gardens where the property owner is practicing seed saving could result in hybrid seeds being dispersed or planted in the following year. Whether home gardeners would use the same careful evaluation of plant traits as commercial growers to remove off-types is unknown.

d. Gene Flow Between Sugar Beet and Wild Beet Species

(1) Wild Beet in Europe

Wild beet can be very common in European sugar beet and vegetable beet production. Several studies have documented the movement of crop alleles (genetic sequences) into wild populations as well as from wild populations into crop production (Ellstrand, 2005).

In Europe, crop varieties of beet (*B. vulgaris* ssp. *vulgaris*) include sugar beet, Swiss chard, table beet, and fodder beet. The cultivated beet can also establish outside of cultivation. In addition to escaped feral sugar beet (*B. vulgaris* ssp. *vulgaris*), there are closely related subspecies of *B. vulgaris* (ssp *vulgaris*, ssp. *maritima*, and ssp. *adanensis*) and related species, *B. macrocarpa* and *B. patuala*. These subspecies and species arefound throughout the coasts of northern and western Europe, the Mediterranean region, and from Asia Minor to Bangladesh (OECD).

Figure 3-12. Representation of the available county level information for the production of A) Swiss chard seed; B) table beet seed; and C) sugar beet seed in 2011

Map D indicates where sugar beet seed production and vegetable beet seed production occur in the same county. (McReynolds, 2011) Note: Not shown on map: H7-1 sugar beet seeds were also planted in one county in Colorado.

Sugar beet and vegetable beet cultivation in Europe like the U.S., has distinct root and vegetable production areas. Root and vegetable production areas include much of Europe. The primary seed production areas in Europe include eastern England, southwestern France, and northern Italy, although smaller regions also produce limited seed (e.g., Denmark). As these seed production areas overlap with the distribution of wild beet in Europe, they are "hotspots" for gene flow between populations (Bartsch et al., 2003). Vegetable crop production areas also overlap with wild beet distributions in Europe.

Studies examining gene flow in Europe between wild beet and sugar or vegetable beet have demonstrated that both pollen-mediated gene flow and seed-dispersal can play a role in the occurrence of wild beet in sugar beet production fields. In Italian seed production areas, studies have documented pollen-mediated gene flow out of sugar/vegetable beet seed fields into local wild *B. vulgaris* ssp. *maritima* populations (Bartsch et al., 2003), although studies in southern France were unable to detect crop-to-wild gene flow (Desplanque et al., 1999). Different methods were used for detecting hybrids but in some cases wild populations were seen to carry a large proportion of crop alleles (gene sequences found in crops), indicating ongoing gene flow. In other studies (Andersen et al., 2005), hybrids were identified as being triploid, implicating pollen-mediated gene flow from tetraploid male lines used in CMS sugar beet seed production. Pollen-mediated gene flow also occurs into seed production fields. As described in the sections above, pollen-mediated gene flow can be observed both as wild off-types in vegetable production regions that have been planted with hybrid seeds or following the successful establishment of wild beet in the seed production fields themselves. Using genetic markers (Random Fragment Length Polymorphisms and microsatellites), other studies have documented gene flow into seed production areas followed by dispersal to vegetable production regions. Once planted, wild- hybrid off-type plants flower in the first year and disperse seeds, creating a weed seed bank. Although these plants are not difficult to control with herbicides in other crops, they are a problematic weed in *Beta* crops because there are not selective herbicides that distinguish the wild species from the conventional domesticated crop. Studies have also been conducted to measure the rate of gene flow between wild beet populations within vegetable crop fields. Fénart et al.(2007) examined the paternity of hybrid seeds produced by wild beet and determined that gene flow between fields can occur at 3 miles between populations with a few hybridization events at a distance of 5 miles.

Seed dispersal has also been identified as playing a role in the presence of wild beet in Europe. Studies using the CMS genetic signature of female plants and chloroplast markers have tracked the movement of seeds out of cultivated fields up to 1,500 meters, indicating that seed dispersal is a potential vector for the establishment of feral beet (Arnaud et al., 2003). Limited pollen-mediated gene flow was also detected. Waterways have been implicated as a major dispersal pathway for both wild beet species and feral beet. The seed ball produced by *Beta* sp. is resistant to waterlogging and can float over great distances, increasing the potential for seed dispersal (Cureton et al., 2006).

To summarize, gene flow has been detected in both directions between crop and wild populations. Both pollen-mediated and seed-mediated gene flow have been implicated in the development of wild beet populations in

Europe. This is due in part to extensive overlap between flowering crop populations (seed production areas) and wild beet species.

(2) Wild Beet in the United States

No native species of *Beta* occur in the United States or North America – all forms of beet in the United States are introduced. Beet species that have been introduced into the United States include *B. vulgaris* (ssp. *vulgaris*, ssp. *maritima*), *B. procumbens*, and *B. macrocarpa*. The distribution of wild beet species in the United States is restricted to two States, Pennsylvania, and California. There is no overlap at the county level of sugar beet seed production and wild beet populations however, as discussed below, there is overlap of wild beet populations and sugar beet root production in Imperial Valley California.

The only location where *Beta vulgaris* ssp. *vulgaris* feral beet are recorded is in California. Research by Bartsch and Ellstrand (1999) suggests that some populations of wild beet in California are actually feral varieties of Swiss chard and table beet (Bartsch et al., 2003). This is evidence that seed dispersal and persistence from vegetable beet crops is possible despite ecological limitations. As they are the same species, there are no specific differences in flowering times or barriers to gene flow between feral beet and sugar beet, though asynchrony may occur due to variation in the planting time of the crop.

Some populations of California wild beet may be introductions of the sea beet (*B. vulgaris* ssp. *maritima*). These beet are primarily found in proximity to the California coast (Fig. 3–13) whereas sugar beet root crop production is further inland. Imperial Valley appears to have an unsuitable climate for wild populations of *B. vulgaris* (Beet Sugar Development Foundation et al., 2011). Although wild *B. vulgaris* has been reported to be present in the Imperial Valley, it's presence has not been confirmed by experts (Calflora, 2011) and the previous reports, which were based on identification through morphological features, may have confused it with the widely prevalent and strongly resembling, *B. macrocarpa* . Wild beet of the species *Beta vulgaris* and sugar beet have overlapping flowering times and are fully sexually compatible. Hybrid plants derived from cross pollination between sugar beet and wild beet could be expected to flower in the first year without vernalization. Additionally, hybridization would result in a mix of wild traits and crop traits, for example, little or no sugary root (Ellstrand, 2003). Although many studies have documented hybridization between sugar beet and sea beet in Europe, no direct evidence of these hybrids has been found in the United States.

The distribution of *B. macrocarpa* in the United States is restricted to California and *B. macrocarpa* has been identified as a frequent weed in sugar beet fields in the Imperial Valley (Fig. 3–14) (2011). Based on the use of genetic markers, *B. macrocarpa* is believed to have been introduced to the United States from populations originating from Spain. Some evidence of introgression between sugar beet and *B. macrocarpa* has been reported in one population of wild beet in the Imperial Valley (Bartsch and Ellstrand, 1999). This evidence, based on isozyme analysis, requires further testing with current and more sensitive molecular DNA markers before a conclusion can be reached that introgression has indeed occurred. This is because isozymes are shared by many populations while DNA markers are much more specific. Therefore,the DNA markers increase the certainty by which two populations and their offspring can be identified. Several observations are inconsistent that introgression of *B. vulgaris* into *B. macrocarpa* occurred based on the low likelihood of crosses between the two. First, greenhouse crosses using sugar beet as the pollen parent were unsuccessful with *B. macrocarpa* female plants. The reciprocal cross using *B. macrocarpa* pollen onto sugar beet was successful, but the progeny were abnormal and showed signs of chromosomal instability (Lewellen et al., 2003). Second, *B. macrocarpa*, unlike *B. vulgaris*, is highly self fertile and much less prone to outcrossing. Third, *B. macrocarpa* begins to flower in January and has largely gone to seed by May. Bolters of the *B. vulgaris* root crop only begin to flower in April so there is little, if any, flowering overlap (Bartsch et al., 2003; Lewellen, 2011). The putative introgression event is hypothesized to have occurred due to rare climatic episodes that synchronized flowering between the species (Bartsch and Ellstrand, 1999).

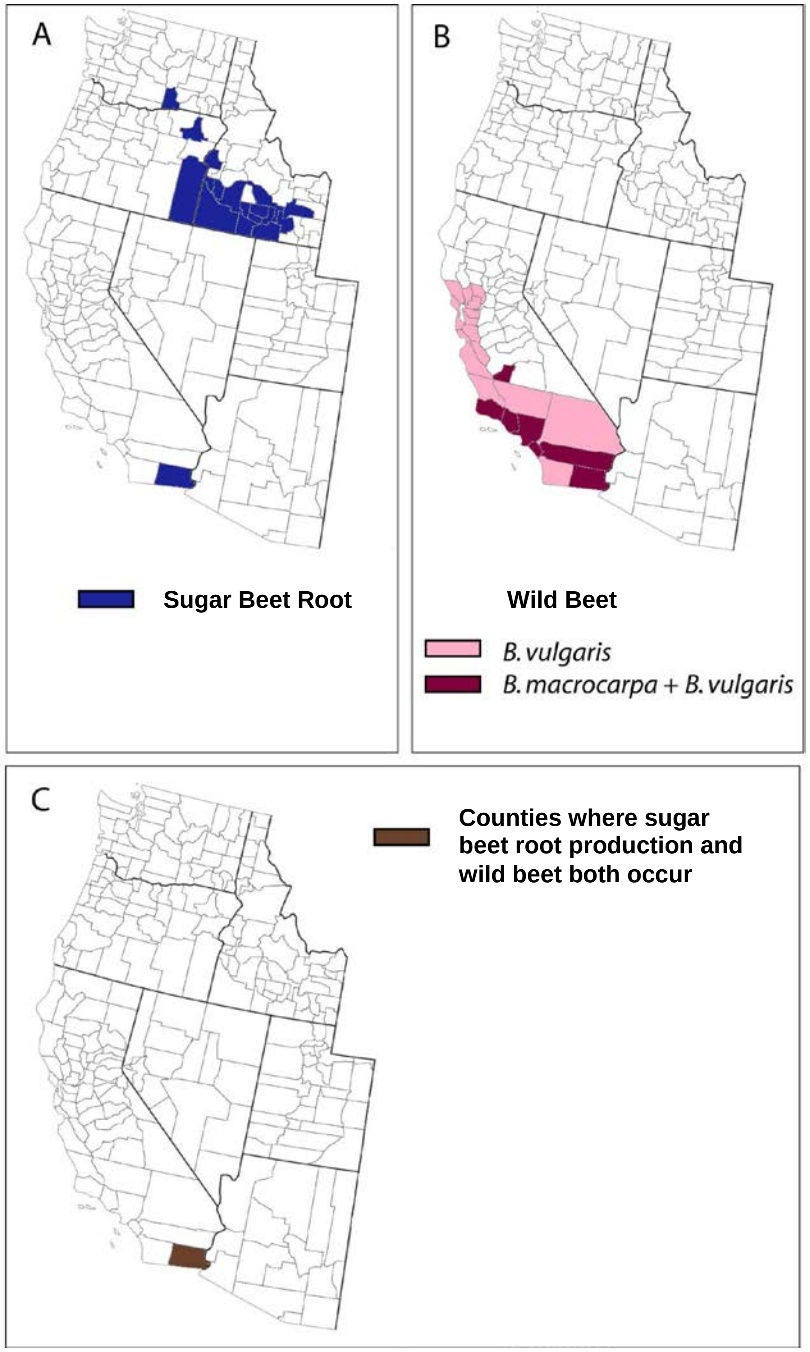

Figure 3-13. Representation of the available county level information for the production of A) sugar beet root; B) wild beet distributions (*B. procumbens* not shown); and C) counties where sugar beet root production and wild beet species occur

The only county where both sugar beet root production and wild beet occurs is in Imperial Valley. In Imperial Valley the predominant wild species is *B. macrocarpa*. The presence of wild *B. vulgaris* has been reported but not confirmed in Imperial Valley (sources (Calflora, 2011; USDA-APHIS, 2011b)

Figure 3-14. Sugar beet fields in Imperial Valley in early May

A. A mostly weed-free sugar beet field. B. A sugar beet field containing *B. macrocarpa*. The brown color represents mature seeds already formed on *B. macrocarpa*. The sugar beet plants have not yet flowered. C. Mature seeds collected from *B. macrocarpa* plants shown in B. Photos from Neil Hoffman

Beta procumbens has been identified in Pennsylvania, a State that currently does not produce commercial sugar beet. Although hybrids can be formed between *B. vulgaris* and *B. procumbens*, hybrids have not been observed to occur naturally and seedlings typically do not survive (OECD).

To summarize, as there is no overlap between the distribution of wild *Beta* species in the United States and sugar beet seed production areas, the potential for successful gene flow is negligible. Wild beet overlaps with California sugar beet root production in only Imperial county, (Fig. 3–13). The predominant wild *Beta* species in Imperial Valley is *Beta macrocarpa,* which does not readily cross with sugar beet and flowers prior to the crop.

e. Detecting Outcrossing and Modeling Gene Flow

(1) Detecting Outcrossing

Seed producers are aware of the potential for cross pollination and gene flow to occur between any two compatible crop species. As a result, isolation distances are utilized to separate and thus reduce the overall potential for cross pollination to occur. However, it is very unlikely that cross pollination can be prevented, only mitigated to levels that are very low. As a result, a small percentage of crosses are tolerated and the rate of unintended gene flow can be determined by monitoring seed lots.

If pollen-mediated gene flow occurs into a vegetable seed production field or vice versa, the events could be detected by two types of quality control measures before selling the seed: either by genetic testing of the seed or by a grow-out of the seed and inspection for nonuniformity. Seeds that have formed between sugar beet and vegetable beet cultivars (hybrids) will have a mix of the morphological traits associated with the parent cultivars. These plants are considered “off-types” because the mix of traits is visually identifiable. Though sugar beet seed is not typically certified, it is customary to evaluate the amount of varietal off-types torespond to customer demand for quality. Off-types between different groups (such as Swiss chard, table beet, and sugar beet) are less tolerated than between different varieties within a group (for example red and orange table beet). As a result, the isolation distances are greater for sexually compatible varieties between different groups (see section III.B.1.b(10) WVSSA isolation distances). For off-types between table beet of a similar market class, 5 percent is tolerable while off-types between table beet and Swiss chard are about 1 to 2 percent (Navazio, 2010). Evaluating crop purity is not a new step that has resulted due to the initial deregulation of H7-1. However, with H7-1 production, vegetable beet farmers may produce for markets that are sensitive to less than one seed in 10,000 (0.01%) if it contains a GE trait. Assuring 100 percent purity is not possible. However isolation distances and best management practices should enable the production of fewer than 0.01% offtypes in most circumstances.

The purity of breeding and foundation seeds is important in the prevention of adventitious presence of other *Beta* crops in subsequent commercial seed production. Concern regarding the potential for gene flow between *Beta* crops include the potential for these foundation seeds to have adventitious presence of hybrid off-types caused by gene flow of vegetable beet into sugar beet or vice versa. However, while unintended pollen-mediated gene flow between *Beta* cropscan be detected, LLP does not imply that the entire seed lot is off-type and cannot be used in the future. According to Stander (2010), “the removal of unwanted genetic traits from a line is routine in plant breeding programs.” If the breeder or foundation seed has LLP, the seed can be cleaned using the “genetic bottleneck” as described by Stander (2010). In case of sugar beet cross pollinated with vegetable beet or vice versa, the seed containing the unwanted trait will be exclusively hybrid seed. The task is to plant a sample of the seed lot and identify the plants that are hybrid plants. These plants are removed and seed is only collected from the non-hybrid plants. The genetic bottleneck means that the breeder only collects seed which are known to be true to type and in that way the unwanted trait is removed. In the case of cross pollination between sugar beet and vegetable beet, hybrid plants are usually different in leaf coloration, root shape, plant size, or other characteristics. The breeder can usually plant out a sample of seed, rogue out the hybrid off-types and simply collect seed from the remainder. In the event that plants do not differ visibly, there are non destructive cost effective tests that can be done on leaf samples from each plant before the plants flower. To increase the efficiency and reduce the costs of testing, groups of plants can be tested as bulk samples where all plants in the group are discarded if it tests positive. Pooling samples is very effective in cases of low level presence, because when the frequency of the GE trait is low, even batches of 50 plants are unlikely to contain the GE trait. As a result, most batches will test negative for the GE trait and these could be selected as a group to regenerate the line of interest. Subsequent breeding from only the plants identified as being free of hybrid traits could restore the breeder or foundation seed to purity in a single generation.

Growers and consumers are also capable of detecting off-types that result from gene flow between sugar beet and vegetable beet varieties. A hybrid plant produced due to gene flow between sugar beet and Swiss chard would have characteristics from each of the parents, depending on the dominant-recessive nature of the traits. As sugar beet and Swiss chard have large differences in the desired product, sugary root versus edible leaves and stem, the hybrid plant would appear to be an off-type to growers of each crop type (Fig. 3–15). The Swiss chard grower would reject the hybrid off-type because of the mix

Figure 3- 15. Photo of hybrid "off-type" plants in a sugar beet field.

Hybrids formed with Swiss chard as the pollen parent and sugar beet as the seed parent results in hybrid seed that grows into a visibly distinct plant (larger with increased leaf size) (Stander, 2010)

of undesirable flavor, color, and shape of the leaves and stems. Similarly, sugar beet growers would also reject this hybrid plant because of reduced sugar in the root and other undesirable characteristics. Hybrids between sugar beet and table beet would be rejected by table beet growers due to changes in root color and changes in root morphology (see Fig. 4-3). If such hybrids were too common, growers would complain to the seed producer and or not purchase the product.

Management practices in the Willamette Valley have been designed to minimize the amount of visible off-types formed between sexually compatible species and varieties and to allow the coexistence of sugar beet, Swiss chard, and table beet seed production in the valley. The seed companies that produce sugar beet seed in the Willamette Valley also monitor their seed harvests for "off-types" by growing out seed subsamples and observing the growing plants for evidence of hybrids (Hovland, 2010; Lehner, 2010). According to Lehner (Lehner), none of Betaseed seed lots had off-types in the preceeding year (2009). Likewise Anfinrud (Anfinrud) indicated that off-types are only observed occasionally and are suspected to be due to unpinned and unmonitored home gardens (Anfinrud, 2010).

In addition to visual inspection for hybrid off-types, gene flow between H7-1 varieties of sugar beet and any other *Beta* crops can be detected by testing for the H7-1 protein with strip tests or the H7-1 DNA by using

DNA amplification procedures. Strip tests are relatively inexpensive (less than 10 USD),can detect the presence of transgenic protein from pooled samples and are sensitive to 0.1 percent (1 H7-1 seed in 1,000 seeds) (Anklam et al., 2002; STAVE, 2002) Strip tests do not require specialized equipment, can be used outside of the laboratory and under field conditions, and can be used to test seeds. Several companies produce strip tests to test for the GE protein 5-enolpyruvylshikimate-3-phosate synthase (EPSPS): Quickstix™ kit for Roundup Ready® bulk sugar beet seed (Envirologix, Portland ME); AgraStrip® RUR Bulk Grain Traitchek (Romer Labs Inc. Union MO); Roundup Ready® ImmunoStrip (CP4 EPSPS) (AgDia, Elkhart IN) (USDA-APHIS, 2010a). At least one of the major vegetable seed producers in the Willamette Valley has used test strips to test their seed since 2007 to look for the presence of the H7-1 trait (Hake, 2011; Tichinin, 2011). They detected H7-1 from one field in 2007 and in another field in 2008 (Tichinin, 2011). No H7-1 was detected in their vegetable beet seed in subsequent years (see FEIS section IV.B.5.a.(2) for more discussion).

PCR techniques are more expensive (150–1,050 USD) but are more sensitive (1 seed in 10,000) and quantitative (Bullock et al., 2002; Auer, 2003). At least one vegetable beet seed producer has tested his fields over the past three years using the PCR technique and has not detected the H7-1 trait (Hoffman, 2010). Detection of H7-1 has been documented in some lots of non-H7-1 sugar beet production. Anfinrud (2010) states that pooled samples (from WCBS) of non H7-1 sugar beet were tested following standard purity testing protocols using PCR techniques in 2007 and the H7-1 trait was detected. Subsequent fine scale testing revealed that the percent of adventitious presence was less than 0.1 percent of seeds. No WCBS pinned fields were in violation of isolation distances of non H7-1 seed field and the source of the adventitious presence was not determined.

(2) Modeling Gene Flow

Modeling gene flow between Beta spp. production is a very complex process. Several different environmental and biological factors act to increase and decrease the likelihood of pollen moving between any two populations. To generalize, the potential for pollen-mediated gene flow to occur between fields/populations of Beta species is influenced by a number of factors: wind speed and wind direction moving from source to sink fields/populations, insects (to a lesser degree), synchronized flowering time between fields/populations, distance between source and sink populations, topographic barriers (e.g., wind rows, cliffs), pollen viability, pollen survivability, temperature, humidity, and relative sizes of source and sink fields (Rognli, Nilsson et al., 2000). As distances increase between populations, the potential for gene flow decreases.

Regarding limitations on pollen-mediated gene flow of the H7-1 trait, 85 percent of H7-1 seed production in the Willamette Valley utilizes female (male sterile) plants that carry the H7-1 trait and non-H7-1 male pollen producing plants. The production of H7-1 pollen from these sources is negligible (Lehner, 2010). The remaining 15 percent of H7-1 seed production produces viable H7-1 pollen. However, the factors of isolation distance and pollen cloud competition act to reduce the likelihood of successful long distance gene flow.

Models have been developed in an attempt to understand the potential for pollen-mediated gene flow out of sugar beet fields. The GENESYS-BEET model is a computational model developed by Sester et al. (2008) and has been used to examine many different components of the cultivated beet and wild beet lifecycles (Sester et al., 2008; Colbach et al., 2010) (Fig. 3–16). Results examining the many parameters that contribute to gene flow to wild beet (e.g., pollen-mediated gene flow, seed-dispersal, vernalization, bolting, and reproductive mode) were found to be largely congruent with field-based observations. From this model the authors conclude that the introduction of H7-1 lines of sugar beet is not likely to result in harvest impurities (gene flow between two varieties of sugar beet or between sugar beet and vegetable beet), but might contribute to the rise of herbicide-resistant wild beet in production fields, if sexually compatible species were growing in proximity. However, because wild beet do not grow in the states where sugar beet seed production occurs, as discussed in section III.B.5.d, this possibility is not likely.

Several studies (as reviewed in (Darmency et al., 2009), that have modeled the distribution of gene flow/pollen movement in sugar beet have determined that while pollen movement and gene flow can be as high as 40 percent near source fields, the majority of pollen moves a short distance from its source and decreases to around 1 percent at 1,000 feet and drops to < 0.10 percent at 3,280 feet. Additionally, the measured rate of gene flow (1 percent at 1,000 ft and < 0.10 percent at 3,280 feet) resulted from studies where CMS male sterile plants were the receptor population. The authors concluded that the receptor plants were under pollen limitation indicating that there was little to no local pollen cloud acting as competition for migrating pollen. This conclusion suggests that the real-world rate of gene flow that would result between two actively producing pollen sources would likely be much lower than < 0.10 percent at 3,280 feet. As pollen moves greater distances, gene flow rate continues to decline and tends to follow a specific leptokurtic pattern (power-law distribution) (Fig. 3–17). Dispersal distance is influenced by the characteristics of the pollen (size, weight, and shape); environmental conditions such as wind speed, direction, and turbulence; topography; pollen source field size; and architectural features of the plant such as height (Jackson and Lyford, 1999; Aylor, 2003).

One particularly important aspect to consider regarding the modeling of gene flow risk is the relative size of the pollen clouds moving from source fields to the pollen clouds produced by sink fields. Quantitative information detailing the strength of adventitious pollen clouds (from source fields) versus local pollen clouds (at sink fields) could be derived from studies of pollen movement (Darmency et al., 2009).

At increasing distances, incoming pollen clouds would continue to be progressively smaller relative to local pollen clouds. At sink fields there is great competition within the pollen cloud for the limited available ovules (only one per flower). As an average sugar beet plant produces 1 billion pollen grains and roughly 10,000 seeds (OECD), the pollen to ovule ratio is 100,000:1. In other words there is a huge excess of local pollen available to fertilize each potential seed. To cross pollinate, incoming pollen must compete against this local pollen source. APHIS can estimate how much the incoming pollen cloud is diluted due to dispersal as a function of distance based on the Darmency study. The results of pollen dispersal from Darmency et al., (2009) suggest that the rate of pollen movement that results in gene flow at 3,280 feet to CMS male sterile plants (no pollen production) is < 0.1 percent, or < 1 in 1,000 pollinations. In other words, at 3,280 feet, there is no longer an excess of pollen for each ovule, but only enough pollen to fertilize one out of every 1,000 ovules. It is important to note that this is the rate of outcrossing to CMS plants, without a local competing pollen cloud. Over this distance APHIS can estimate that the pollen cloud was diluted 100 million fold, from a 100,000 fold excess at the source to a limitation of 1 grain for every 1,000 ovules at 3,280 feet. The incoming pollen cloud, which has been significantly diluted over distance, is now further diluted by the local pollen cloud which will be in vast excess over the available ovules. The relative sizes of the pollen clouds are influenced by the size of the fields and the number of plants that produce pollen. Hence, a large field produces proportionally more pollen than a smaller field; hybrid fields which have less male fertile plants produce proportionally less pollen than an open pollinated field. A large hybrid seed field might be 100 acres while a small open pollinated field may be 0.1 acre. The hybrid field might have one fourth as many pollinators so the large hybrid field might produce 250 times more pollen than the small open pollinated field. However, because the pollen concentration declines so precipitously with distance, the contribution of field size is a minor factor in the potential for cross pollination at the distances under consideration.

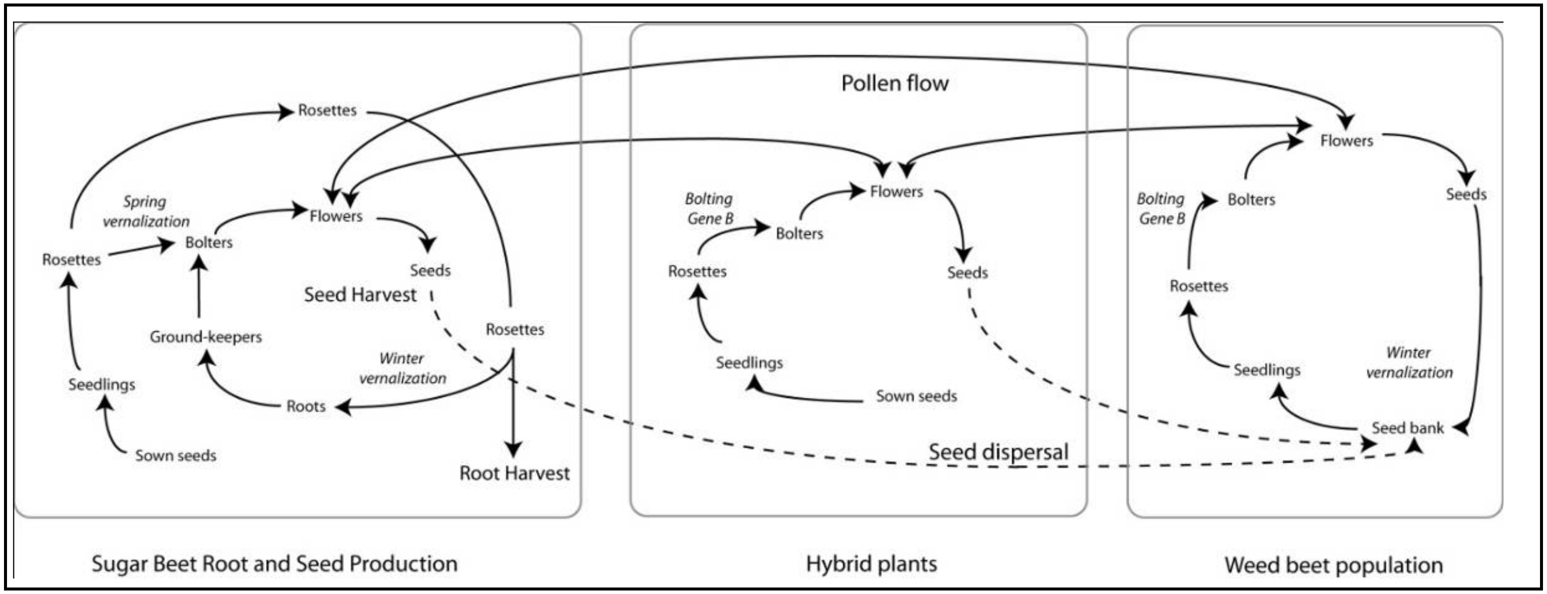

Figure 3-16. Lifecycles occurring in cultivation areas of sugar beet and modeled in Genesys-Beet (left: biennial crop plants, center: hybrids, right: weeds) with potential pollen flow and seed dispersal showing connections between cycles

(Source: (Sester et al., 2008)) Bolting is Caused Either by Vernalization of Roots (Crop Plants) or Seeds (Weeds) During Winter, Accidental Spring Vernalization of Rosettes (Crop Plants) or by the Bolting Gene B (Hybrids, Weeds)

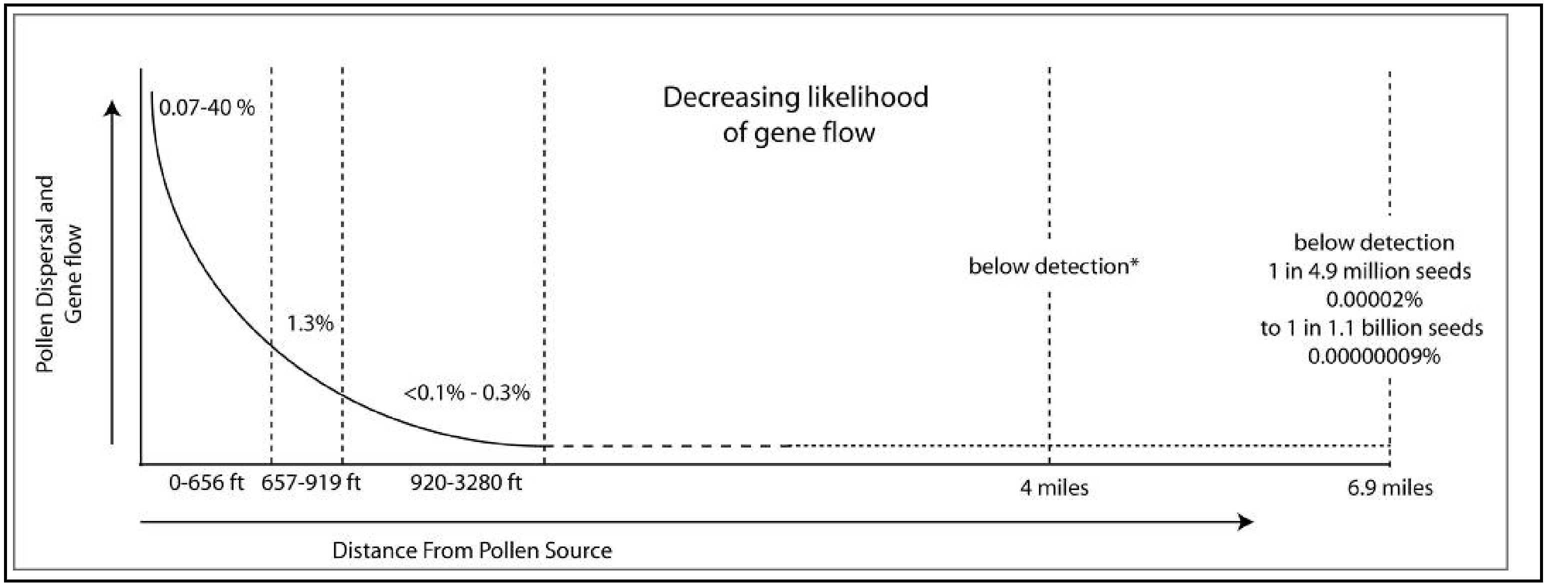

Figure 3-17. Schematic representation of relationship between gene flow rate and distance

Measures of percent gene flow at short distances range greatly due to differences in research studies but the pattern decreases with increasing distance. Decreasing likelihood of gene flow occurs as distance increases. (Sources: (Darmency et al., 2009; Westgate, 2010). Adapted from data presented in Darmency *et a*l. (2009) Asterisk indicates estimate of gene flow at 4 miles is below detection limits. Detection limits are 1 in 10,000 seeds or 0.01 percent. Computer model estimates at 6.9 miles adapted from Westgate (2010).

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Based on this analysis, incoming pollen from another source has extremely limited opportunity for successful fertilization. In a large, densely planted population, such as a seed production field, successful pollination and fertilization is much more likely from the pollen originating in the local sink cloud within the field than from pollen migrating from another field (Hoffman, 2010; Westgate, 2010) Most of the pollen migrating from source fields becomes diluted during long-distance pollen dispersal because incoming pollen is vastly overwhelmed by the concentration of local pollen.

Computer-based models using these biological and environmental parameters demonstrate that these assumptions about the rate of pollen dilution and corresponding decrease in gene flow potential continues as distances between fields increase (Darmency et al., 2009; Westgate, 2010). Using biological and environmental information to model long distance pollen flow, Westgate (2010) examined the potential for gene flow from sugar beet into Swiss chard in the Willamette and Rogue Valleys of Oregon. Based on these simulations, the highest likelihood for successful gene flow between vegetable beet and sugar beet fields separated by 6.9 miles ranged from 1 in 4.9 million to 1 in 1.1 billion depending on the modeled date. Given the assumptions of this model, the rapid decrease in pollen movement over distance, and the likely high competition of the pollen cloud and sink populations, the level of gene flow at a 4-mile isolation distance was estimated to be lower than detection limits with current strip (0.1 percent, 1 in 1,000 seeds) or PCR tests (0.01 percent, 1 in 10,000 seeds) (Westgate, 2010). The conclusion of this study was that the chances of detectable gene flow at a 4-mile isolation distance are extremely low and below detection limits by PCR; < 0.01 percent. Given the rapid dissipation of sugar beet pollen in the air and the high competition of local pollen clouds, it is likely that isolation distances much less than 4 miles would still result in non-detectable gene flow. Quantitative studies have not been identified that have tested the likelihood of detecting gene flow at distances greater than 3,280 feet. In the instances where cross pollination between vegetable beet and sugar beet have occurred, the causes are generally not known (Anfinrud, 2010; Tichinin, 2011). Likely possibilities are an unidentified nearby pollen source and impure breeding stocks rather than insufficient isolation distance.

Sugar beet root crops that have aberrantly bolted could also act as pollen sinks and sources. However, modern sugar beet cultivars have been selected to have very low bolting rates (0.01 percent of plants). Of these bolting plants, the majority will be removed by management practices to prevent bolting and reductions in the root crop. Bolting root crops outside of California are not at risk of gene flow to or from wild beet. In California, the likelihood of gene flow from a bolting plant in a sugar beet root crop to wild beet (*B. macrocarpa*) is low given the asynchrony in flowering between the two,the high degree of self fertility in *B. macrocarpa*, and the lack of sexual compatibility between the two species. These properties make gene flow between these populations unlikely (Fig. 3–18).

The timing of planting, vernalization, bolting, flowering, and harvesting can vary depending on the seed or root crop, as well as for wild beet. The lifecycles of crop and wild beet are described below.

1) Seed production for *Beta* seed crops typically occurs in the Pacific Northwest, where vernalization can occur during the winter months without killing the young plants. Sugar beet seed is planted in late summer–fall in year one (August–September). Swiss chard and table beet seed is also planted in late summer–fall but may be planted earlier than sugar beet (July–August). Plants are vernalized over the winter. Following vernalization, sugar and vegetable beet bolt in April and flower in early June–July (Westgate, 2010; Beet Sugar Development Foundation et al., 2011) and set seed for harvest in the mid-late summer of year two (August) (Anfinrud, 2010; Hoffman, 2010).

2) Sugar beet root production in the United States occurs in geographies with weather conditions that are too severe for sugar beet to survive. Seed is planted in early spring of each year and vegetative roots are harvested in the fall of each year (September to November). Spontaneous bolting can occur (0.01 percent) and would tend to occur in summer with pollen release in August-September. It is standard practice for bolters to be removed or "topped" by farmers. It should be noted that if the sugar beet root crop flowers, pollen release is expected to occur approximately two to three months after a sugar beet seed crop and the plants would not be expected to cross pollinate with a seed crop even if they were in proximity.

3) Sugar beet root production in the Imperial Valley of California is different from the rest of the United States. While winter conditions are temperate, the summer temperatures are too high for plants to survive. Seed for root production is planted in September to October. Plants grow throughout the winter and are harvested in April through July. Spontaneous bolting in California sugar beet is more likely than in the northern regions. Bolters can start to appear in April.

4) The flowering period of wild beet populations in Imperial Valley typically occurs in February and March prior to the flowering of sugar beet bolters. Wild beet generally have produced seeds at or before pollen release from sugar beet bolters. It is possible that

flowering overlap could occur based on rare climate conditions (Bartsch and Ellstrand, 1999). Glyphosate drift has been reported to delay flowering (Londo et al., 2011) which could conceivably promote flowering overlap between wild beet and bolting H7-1 sugar beet

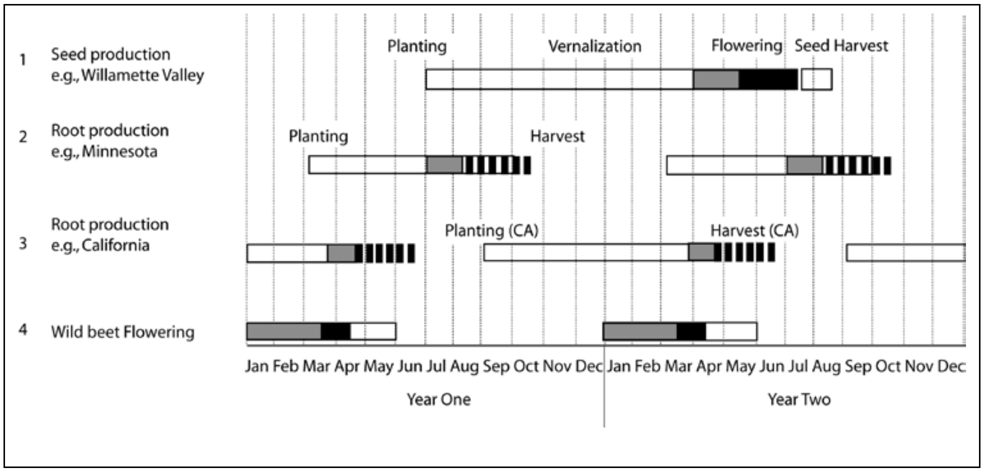

Figure 3-18. Schematic displaying differences in growing seasons and sugar beet production

Hollow bars indicate the approximate lifecycle of each crop type or wild beet. Grey boxes indicate the approximate range of time associated with bolting. In 2011, APHIS received notices from sugar beet growers when plants in the root crop bolted. In that year the first notice APHIS received was on June 9 while the majority of bolters occurred in July and August. While it is unlikely that bolters would emerge much earlier than June1 in the northern regions, that possibility cannot be completely ruled out as climate conditions vary from year to year. Black boxes indicate the approximate range of the time associated with flowering, or the time of anthesis (when pollen is shed). Anthesis is expected to occur several weeks after bolting and can last 3-4 weeks. Broken boxes indicate rogueing of bolters in root crop production, which can occur beyond expected harvest time as harvest can be delayed by weather.

C. Biological Resources

The affected environment for biological resources consists of the animals and plants that occur in sugar beet fields and the areas within the vicinity of sugar beet fields (e.g., nearby surface waters, ditches, hedge rows, fence rows, wind breaks, yards, etc.) that might be affected by herbicide use and other crop management practices. Additionally, livestock that are fed sugar beet tops or co-products (sugar beet pulp and molasses) from sugar beet processing are included in the affected environment.

The landscape surrounding a sugar beet field varies depending on the specific location of where the sugar beet are grown. Biological resources in the surrounding area and within the sugar beet fields themselves might differ under the action alternatives depending on the different management practices associated with the presence or absence of the H7-1 gene in sugar beet. These practices largely reflect different patterns of herbicide use and tillage and their respective impacts on food resources, reproduction habitat, and protection from predators that may impact the non-target species in the sugar beet field and the non-target area adjacent to the sugar beet field.

1. Animals

Wildlife abundance and composition in and surrounding sugar beet fields depend on geographic location, surrounding habitat conditions, sugar beet field size, and proximity to other sugar beet fields. For example, large patches of wildlife habitat generally support more species than smaller patches of similar habitat (Turner et al., 2001). Also, those species that are specific to sugar beet fields (e.g., the sugar beet root maggot) likely are greater in abundance in areas where several sugar beet fields are in close proximity to each other compared to isolated fields. Animals that could be affected by the alternatives evaluated in this EIS include livestock and wildlife including mammals, birds, reptiles, amphibians, fish, and terrestrial and aquatic invertebrates.

a. Livestock

As mentioned in section III.B.1.a(1), sugar beet processing generates two valuable agricultural co-products: sugar beet pulp and sugar beet molasses. The sugar beet pulp, which is high-quality feed due to its high energy and high fiber content (Harland, Jones et al., 2006), is fed to cattle and sheep. In contrast to molasses derived from sugar cane, which has some food uses, sugar beet molasses is used mainly for livestock feed, partly as a source of energy. Molasses from sugar beet also is sprayed onto low-quality feeds, such as straw and hay, and onto dried sugar beet pulp shreds or pellets to enhance palatability (CFIA, 2002; Harland, Jones et al., 2006). Sugar beet tops, which are sources of protein, vitamin A, and carbohydrates, also can be used for livestock feed or as silage (Cattanach, Dexter et al., 1991). During fiscal year (FY) 2010, 10,453 tons of sugar beet were used as livestock feed in the United States, which was less than 0.01 percent of total livestock feed grain (not including forage crops; USDA–ERS, 2010d). Sugar beet-derived feed generally is consumed by ruminant livestock, such as cattle, sheep, and goats, but can also be fed to pigs (Harland, Jones et al., 2006). The recommended commercial feed content of sugar beet byproducts for mammalian livestock ranges from 5 to 40 percent, depending on the animal and their intended purpose (i.e., breeding, dairy producing, fattening for meat) (Harland, Jones et al., 2006). Poultry consumption of sugar beet-derived feed is uncommon, and is recommended by Harland et al. (2006) at rates less than 5 percent. Despite its suitability as feedstuff for a variety of animals, sugar beet-derived feed makes up only a small percentage of total animal feed used in the United States.

b. Mammals

Small mammals, such as rabbits, mice, voles, and other rodents, use sugar beet fields for foraging, cover, and shelter, some burrowing into the soil for seed storage, reproduction, and shelter from weather. Rodents can be problematic to sugar beet farmers because they can cause mild damage to the fields in the summer, especially when the soil is dry. Field mice (*Apodemus sylvaticus*) can excavate and destroy sugar beet seeds, and rabbits (*Oryctolagus cuniculus*) and hares (*Lepus capensis*) graze on the vegetation, contributing to plant loss (Dewar and Cooke, 2006). Furrow irrigation appears to deter rodents (Virchow and Hygnstrom, 1991). Sugar beet growing regions that use furrow irrigation include the Southern Great Plains subregion (western Nebraska, southeastern Wyoming, and northeastern Colorado, primarily in the valley of the Platte River and its tributaries) and Imperial Valley (Mikkelson and Petrof, 1999; Thomas et al., 2000; McDonald et al., 2003; Beet Sugar Development Foundation et al., 2011). In other agricultural areas that do not rely on irrigation to deter rodents, commercially available rodenticides or rodent deterrents are used to combat any rodent problem (Witmer and Eisemann, 2007).

Larger mammals, such as deer, use sugar beet fields for foraging. Deer can often be a problem after planting stecklings, because deer are attracted to the delicate growing leaves of the plant. As part of harvesting the sugar beet root for sugar production, the leafy sugar beet "tops" are usually left in the field, but they occasionally are fed to ruminant livestock as silage (U.S. FDA, 2004). These leafy "tops" may also be eaten by foraging wildlife.

As discussed in sections III.B.1.d(3) and III.B.1.d(4), herbicides are applied to sugar beet fields to control weeds and to maximize crop yield. Some typical end-use products (TEP) are more toxic than the technical grade acid equivalent (TGAE) or active ingredient (TGAI), respectively. The adjuvants included in the formulated products to improve the efficacy of the herbicide also increase its toxicity to mammals. Toxicity of the herbicides to mammals is discussed in more detail in the chapter on environmental consequences, in section IV.C.1.b.(1).

In recent years, some scientists have proposed that chemicals might inadvertently be disrupting the endocrine system of humans and wildlife. Endocrine systems, also referred to as hormone systems, are found in all mammals, birds, fish, and many other types of living organisms. They are made up of:

- glands located throughout the body,
- hormones that are made by the glands and released into the bloodstream or the fluid surrounding cells, and
- receptors in various organs and tissues that recognize and respond to the hormones.

A variety of chemicals have been reported to disrupt the endocrine systems of animals in laboratory studies, and there is strong evidence that chemical exposure has been associated with adverse developmental and reproductive effects on fish and wildlife in particular locations(U.S. EPA 2011e). Colborn and Carroll (2007), review human epidemiological studies that link a number of herbicides with reproductive and developmental effects. Included on the list are many of the herbicides used in sugar beet production including synthetic auxins, fatty acid synthase inhibitors (thiocarbamates), ALS inhibitors (imidizolanones and sulfonylureas), and glyphosate (Colborn and Carroll, 2007). Given the widespread use of glyphosate, it has been the subject of laboratory studies and possible endocrine disruptive effects from this herbicide have been reported (Walsh et al., 2000; Williams et al., 2000; Richard et al., 2005; Jaensson, 2010; Paganelli et al., 2010).

Disruption of the endocrine system can occur in various ways. Some chemicals mimic a natural hormone, fooling the body into over-responding to the stimulus (e.g., a growth hormone that results in increased muscle mass), or responding at inappropriate times (e.g., producing insulin when it is not needed) (U.S. EPA 2011b). Other endocrine disrupting chemicals block the effects of a hormone from certain receptors (e.g., growth hormones required for normal development) (U.S. EPA 2011b). Still others directly stimulate or inhibit the endocrine system and cause overproduction or underproduction of hormones (e.g., an over or underactive thyroid) (U.S. EPA 2011b).

The Endocrine Disruptor Screening Program (EDSP) focuses on the estrogen, androgen, and thyroid hormones (U.S. EPA 2011b). Estrogens are the group of hormones responsible for female sexual development. Androgens are responsible for male sex characteristics. The thyroid gland secretes two main hormones, thyroxine and triiodothyronine, into the bloodstream. These thyroid hormones stimulate all the cells in the body and control biological processes such as growth, reproduction, development, and metabolism.

The EPA Endocrine Disruptor Screening Program (http://www.epa.gov/endo/) was created as a response to a mandate of the 1996 Food Quality Protection Act (FQPA) and the 1996 Amendments to the Safe Drinking Water Act (SDWA) which require EPA to:

"Develop a screening program, using appropriate validated test systems and other scientifically relevant information, to determine whether certain substances may have an effect in humans that is similar to an effect produced by a naturally occurring estrogen"

The two acts call for the "testing of all pesticide chemicals" and "any other substance that may be found in sources of drinking water" (U.S. EPA 2011b).

The screening has been expanded to include effects on fish and wildlife in addition to humans.

These laws require EPA to develop a screening program that uses appropriate validated test systems and other scientifically relevant information and determine if the effect that certain substances have in humans is similar to the effect produced by a naturally occurring hormone (U.S. EPA 2011b). The science related to measuring and demonstrating endocrine disruption is in its' infancy, so validated methods of testing that indicate specific effects of an endocrine disruptor are still being developed (U.S. EPA 2011b). While EPA has some data on endocrine-disrupting pesticides, currently insufficient scientific data are available on most of the estimated 87,000 chemicals produced today to allow for an evaluation of endocrine associated risks (U.S. EPA 2011b).

To address this issue, EPA is developing a two-tiered screening and testing process (U.S. EPA 2011b). In Tier 1, EPA hopes to identify chemicals that have the potential to interact with the endocrine system (U.S. EPA 2011b). In Tier 2, EPA will determine the specific effect caused by each endocrine disruptor and establish the dose at which the effect occurs (U.S. EPA 2011b). While this approach is expected to enable EPA to gather the information needed to identify endocrine disruptors and take appropriate regulatory action, as mandated by Congress, at this time a determination has not been made for any of the herbicides used on sugar beet.

c. Birds and Reptiles

Because sugar beet fields provide shelter for small rodents, the fields can be important foraging areas for raptors, such as hawks and owls, and for snakes (Kaffka, 1996). Over-wintered sugar beet fields are excellent cover and provide food sources (insects) for nesting pheasants (Kaffka, 1996). Also, several bird species feed on sugar beet leaves and seedlings (e.g., skylarks and house sparrows) (Dewar and Cooke, 2006). Turtles might conceivably move between habitats through sugar beet fields and some might browse on the plants. Lizards would not be present in the colder climates, but might forage on ground insects in sugar beet fields in the more temperate climates. However, the presence of large numbers of reptiles in sugar beet fields is not expected because agricultural fields are not ideal habitat for reptiles due to relatively constant disturbances associated with agriculture (e.g., tilling and pesticide application). Some farmers apply insecticides to their agricultural fields to minimize insect damage. In so doing, farmers reduce the food source (insects) for carnivorous reptiles (e.g., lizards), forcing the species to forage in other areas.

d. Amphibians and Fish

Several species of amphibians (e.g., frogs, toads, salamanders) and fish might be located in water bodies adjacent to or downstream from H7-1 sugar beet fields. Amphibians use a wide range of aquatic habitats for their breeding sites. The presence of large numbers of adult-stage amphibians in sugar beet fields is not expected because agricultural fields are not ideal habitat for amphibians due to relatively constant disturbances associated with agriculture (e.g., tilling and pesticide application). As mentioned above, some farmers apply insecticides to their agricultural fields to minimize insect damage. In so doing, farmers reduce the food source (insects) for terrestrial-phase amphibians, forcing the species to forage in other areas. Likewise, fish are not expected in agricultural fields, although they may exist in nearby surface waters that receive runoff from the sugar beet fields during storm events or from spray drift that enters water bodies directly from ground or aerial applications.

As shown in Table 3–22 below, the potential for bioconcentration of the herbicides in fish is generally low, with a couple (ethofumesate and phenmedipham) being moderate. Ethofumesate bioconcentration in viscera (internal organs) is moderate, but only of concern for wildlife consuming fish. The bioconcentration factors (BCFs) for ethofumesate for the fillet of the fish or the whole fish is low. A notable exception to the low BCF values is trifluralin, which can bioconcentrate to a level more than 5,000 times the concentration of trifluralin in water. Additional information on tissues tested, however, was not provided by the source cited. Other aspects of toxicity of the herbicides to amphibians and fish are discussed in more detail in the chapter on environmental consequences, in section IV.C.1.d.(1).

Table III-22. Bioconcentration Factors (BCFs) for Herbicides Used on Sugar Beet

Herbicide	BCF (kg/L)	Descriptor	Source
Clethodim	0.7–2.1 fillet; 2.3–3.6 whole fish	Low	(U.S. EPA 2007b)
Clopyralid	13	Low	WDOT, 2006; (NLM, 2003)
Cycloate	190	Low	(NLM (National Library of Medicine), 2009)
Desmedipham	20 filet; 98 whole fish; 159 viscera	Low	(U.S. EPA 1996b)
EPTC	37 edible fish; 60 whole fish; 110 non-edible	Low	(U.S. EPA 2010d)
Ethofumesate	595 viscera; 17 fillet; 67 whole fish	moderate	(U.S. EPA Undated-b)
Glyphosate	0.5	Low	(University of Hertfordshire, 2011a)
Phenmedipham	165	moderate	(University of Hertfordshire, 2011b)
Pyrazon	2–23	Low	(NLM (National Library of Medicine), 2007)
Quizalofop-p-ethyl	1–4	Low	(U.S. EPA 2007a)
Sethoxydim	7 edible; 25 non-edible; 21 whole fish	Low	(U.S. EPA 2005b)
Trifluralin	5,674	High	(University of Hertfordshire, 2011c)
Triflusulfuron-methyl	1.3	Low	(University of Hertfordshire, 2011d)

e. Terrestrial Invertebrates

Terrestrial invertebrates that live in and around sugar beet fields include many beneficial species of insects that prey upon pest species (e.g., aphids) and can effectively reduce pest populations (Dewar and Cooke, 2006). Additionally, many insect species serve as pollinators of crop flowers (e.g., honey bees). Examples of beneficial predatory insects include the larval and adult stages of several ladybird species (e.g., *Adalia bipunctata*, *A. decempunctata*, *Coccinella septempunctata*, and *Propylea quatuordecimpunctata*), adult and larval stages of lacewings (particularly in Chrysopidae and Hemerobiidae), the larvae of several hover fly species (particularly in the genera *Platycheirus*, *Scaeva*, *Sphaerophoria*, and *Syrphus*), ground beetles (Carabidae), rove beetles (Staphylinidae), and mites (Dewar and Cooke, 2006). Non-insect beneficial invertebrates of note in agricultural systems are earthworms that help to aerate soils, redistribute soil nutrients, and improve soil texture.

Other terrestrial invertebrates, particularly insects, are pest species to certain crops, and can cause significant destruction if not controlled. For example, the sugar beet root maggot is the most destructive insect pest of sugar beet in many states. Many other above- and below-ground arthropods generally are present, with those considered to be pests to sugar beet including various species of symphylids and millipedes, wireworms (beetle larvae), cutworms and other caterpillars, lygus bugs, and aphids (Dewar and Cooke, 2006); see section III.B.1.c(5)). Insecticides are used to control insect pests and can be applied at planting and at intervals after planting, depending on label use restrictions (USDA-APHIS, 2011b). Toxicity of the herbicides to terrestrial invertebrates is discussed in the chapter on environmental consequences, in section IV.C.1.e.(1).

f. Aquatic Invertebrates

Aquatic invertebrates that could be present in surface waters adjacent to sugar beet fields include insect larvae and small crustaceans (e.g., water fleas, amphipods, crayfish). Some graze on algae on rocks and other surfaces; others consume detritus in bottom sediments; still others have feeding apparati that allow them to catch micro-organisms and detritus flowing downstream. Toxicity of the herbicides to aquatic invertebrates is discussed in the chapter on environmental consequences, in section IV.C.1.f.(1).

2. Micro-organisms

Beneficial and pathogenic micro-organisms are associated with sugar beet. Beneficial soil micro-organisms include many species of bacteria and fungi that are important in nutrient cycling and recycling in soils. They biodegrade organic matter (e.g., crop residues) and release nutrients contained in the organic matter in the inorganic form, so plants can take up the nutrients (Bot and Benites, 2005).

Pathogenic micro-organisms are those that are detrimental to the crop (e.g., disease-causing) and can vary from region to region. For example, sugar beet in California that are over-wintered in the field have problems with BCTV, which is spread by the beet leaf hopper (*Circulifer tenellus*). Likewise, one of the most important root diseases in sugar beet production is *Aphanomyces* root rot, caused by the soil borne oomycete (*Aphanomyces cochlioides*) (Harveson, 2007). This fungus occurs infrequently in the Imperial Valley, but can be a problem in other regions, such as southern Minnesota and the Red River Valley of North Dakota and Minnesota. Over the past decade, this pathogen has become an important part of a root disease complex (including *Rhizoctonia* root rot and *Rhizomania* or crazy root) and has been demonstrated to be widely distributed throughout western Nebraska and other areas of the Central

High Plains. Chemical control is possible only as a seed treatment (dressing) with hymexazol (Harveson, 2007). Additional root pathogens include *Erwinia carotovera* and *Fusarium oxyporum* (Christenson and Draycott, 2006). The most common sugar beet seedling pathogens are soil-borne fungi. Of particular concern are *Aphanomyces cochlioides and Rhizoctonia solani*, as well as several *Pythium and other* species (Asher and Hanson, 2006). These, like many varieties of fungi, survive for long periods of time in the soil.

Sugar beet pests also include nematodes (parasitic, microscopic worms), such as false root knot nematode (*Nacobbus aberrans*) and beet cyst nematode (*Heterodera schachtii*) (Dewar and Cooke, 2006). Beet cyst nematode is found in almost all beet-growing areas, and false root knot nematode is a serious sugar beet pest in some parts of the western United States (Dewar and Cooke, 2006).

Several aspects of sugar beet production can affect the population density and species composition of soil micro-organisms, fungi, and bacteria in particular. These include herbicide applications, tillage practices, and crop rotation. Some types of soil micro-organisms share metabolic pathways with plants, and might be affected by herbicides. Tillage disrupts multicellular relationships among micro-organisms, and crop rotation changes soil conditions in ways that favor different microbial communities.

3. Plants

Plant composition in and surrounding sugar beet fields depends on, among other characteristics, geographic location, surrounding habitat conditions, and sugar beet field size. For purposes of discussion, plants are divided into target weed species and non-target plant species. Target weed species are those weeds located within sugar beet fields that compete with the crop for available resources (e.g., sunlight, water, nutrients). Non-target plant species include other nearby crops and non-agricultural plants.

a. Developing Herbicide Resistance and Weed Shifts

This section starts with an overview of herbicide resistance and weed shifts along with the mechanisms by which they occur. It then discusses herbicide mechanisms of action, measures to mitigate the evolution of herbicide-resistant weeds, the herbicide resistance of weeds in general, and major sugar beet weeds in particular.

(1) Overview of Herbicide Resistance, Weed Shifts, and Associated Mechanisms

The Weed Science Society of America (WSSA) official definitions for resistance and tolerance are as follows (WSSA, 2008):

- Herbicide resistance: "Herbicide resistance is the inherited ability of a plant to survive and reproduce following exposure to a dose of herbicide normally lethal to the wild type. In a plant, resistance might be naturally occurring or induced by such techniques as genetic engineering or selection of variants produced by tissue culture or mutagenesis."

- Herbicide tolerance: "Herbicide tolerance is the inherent ability of a species to survive and reproduce after herbicide treatment. This implies that there was no selection or genetic manipulation to make the plant tolerant; it is naturally tolerant."

The Penn State Agronomy guide[10] provides the following definition of a weed shift:

> "A weed shift is the change in the composition or relative frequencies of weeds in a weed population (all individuals of a single species in a defined area) or community (all plant populations in a defined area) in response to natural or human-made environmental changes in an agricultural system. Weed shifts occur when weed management practices do not control an entire weed community or population."

Natural differences between species, such as differences in tolerance to herbicides or greater ability to survive cultural and/or mechanical control, can contribute to shifts in the dominant weed species within crop fields.

Weed shifts occur when the local population of weeds changes due to the changing pressures of differing management strategies. Weed shifts could occur due to natural differences in herbicide tolerance in some weed species. For example, while the herbicide Betamix® is very good at controlling pigweed species, cocklebur is naturally tolerant. In crop production where Betamix® is used as a postemergence herbicide, one might expect a progressive shift in the presence of the weed community/population to fields dominated by cocklebur (see section III.B.1.d). However, it should be noted that weed shifts are not a unique phenomenon associated with the use of herbicides. Weed communities can change over time in response to whatever form of control is utilized, including changes in tillage, manual weed control, and herbicide application (Johnson et al., 2009). Because weed shifts can occur regardless of the mechanism for weed control, a natural shift to weeds

[10] http://extension.psu.edu/agronomy-guide/pm/sec1/sec14a

species that are inherently more tolerant to herbicides is not a unique property associated with any one herbicide.

Plants of a given species are not all identical, but are made up of "biotypes" with various genetic traits. Biotypes possess certain traits or characteristics not common to the entire population. Herbicides, that suppress or kill weeds, exert selection pressure on weed populations. When a selection is applied through an herbicide application or management technique, a biotype that confers a selective advantage becomes more prevalent. Herbicide resistance arises when a rare individual in a population has a mutation or rare combination of alleles that confers a fitness advantage in the presence of the herbicide. When an herbicide is applied, surviving plants, those that had reduced sensitivity to the herbicide, have a competitive reproductive advantage. The progeny of these surviving plants are more likely to possess the same or superior herbicide resistance. With repeated application of the same herbicide and no other herbicide or weed control practice, the resistant biotypes can become the dominant biotype in that weed community. The herbicide does not cause the mutation but selects for the survival of this rare individual.

Herbicide resistance is not a unique or new phenomenon. The development of weeds resistant to a particular herbicide mode of action is an issue that growers have faced for decades with all herbicides. (Neve, 2007; Johnson et al., 2009; Orloff et al., 2009). Crops with engineered herbicide resistance do not exert selection pressure on weeds directly. Rather the agricultural practices associated with weed control during cultivation of the plant exert selection pressures on weeds (Boerboom and Owen, 2007; Owen, 2008).

In other words, herbicide resistance is primarily a result of management practices utilized in crop fields independent of the crop It is important to note that even if crop management practices, such as repeated use of the same herbicide, contribute to the development of herbicide-resistant weeds, the herbicide can continue to be an effective means of control of other weeds in the same crop. For example, while 69 different weed species have developed resistance to the herbicide atrazine beginning in the early 1970's (Heap, 2012), this herbicide is still an effective method of weed control and is still one of the most widely used herbicides on corn (Tranel et al., 2011). When used in herbicide product or tank mixes, continued selection for resistance to only one herbicide is avoided. In this way, atrazine resistant weeds are manageable for corn farmers in the U.S. cornbelt (Nandula, 2010).

Shifts in weed species composition from highly susceptible toward more naturally tolerant species will happen more rapidly than selection for resistance (Shaner, 2000; Orloff et al., 2009).

The herbicide-resistant trait can spread into other population of sexually compatible plants by cross pollination. In this way, traits can be introduced into wild relatives from crop plants. Furthermore, resistance can spread between populations of wild relatives resulting in multiple herbicide resistance (Tranel et al., 2011), The potential for hybridization between H7-1 sugar beet and sexually compatible species is discussed in section III.B.5.

Different mechanisms can allow herbicide-resistant weed populations to persist from year to year. For example, resistant weeds that mature and release seeds into crop fields or field margins can lead to the formation of a weed seed bank that may be buried for several years. Differences in soil management (tillage) for future crop species may ultimately result in these resistant seeds resurfacing where they can germinate and grow in subsequent years in rotation crops (Sosnoskie et al., 2009).

Resistant weeds are not restricted to the location in which they arose. Resistant weed seeds may move between infested and clean fields through mechanisms of seed and pollen dispersal. For example, (Shields et al., 2006; Dauer et al., 2009b)reports that horseweed seeds were collected at heights ranging from 41 to 140 m above ground level and therefore infers that horseweed seeds are entering the Planetary Boundary Layer (PBL) of the atmosphere, where long-ranged transport of aerial biota frequently occurs. With wind speeds in the PBL frequently exceeding 20 m/s, it was concluded that seed dispersal can exceed 100 km in a single dispersal event (Shields et al., 2006; Dauer et al., 2009b). As such, the selection for resistant biotypes in a nearby field may lead to increased potential for herbicide-resistant biotypes in neighboring fields, both due to dispersal of seeds and through pollen movement and hybridization between populations. Through seed dispersal, herbicide-resistant weeds can move from crops to non-agricultural lands and vice versa.

Additionally, connectivity between separated fields could result if farmers own or lease discontinuous field plots and use the same equipment between fields without proper cleaning. Computer simulations modeling the dispersal of glyphosate-resistant *C. canadensis* indicated that adding conventional crop rotations (alfalfa) to Roundup Ready® soybean cultivation would not limit spread of the herbicide-resistant weeds in the short term but could have long term benefits by reducing the ease at which resistant weeds spread. In contrast, inclusion of an additional Roundup Ready® crop rotation (Roundup Ready® corn) increased the potential spread rate of glyphosate-resistant weeds to neighboring fields because additional herbicide selection would be applied (Dauer et al., 2009a). Weeds, including herbicide-resistant biotypes, can also spread between croplands and non-agricultural settings and vice versa. About half of all glyphosate-resistant weed species have developed from the use of glyphosate in non-agricultural settings or in agricultural settings such as orchards that do not involve the use or RoundupReady® crops. Some of these settings are listed in Table 3–23.

(2) Herbicide Mechanisms of Action and Resistant Weeds

Herbicides are classified according to their mechanism of action, which is the overall manner by which the herbicide affects a plant at the tissue or cellular level. Most herbicides bind to, and thereby block the action of, a specific enzyme. WSSA (WSSA, Undated)has classified herbicides by group number, based on their mechanism of action. Currently, there are 13 main herbicides used in sugar beet cultivation (see Table 3-16 and 3–17) and they fall into Groups 1, 2, 3, 4, 5, 8, and 9 (Dexter et al., 1994; Tranel and Trucco, 2009). These herbicides represent the following mechanims of action: acetyCoA carboxylase inhibition (ACCase) (clethodim, quizalofop-p-ethyl, sethoxydim); acetolactate synthase (ALS) inhibition (triflusulfuron-methyl); mimic of the plant growth regulator, auxin (clopyralid); fatty acid synthesis inhibition (cycloate, EPTC, ethofumesate); Photosystem II inhibition (desmedipham, phenmedipham, pyrazon); Microtuble (mitosis) inhibition (trifluralin); and 5-enolpyruvylshikimate-3-phosphate (EPSP) synthase inhibition (glyphosate) (HRAC (Herbicide Resistance Action Committee), 2011).

Currently, five different modes of herbicide resistance have been identified in weed species: (1) altered target site due to a mutation at the site of herbicide action, which results in the complete or partial lack of inhibition; (2) metabolic deactivation, where the active chemical of the herbicide is broken down or transformed into non-toxic components; (3) reduced absorption into the plant or reduced translocation (movement) within the plant; (4) sequestration or compartmentalization of the herbicide such as in storage vacuoles or the cell wall; and (5) gene amplification or overexpression of the target site in excess of herbicide dose (Nandula, 2010). Mechanisms for herbicide resistance for each of the classes of herbicides used in sugar beet cultivation are detailed below (as referenced in (Tharayil-Santhakuma, 2003). The number of resistant species for each herbicide group is presented at the end of each group description (Heap, 2011).

ACCase (Group 1): Group 1 herbicides function by inhibiting the action of the enzyme ACCase which is needed for lipid biosynthesis. Group 1 herbicides used in sugar beet production includes clethodim, quizalofop-p-ethyl, and sethoxydim. Group 1 herbicides are used to control grasses. Forty weed species have ACCase resistance.

ALS (Group 2): Group 2 herbicides function by inhibiting the action of the enzyme ALS which is needed for amino acid synthesis. The group 2 herbicide used on sugar beet is triflusulfuron-methyl. It is used to control broadleaf weeds such as bedstraw, kochia, redroot pigweed, shepherd's purse, smartweed, velvetleaf, wild mustard, and wild radish. One hundred and nine weed species have ALS resistance.

Microtubule (Mitosis) Inhibitors (Group 3): Group 3 herbicides function by inhibiting cell division. Trifluralin is the group 3 herbicide used on sugar beet. It controls annual grasses and some broadleaf weeds. Ten weed species have resistance to microtubule inhibitors.

Synthetic Auxin Mimics (Group 4): Group 4 herbicides function by mimicking the plant growth hormone auxin and causing uncontrolled cell growth. Clopyralid is the group 4 herbicide used on sugar beet. It is used to control broadleaf weeds such as Canada thistle, wild buckwheat, cocklebur, jimsonweed, ragweed, marshelder, and wild sunflower. Twenty-eight weed species have resistance to synthetic auxins.

Photosystem II Inhibitors (PSII) (Group 5): Group 5 herbicides function by inhibiting photosynthesis. For use on sugar beet, they include desmedipham, phenmedipham, and pyrazon. They are used to control broadleaf weeds such as annual sowthistle, black nightshade, lambsquarters, common ragweed, and redroot pigweed, sheperd's-purse, annual smartweed, and purslane. Sixty-nine weed species have resistance to PSII inhibitors.

Fatty acid Synthesis (Group 8): Group 8 herbicides function by inhibiting the synthesis of fatty acids and lipids. Herbicides used in this group on sugar beet include cycloate, EPTC, and ethofumesate. These herbicides control grasses such as barnyardgrass, crabgrass, foxtail, wild oats, and broadleafs such as lambsquarters, purslane, redroot pigweed, black nightshade, common chickweed, kochia, Russian thistle, wild buckwheat,. Specific mechanisms for resistance to fatty acid synthesis inhibitors have not been identified. Eight weed species have resistance to fatty acid synthesis herbicides.

Inhibition of 5-enolpyruvylshikimate-3-phosphate (**EPSP**) synthase which is needed for amino acid synthesis. **(Group 9):** Group 9 herbicides function by inhibiting the action of the enzyme EPSPS, interfering with the shikimate pathway[11], an essential metabolic process in plants. Because this enzyme is present in nearly all plants but absent in most if not all animals, and glyphosate binds to this enzyme and does not appear to bind to other targets, it is highly specific (Cole, 2010). The group 9 herbicide used in sugar beet is glyphosate which is used to control grasses and broadleaf weeds. Twenty-one weed species have confirmed resistance to glycine herbicides.

[11] The shikimate pathway links the metabolism of carbohydrates to biosynthesis of aromatic compounds.

Glyphosate resistance in plants has been engineered into crop plants by transforming plants with a resistant *epsps* gene. The most common trait, CP4, is a naturally occurring resistant *epsps* gene isolated from the soil bacteria, *Agrobacterium*. Another route used to create a glyphosate resistance gene has been to convert a sensitive plant *epsps* gene into a resistant version by site directed mutagenesis. A third route has been to introduce into plants an enzyme that inactivates glyphosate through N-acetylation (Castle et al., 2004). In this case an N-acetylase gene was found in *Bacillus licheniformis* that had weak activity torwards glyphosate. The efficiency of this enzyme was increased by directed evolution in the lab (Castle et al., 2004).

Different mechanisms have been identified that confer glyphosate resistance in weeds. (Baerson et al., 2002; Stoltenberg and Jeschke, 2003; Nandula et al., 2005; Cerdeira and Duke, 2006; Funke et al., 2006; Wakelin and Preston, 2006; Yuan et al., 2006; Service, 2007; Jasieniuk et al., 2008; Gaines et al., 2010; 2010; Powles and Yu, 2010; Yuan et al., 2010) .

- *Resistant EPSPS* – Variants of EPSPS with decreased binding to glyphosate have evolved in the weed species goosegrass (*Eleucine indica*), Wimmera ryegrass (*Lolium rigidum*), and Italian ryegrass (*Lolium multiflorum*) (Gaines et al., 2010).

- *Increased copy number of epsps gene* – Glyphosate-resistant populations of *Amaranthus palmeri* found in Georgia were found to have 5- to 160-fold more copies of the *epsps* gene in their genomes compared to glyphosate-sensitive populations. Furthermore, the extra copies were found to be distributed among all the chromosomes, suggesting a transposon-mediated amplification. The resulting overexpression of *epsps* likely confers resistance to glyphosate (Gaines et al., 2010; Powles, 2010).

- *Altered translocation of glyphosate* – Some limited evidence indicates that, in some glyphosate-resistant ryegrass, glyphosate accumulates in mature leaf tissue rather than in the growing parts. In addition, although the mechanism of resistance in horseweed is unknown, translocation experiments suggest that resistant biotypes do not translocate glyphosate to the growing parts of the plant (e.g., roots, young leaves, and crown).

- *Subcellular sequestration* – Glyphosate-resistant horseweed has been shown to exhibit vacuolar sequestration. By compartmentalizing glyphosate away from the cytoplasm, plant cells can keep glyphosate from coming in contact with EPSPS (Ge et al., 2010).

Even though glyphosate has been used extensively as a preplant burndown for more than three decades and on GE crops for the past 15 years, fewer cases of developed resistance have been reported compared to many other herbicides (see section III.C.3.a.(4), Fig. 3-19). Furthermore, even though 21 species have selected for herbicide resistance, glyphosate is still highly effective in controlling more than 250 weeds (USDA-APHIS, 2011b).

In 2009, approximately 135 million of the 173 million acres of corn, soybeans, and cotton in the United States were planted with an herbicide-resistant variety, with the most common resistant trait being glyphosate resistance (USDA-NASS, 2009b). An estimated 6 percent of the total planted corn, soybean, and cotton acres in the United States have some level of weeds that are resistant to glyphosate (WSSA, 2010).

Selection of glyphosate-resistant weeds has occurred most commonly when glyphosate is used in consecutive years without other herbicides in vineyards, orchards, or roadways, or where glyphosate-resistant cotton, corn and soybean are planted without rotation. Although about half of the glyphosate-resistant biotypes have been selected from glyphosate use in situations not involving RoundupReady® crops, most of the acreage containing glyphosate-resistant weeds is on land used to cultivate RoundupReady® crops. This is because just over 75% of the glyphosate use in the U.S. is on RoundupReady® crops. The increasing numbers of glyphosate weeds results from the independent selection of new biotypes as well as dispersal of existing biotypes by wind, animals, flooding, vehicles, and shared farm equipment.
Sugar beet is a crop susceptible to many diseases, nematodes, and insects. In some areas, by contractual agreement with sugar beet cooperatives, sugar beet growers are prohibited from planting a sugar beet root crop in the same field more frequently than once every 3 years. In other areas such as California, back-to-back planting of sugar beet is allowed as long as sugar beet are planted no more than 4 years out of every 10 years. (2011). In some sugar beet-growing States (including Oregon, Washington, and Idaho), sugar beet may be the only glyphosate-resistant crop grown in the rotation. In other States (Colorado, Montana, Wyoming, Nebraska, Northern North Dakota, and Northern Minnesota), at least one non-glyphosate-resistant crop is included in the rotation. Southern Minnesota and Michigan farmers may grow glyphosate-resistant crops in all three rotations (USDA–APHIS, 2010a). In Wyoming and California, sugar beet growers may grow sugar beet in consecutive years before rotating to another crop. The role of crop rotations in delaying the development of resistance is discussed further in the sections below.

(3) Measures to Mitigate Selection of Herbicide-resistant Weeds

Overview of Mitigation Measures. Strategies to minimize herbicide-resistant weed development include (Stachler and Zollinger, 2009; Barrett et al., 2011).

- Rotate herbicides with different mechanisms of action in consecutive years. By changing herbicides with different mechanisms of action between years, an individual that arises with a new mutation conferring herbicide resistance to the first herbicide is unlikely to survive due to control of that individual with the second herbicide. As a result, the emergence of herbicide-resistant populations will be delayed. Because herbicide resistance is a heritable trait, multiple growing seasons of herbicide use are required before herbicide-tolerant weeds emerge and become the predominant biotype in a specific area (Cole, 2010). Researchers have concluded that even if growers completely relied on only one herbicide, at least 5 years are likely required for a herbicide-resistant weed population to develop (Beckie, 2006; Neve, 2008; Werth et al., 2008; Kniss, 2010b). A report from 2001 suggested that selection of glyphosate-resistant weeds could occur in as little as three years based on the observation that glyphosate-resistant horseweed was observed in glyphosate-resistant soybean in 2000, approximately three years after the soybean was first grown in the State (VanGessel, 2001). However, this interpretation ignores the widespread use of glyphosate as a preplant treatment in no till soybean long before the introduction of glyphosate-resistant crops. For example, (Bruce and Kells, 1990) noted that glyphosate is one of the most effective herbicides for controlling horseweed in no-till soybean. According to (U.S. EPA 1993c), before the introduction of RR® soybean, "glyphosate is among the most widely used pesticides by volume" and" the largest use sites include hay/pasture, soybeans and field corn". According to the USDA National Agricultural chemical use database(USDA-NASS, 2011a), 8% of soybean acres in Delaware were treated with glyphosate in 1994 (the only year prior to the release of RR® soybean where data is listed for the State of Delaware). According to (Reddy and Norsworthy, 2010)p. 169, 2.9 million kg/year of glyphosate were used on soybeans in 1995 which is prior to the first use of RR® soybean. Horseweed usually germinates in the fall and so usually has emerged prior to planting soybeans (Loux et al., 2006)and would be directly exposed to preplant applications of glyphosate. Therefore,it is expected that selection of glyphosate-resistant horseweed began with the use of glyphosate in conventional no till soybeans and (VanGessel, 2001) underestimated the time over which selection of glyphosate-resistant horseweed had occurred.

- Crop monitoring, follow up, subsequent testing and reporting by academic and industry weed scientists in cases of suspected resistance are important parts of all herbicide-resistance stewardship programs.

- Apply herbicides in tank-mix, prepackage, or sequential mixtures that include multiple mechanisms of action. Two or more herbicides in the tank-mix must have substantial activity against potentially resistant weeds. Most commercial premixes do not contain herbicides that target the same weed species. Antagonism among tank-mix partners should be avoided. Use of herbicides with different mechanisms of action, either concurrently or sequentially, is an important defense against weed herbicide resistance (WSSA, 2010). According to WSSA, "Use of a single product or mode of action for weed management is not sustainable. Some of the best and most sustainable approaches to prevent resistance include diversified weed management practices, rotation of mechanisms of action and especially the use of multiple product ingredients with differing mechanisms of action" (WSSA, 2010).

  A common practice of conventional sugar beet growers is to use herbicides applied at several times but at low levels. This "micro-rate" application method utilizes mixes of herbicides designed to reduce weeds while limiting damage to the sugar beet crop. Dale et al. (2006)examined the efficacy of micro-rate herbicide applications. The mixture of herbicides in the micro-rate technique may act to lower the likelihood of selection of resistant weeds by utilizing multiple modes-of-action. However, Dale et al. (2006) also noted that not all weeds were eliminated as a result of micro-rate applications. While the micro-rate method of weed control has been widely adopted in conventional sugar beet production and has lead to reduced amounts of herbicide used in sugar beet fields (Dale et al., 2006), it may also represent a potential mechanism for rapid resistance evolution. Research by Neve and Powles (2005) examined the effect of low doses of herbicides on the weed *Lolium rigidum* and observed rapid changes in herbicide resistance after exposure. Additionally, low-dose exposure to some herbicides not only leads to increased resistance in the tested populations it also resulted in cross-resistance between several different ACCase and ALS herbicides (Neve and Powles, 2005). Low levels of herbicides increase the likelihood that resistant weed biotypes survive, hybridize with other biotypes, and create new biotypes that have resistance to higher doses of the herbicide (Stachler and Zollinger, 2009).

- Rotate crops, particularly those with different lifecycles, e.g., winter annual crops (winter wheat), perennial crops (alfalfa), and summer annual crops (spring wheat, corn, or beans). Do not use herbicides with the same mechanism of action in the different crops unless other effective control practices are also included such as the use of an herbicide with a different mechanism of action or a different tillage or cultural practice Crop rotation is an additional effective strategy for managing herbicide-resistant weeds because it provides more control opportunities and disrupts life cycles of weeds that are crop mimics ((Derksen et al., 2002)and references therein). Because cropping systems create different environments, weed communities become more diverse in diverse cropping systems and the predominance of any one weed is minimized (Liebman and Dyck, 1993; Derksen et al., 2002). Crop rotation independent of herbicides is thought to be important in altering weed communities. (Liebman and Dyck, 1993). Several mechanisms could be responsible for this effect, including allelopathy, microbial community changes, and the ability of one crop to exploit resources differently than another so it can avoid competition with weeds, (Sosnoskie et al., 2009). Differences in crop height, density, and canopy architecture can also favor some weed species over others (Sosnoskie et al., 2009). Additionally, more diverse crop rotations allow growers to vary the timing and mechanisms of action of herbicides, thus delaying the selection of herbicide-resistant biotypes (Derksen et al., 2002). For example, in a corn-soybean rotation, broadleaf weeds can be controlled more effectively in corn, a warm season grass, than in soybean, a warm season broadleaf crop, using herbicides that target broadleaf weeds while grasses can be controlled more effectively in soybean than in corn using herbicides that target grasses. Thus the different cultural conditions of the crop rotation such as planting date, harvest date, tillage practices, irrigation practices, fertilization practices, available herbicide chemistries, and herbicide timing (preseeding, in crop, preharvest, or postharvest) vary the selection pressures on the crop. The more diverse the crop rotation, the more varied the selection pressure, and the less likely weeds will be selected to a given selection pressure such as herbicide (Derksen et al., 2002; Nazarko et al., 2004).

Sugar beet crops are rotated with other crops in all of the five root production regions of the United States (see section III.B.1). For a full discussion of crop rotations in the different regions see sections III.B.1.b(16) and III.B.1.c(4).

- Scout fields regularly and identify weeds that escape herbicide treatment. Do not allow weeds to flower and hand weed if necessary. Monitor changes in weed populations early (a few plants in the field) and restrict spread of potentially resistant weeds that match the field history and herbicide pattern. If there are dead plants, unaffected plants, and/or plants showing intermediate responses, then resistance should be strongly considered. Use full rates of all products and use the most effective adjuvants when tank-mixing with glyphosate.

- Plant into weed-free fields and then keep fields as weed free as possible

- Plant weed-free crop seed

- Use high labeled rates of postemergence herbicides. Reduced rates may allow hybridization among plants resistant to low levels of herbicide to produce plants resistant to high levels of herbicide.

- Apply herbicides at recommended weed sizes.

- Emphasize cultural practices that suppress weeds by utilizing crop competitiveness

- Use mechanical and biological management practices where appropriate

- Prevent field to field and within field movement of weed seed or vegetative propagules

- Manage weed seed at harvest and post-harvest to prevent a buildup of the weed seedbank

- Prevent an influx of weeds into the field by managing field borders

Additional best management practices (BMPs) that can help delay the occurrence of herbicide resistance are discussed below.

WSSA reports higher levels of awareness among growers regarding the need to minimize the potential for development of glyphosate resistance: "In a market research study that surveyed 350 growers in 2005 and again in 2009, in response to the question, 'are you doing anything to proactively minimize the potential for resistance to glyphosate to develop,' 67 percent said yes in 2005 and 87 percent said yes in 2009" (WSSA, 2010). "In a 2007 survey of 400 corn, soybean, and cotton growers, resistance management programs were often or always used by 70% or more of all three grower groups" (WSSA, 2010). The 2007 survey included respondents from 22 States, and although the survey was not targeted at sugar beet growers, the survey did include respondents from three States that together plant more than 57 percent of the sugar beet root crop: Minnesota, North Dakota, and Nebraska (Table 3-5). Corn and/or soybeans are major rotation crops for sugar beet in these States (see Table 3–6). These surveys examined the use of 10 different BMPs of corn, cotton, and soybean farmers and indicated that seven BMPs were readily adopted by farmers (>75 percent) while three were less likely to be followed. The seven BMPs were: use of the labeled rate of herbicides; scouting for weeds before application; scouting for resistant weeds after herbicide applications; starting with clean fields; use of new seed; control of weeds early; and controlling weed escapes. The three BMPs less likely to be followed by farmers of all three crops were: cleaning of equipment; use of multiple herbicides with different mechanisms of action; and supplemental tillage (Frisvold et al., 2009).

Information is widely available from universities and other sources regarding glyphosate resistance. Public universities (e.g., North Dakota State University, University of Minnesota), herbicide manufacturers (e.g., www.weedresistancemanagement.com, www.resistancefighter.com), and crop commodity groups (e.g., National Corn Growers Association, American Soybean Association) have Internet Web sites with information on prevention and management of herbicide resistance. An example of information provided by public universities is that from Dr. Don Morishita, a weed scientist at the University of Idaho, who advises sugar beet growers on weed herbicide resistance management strategies (Dumas, 2008). The Sugar Industry Biotech Council provides weed herbicide resistance resources on its Web site (http://www.sugarindustrybiotechcouncil.org/sugar-industry/weed-resistance-management/).

Monsanto/KWS SAAT AG includes information on weed herbicide resistance management practices in its TUG that is mailed annually to all licensed growers. The sugar beet industry associations also hold annual meetings where weed herbicide resistance management practices and other stewardship measures are included as part of the proceedings.

Sugar beet growers in particular have strong financial and practical interests in managing weeds effectively to reduce the selection of herbicide-resistant weeds and to maximize yield potential. As a result, sugar beet growers and processors have established funds to support research and extension activities on weed resistance. According to (2011), "Western Sugar Cooperative sponsors grower meetings at multiple locations in their growing regions to provide every grower the opportunity to discuss industry issues and learn about new research developments. Researchers from Colorado, Nebraska, and Wyoming, in cooperation with Monsanto, are developing region-specific technology usage guides to address weed management in cropping rotations that include sugar beet. Guides will provide regional and weed specific (kochia, common lambsquarters and pigweed) recommendations for corn, small grains, dry beans, and sugar beet, therefore enhancing the benefits of crop and herbicide rotations."

Sugar beet is a high-value crop, and competition from weeds for moisture and light can negatively impact yields and the overall value of the crop. The development of glyphosate-resistant weeds harms the economic return per acre for the individual farmer and the entire sugar beet industry (Cole, 2010). Farmers are aware that they will pay more for weed control when herbicide-resistant weeds are prevalent (see section III.D.1.e.). Some farmers can be expected to take a long term view towards more sustainable practices and will be willing to incur additional management costs to prevent or delay selection of resistance especially if there is uncertainty regarding the development of alternative herbicides (Pannell and Zilberman, 2000). Others may be unwilling to incur additional costs until the resistant weeds directly affect their farms either because they take a short term view, are faced with financial hardship, expect substitute herbicides to become available over time, or believe their individual actions will not prevent or delay the prevalence of herbicide-resistant weeds (Pannell and Zilberman, 2000). Approximately 80% of growers surveyed in Delaware responded that it was worthwhile to incur additional costs now to preserve glyphosate for future use (Scott and VanGessel, 2007). To encourage sustainable use of glyphosate, Monsanto has implemented the Roundup Ready PLUS™ incentive program for farmers to include residual herbicides, many of which are sold by other companies, in their herbicide management programs in addition to glyphosate (Monsanto, 2011a). Rebates of up to $5/acre for corn, $10/acre for soybean, and $22/acre for cotton are available for using recommended combinations of residual herbicides along with glyphosate. In this way, these rebates help offset some of the additional management costs associated with the control and spread of glyphosate-resistant weeds.

The selection and dispersal of glyphosate-resistant weeds may have costs that are external to the farmers bottom line. These include reduced use of conservational tillage techniques and the associated benefits on the physical environment described in III. E.2-4 and the reliance on herbicides with greater environmental and health risks (Marsh et al., 2006).

The Benchmark Study was conducted over a four-year period on 155 farms, across six states, with a minimum of 40 acres per farm (Wilson et al., 2011). Although it did not involve sugar beet, results from this study demonstrated two important concepts in regard to glyphosate-resistant (GR) crops. First, weed control is improved by rotating GR crops, compared to continuous cropping of GR cotton and soybean (Wilson et al., 2011). Second, weed management is improved by adding a herbicide at planting with a different mode of action than glyphosate, or by combining glyphosate applied postemergence with another herbicide (Wilson et al., 2011). One such additional herbicide being studied for use with glyphosate on H7-1 sugar beet to increase and prolong its effectiveness is ethofumesate (Kniss et al., 2010). (2010) found that ethofumesate use in conjunction with glyphosate provided improved control of redroot pigweed, common lambsquarters, and hairy nightshade. (2011) also found that ethofumesate used as a residual improved weed control with post-emergent applications of glyphosate. If the plant population was below optimum leaving gaps in the sugar beet canopy, control was further improved by application of s- metolachlor or dimethenamid-p at the six to eight leaf stage though control was better with s-metolachlor (Wilson Jr and Sbatella, 2011).

Strategies and recommendations to delay the development of glyphosate-resistant weeds in H7-1 sugar beet are described in the TUG. Specifically, the TUG recommends the use of "mechanical weed control/cultivation and/or residual herbicides" with H7-1 sugar beet, where appropriate, and "additional herbicide mechanisms of action/residual herbicides and/or mechanical weed control in other Roundup Ready® crops" that are rotated with H7-1 (Monsanto, 2011a). Adding a conventional crop in the rotation would promote the use of other non-glyphosate herbicides and provide diversity of the herbicide mechanism of action, which will reduce the selection pressure for glyphosate resistance.

When a grower encounters a biotype that is resistant to an herbicide he or she is using, the grower should remove the resistant biotype using management practices such as those routinely used by sugar beet growers, including herbicide mixtures, herbicide rotation, crop rotation, and increased cultivation.

Rotation Crops as Sources for Resistant Weeds. As mentioned above, crop rotations are an important mechanism that can delay the development of resistance in weed populations. These rotation crops can also be sources of weeds for sugar beet. As discussed in section III.B.1.c(1), there are five different regions that produce sugar beet root crops. Crop rotations are used in all five regions and while there are several common crops used in sugar beet rotations (e.g., corn), differences do exist. (See sections III.B.1.b(16) and III.B.1.c(4) for a discussion on crop rotations.)

Table 3–23 lists the estimated number of acres in sugar beet producing states that are confirmed to have weeds resistant to groups of herbicides used in sugar beet production. While many of these crops are not rotated with sugar beet, it provides an indication of how widespread herbicide-resistant weeds are found. For example, while sugar beet was planted on 1.4 million acres in 2002, 3.1 million acres of the sugar beet producing states reported problems with herbicide-resistant weeds. These estimates may not be very accurate because they may underestimate acreage due to a lag in reporting and they may overestimate acreage when resistant weeds overlap on the same acreage. At this time, the vast majority of herbicide-resistant weeds that pose problems for sugar beet growers are resistant to non-glyphosate herbicides.

In some states, one or more Roundup Ready® crops are rotated with sugar beet (see Table 3–6). Table 3–6 also estimates that just over 40% percent of the sugar beet acreage could be followed with a Roundup Ready® crop.

The most widespread herbicide-resistant weeds likely to impact sugar beet root production include kochia resistant to ALS-inhibitors and wild oat with resistance to ACCase inhibitors.

Table III-23. Estimation of Herbicide-resistant Weed Infestation in Sugar Beet Root Production States

Region	State	Crops Infested	Maximum Acres Infested
Northwest	Idaho	Cereals, lentils, peas, potato, roadsides, wheat	238,000
	Oregon	Alfalfa, cropland, grass seed, bluegrass, mint, orchards wheat	127,800
	Washington	Cereals, lentils, mint, nurseries, roadsides, wheat	17,100
Midwest	North Dakota	Cereals, corn, cropland, soybean, sunflower, wheat	1,513,900
	Minnesota	Corn, cropland, soybean, sugar beet, wheat	128,200
Great Lakes	Michigan	Asparagus, blueberry, carrot, corn, cropland, nurseries, roadsides, soybean, sugar beet, vegetables	169,000
Great Plains	Colorado	Barley, corn, roadsides, wheat	66,300
	Wyoming	Corn and wheat	6,300
	Nebraska	Corn and soybeans	5,500
	Montana	Barley, cereals, cropland, railways, sugar beet, and wheat	617,900
Imperial Valley	California	Almonds, asparagus, barley, corn, onion, orchards, railways, rice roadsides, vineyards, and wheat	205,400

Source: (Heap, 2011)

This is based on the estimated large acreage of cropland infested with these resistant biotypes that includes sugar beet and its rotation crops as analyzed above. In addition, these two species have biotypes that are resistant to multiple mechanisms of action. Kochia resistant to both a PSII inhibitor and an ALS inhibitor was identified in Illinois (Heap, 2011). A wild oat resistant to four mechanisms of action (ACCase inhibitor, ALS inhibitor, thiocarbamates, and arylaminopropionic acids) was identified in Canada (Heap, 2011). Fortunately, wild oat has not yet developed resistance to glyphosate so this herbicide can bring about effective control where many other herbicides cannot.

(4) Herbicide Resistance of Major Sugar Beet Weeds

Weeds and Herbicide Resistance in General. As of March 19, 2012, 374 herbicide-resistant weed biotypes have been reported to be resistant to 21 different herbicide mechanisms of action worldwide (Heap, 2012). The most common are ALS resistant weeds which have 116 biotypes. According to (Tranel et al., 2011), about half of the common waterhemp in any given field in Illinois is estimated to be resistant to ALS herbicides. The next most numerous are biotypes resistant to the class of Photosystem II inhibitors such as triazines which have 69 resistant biotypes, to the ACCase inhibitors which have 41 resistant biotypes, and to the synthetic auxins which have 29 resistant biotypes (Heap, 2012). All four of these classes of herbicides are used on sugar beet as is glyphosate which has 22 biotypes of resistant weeds (Heap, 2012).

Fig. 3–19 shows the increase in herbicide-resistant biotypes with time against some of the more commonly used classes of herbicides. Among the herbicides commonly used in conventional sugar beet farming, Assure® II, Poast®, Select® are ACCase inhibitors – Group 1; Upbeet® is an ALS inhibitor – Group 2; Treflan® HFP is a dinitroaniline that affects microtubule assembly – Group 3; Stinger® is a synthetic auxin – Group 4; and glyphosate is a glycine EPSPS inhibitor – Group 9. Fig. 3–19 shows only the number of confirmed resistant biotypes. The total extent and distribution of resistant biotype varies widely and has not been estimated with any reliable accuracy.

The relative risk that a resistant biotype will be selected to a particular herbicide is highly correlated to the herbicide mechanism of action (Sammons et al., 2007). Herbicide families have been classified according to their risk of resistant weed development. Beckie (2006) lists ALS- and ACCase-inhibiting herbicides as “High” risk for selection of resistant biotypes, while glyphosate is considered a “Low” risk herbicide for the selection of herbicide-resistant biotypes. ALS- and ACCase-inhibiting herbicides are commonly used in conventional sugar beet production, and weeds resistant to these two herbicide groups are widely distributed across sugar beet growing regions of the United States (Kniss, 2010b).

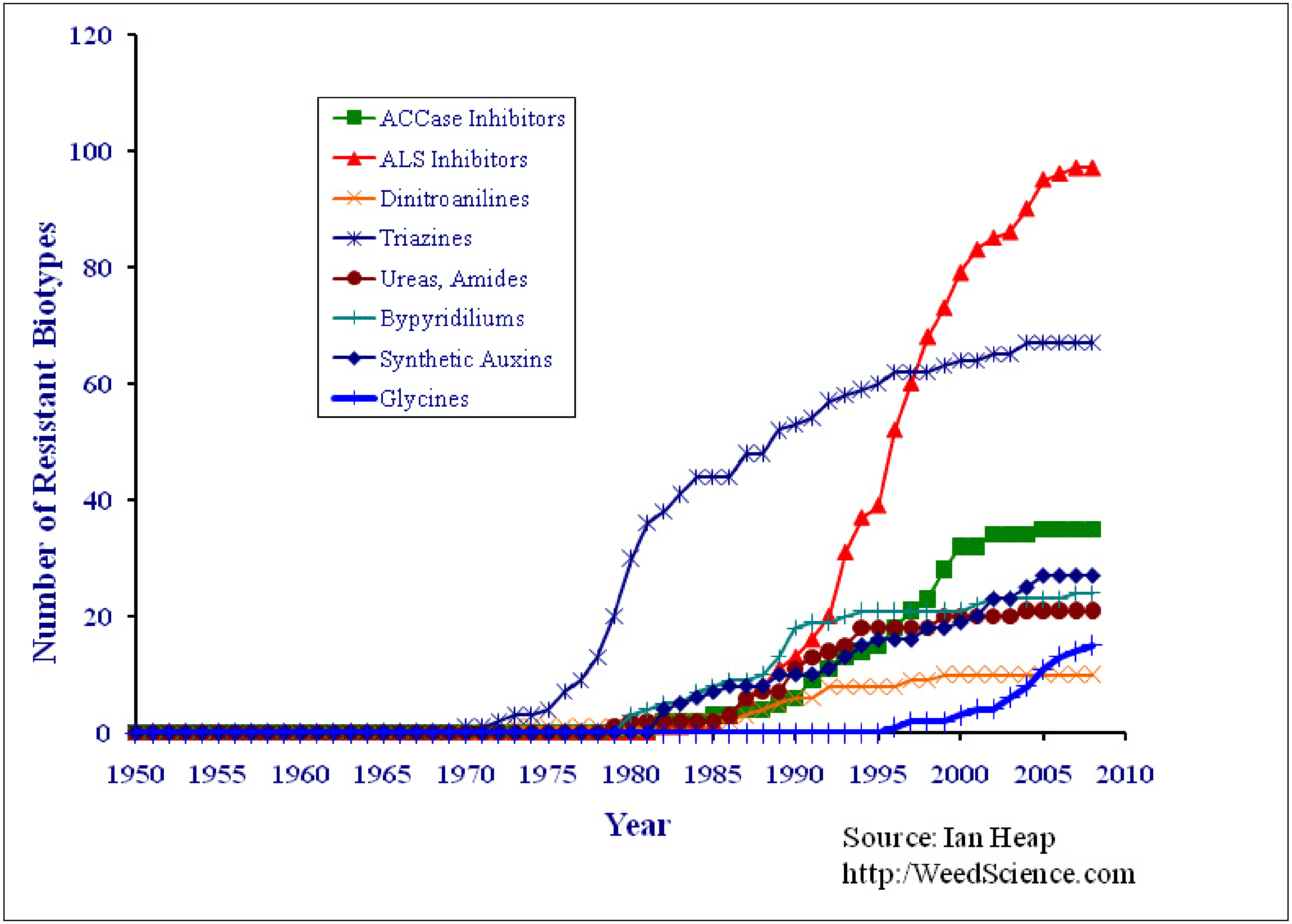

Figure 3-19. Increase in herbicide resistance through present

Because glyphosate is a low-risk herbicide, Kniss has suggested that H7-1 sugar beet can help delay resistance to these high-risk herbicides in additional weeds species (Kniss, 2010b):

> "In fact, glyphosate-resistant sugar beet adds to the diversity of herbicide modes of action in many sugar beet crop rotations because it introduces a new mode of action (glyphosate) into the rotation with non-glyphosate-resistant crops that tend to rely heavily upon acetolactate synthase ("ALS") inhibitors. ALS inhibiting herbicides pose a far greater risk of developing weed resistance than does glyphosate. By adding glyphosate to their crop rotations, growers of glyphosate-resistant sugar beet actually decrease the likelihood of developing resistance to ALS inhibitors, just as the use of other crops and alternative modes of action in rotation with GR sugar beet reduce the likelihood of glyphosate-resistant weeds."

Table 3–24 summarizes the weeds that have developed resistance to herbicide groups used in sugar beet for states where sugar beet is grown commercially. A weed is listed for a State when herbicide resistance has been confirmed. To be listed as an herbicide-resistant weed by the WSSA, weed biotypes must meet all of the following criteria: (1) fulfill the WSSA definition of resistance, (2) confirmation of resistance using acceptable scientific protocols, (3) resistance must be heritable, (4) the weed must demonstrate practical field impact, and (5) the weed must be identified as a problem weed at the species level, not the result of deliberate or artificial selection (WSSA, 2005). The table does not show the extent of the weeds with the noted resistance.

b. Major Weeds of Sugar Beet Production and Herbicide Resistance
Currently, there are many weeds that are noted as problematic weeds for sugar beet growers. For a list of common sugar beet weeds, see section III.B.1.d. Sugar beet (roots) are produced in five regions: Great Lakes, Great Plains, Midwest, Northwest, and Imperial Valley (see Fig. 3–6). Sugar beet weed species may be found in all five regions or be unique to only a subset. Many of these weeds have developed resistance to conventional herbicides and in some cases, glyphosate-resistant biotypes have also been identified.

Based on information in the ISHRW (Heap, 2012)several herbicide-resistant weeds occur in sugar beet or in crops that are grown in rotation with sugar beet (see Tables 3–25). Table 3–9 summarizes the effectiveness of herbicides on major weeds in sugar beet as provided by three sources.

Table III-24. Weeds with Resistance to Herbicides in Sugar Beet States

Species	Common Name	Year	Herbicide Mechanisms of Action
California			
1. *Senecio vulgaris*	Common groundsel	1981	Photosystem II inhibitors
2. *Lolium perenne*	Perennial ryegrass	1989	ALS inhibitors
3. *Cyperus difformis*	Smallflower umbrella sedge	1993	ALS inhibitors
4. *Sagittaria montevidensis*	California arrowhead	1993	ALS inhibitors
5. *Salsola iberica*	Russian thistle	1994	ALS inhibitors
6. *Avena fatua*	Wild oat	1996	Unknown
7. *Ammania auriculata*	Redstem	1997	ALS inhibitors
8. *Scirpus mucronatus*	Ricefield bulrush	1997	ALS inhibitors
9. *Echinochloa phyllopogon*	Late watergrass	1998	ACCase inhibitors
10. *Echinochloa phyllopogon*	Late watergrass	1998	Thiocarbamates and others
11. *Lolium rigidum*	Rigid ryegrass	1998	EPSPS inhibitors
12. *Ammania coccinea*	Long-leaved loosestrife	2000	ALS inhibitors
13. *Echinochloa crus-galli*	Barnyardgrass	2000	ACCase inhibitors
14. *Echinochloa crus-galli*	Barnyardgrass	2000	Thiocarbamates and others
15. *Echinochloa oryzoides*	Early watergrass	2000	Thiocarbamates and others
16. *Echinochloa phyllopogon*	Early watergrass	2000	ACCase inhibitors
17. *Echinochloa phyllopogon*	Late watergrass	2000	Thiocarbamates and others
18. *Phalaris minor*	Late watergrass	2001	ACCase inhibitors
19. *Digitaria ischaemum*	Little seed canary grass	2002	Synthetic Auxins
20. *Conyza Canadensis*	Smooth crabgrass	2005	EPSPS inhibitors
21. *Conyza bonariensis*	Hairy fleabane	2007	EPSPS inhibitors
22 *Echinochloa colona*	Junglerice	2008	EPSPS inhibitors
23. *Conyza bonariensis*	Hairy fleabane	2009	Bipyridiliums
24. *Conyza bonariensis*	Hairy fleabane	2009	EPSPS inhibitors
Colorado			
1. *Aramanthus retroflexus*	Redroot pigweed	1982	Photosystem II inhibitors
2. *Kochia scoparia*	Kochia	1982	Photosystem II inhibitors

Species	Common Name	Year	Herbicide Mechanisms of Action
3. *Kochia scoparia*	Kochia	1989	ALS inhibitors
4. *Avena fatua*	Wild oat	1997	ACCase inhibitors
5 *Kochia scoparia*	Kochia	2011	EPSPS inhibitors[1]
Idaho			
1. *Lactuca serriola*	Prickly lettuce	1987	ALS inhibitors
2. *Kochia scoparia*	Kochia	1989	ALS inhibitors
3. *Salsola iberica*	Russian thistle	1990	ALS inhibitors
4. *Lolium multiflorum*	Italian ryegrass	1991	ACCase inhibitors
5. *Avena fatua*	Wild oat	1992	ACCase inhibitors
6. *Avena fatua*	Wild oat	1993	Thiocarbamates and others
7. *Avena fatua*	Wild oat	1993	Unknown
8. *Anthemis cotula*	Mayweed chamomile	1997	ALS inhibitors
9. *Kochia scoparia*	Kochia	1997	Synthetic Auxins
10. *Amaranthus retroflexus*	Redroot pigweed	2005	Photosystem II inhibitors
11. *Lolium multiflorum*	Italian ryegrass	2005	ACCase inhibitors
12. *Lolium multiflorum*	Italian ryegrass	2005	ALS inhibitors
13. *Lolium multiflorum*	Italian ryegrass	2005	Chloroacetamides and others
Michigan			
1. *Chenopodium album*	Lambsquarters	1975	Photosystem II inhibitors
2. *Ambrosia artemisiifolia*	Common ragweed	1990	Photosystem II inhibitors
3. *Senecio vulgaris*	Common groundsel	1990	Photosystem II inhibitors
4. *Portulaca oleracea*	Common purslane	1991	Photosystem II inhibitors
5. *Portulaca oleracea*	Common purslane	1991	Ureas and amides
6. *Daucus carota*	Wild carrot	1993	Synthetic Auxins
7. *Ambrosia artemisiifolia*	Common ragweed	1998	ALS inhibitors
8. *Amaranthus tuberculatus (syn. rudis)*	Common waterhemp	2000	ALS inhibitors
9. *Amaranthus powellii*	Powell amaranth	2001	Photosystem II inhibitors
10. *Amaranthus powellii*	Powell amaranth	2001	Ureas and amides
11. *Amaranthus retroflexus*	Redroot pigweed	2001	Photosystem II inhibitors
12. *Amaranthus retroflexus*	Redroot pigweed	2001	Ureas and amides
13. *Chenopodium album*	Lambsquarters	2001	ALS inhibitors

Species	Common Name	Year	Herbicide Mechanisms of Action
14. *Polygonum persicaria*	Ladysthumb	2001	Photosystem II inhibitors
15. *Amaranthus hybridus*	Smooth pigweed	2002	ALS inhibitors
16. *Conyza canadensis*	Horseweed	2002	ALS inhibitors
17. *Conyza canadensis*	Horseweed	2002	Photosystem II inhibitors
18. *Conyza canadensis*	Horseweed	2002	Ureas and amides
19. *Atriplex patula*	Spreading orach	2003	Photosystem II inhibitors
20. *Abutilon theophrasti*	Velvetleaf	2004	Photosystem II inhibitors
21. *Chenopodium strictum var. glaucophyllum*	Late flowering goosefoot	2004	Photosystem II inhibitors
22. *Solanum ptycanthum*	Eastern black nightshade	2004	Photosystem II inhibitors
23. *Kochia scoparia*	Kochia	2005	ALS inhibitors
24. *Setaria faberi*	Giant foxtail	2006	ALS inhibitors
25. *Conyza canadensis*	Horseweed	2007	EPSPS inhibitors
26. *Amaranthus palmeri*	Palmer almaranth	2011	EPSPS inhibitors
Minnesota			
1. *Chenopodium album*	Lambsquarters	1982	Photosystem II inhibitors
2. *Abutilon theophrasti*	Velvetleaf	1991	Photosystem II inhibitors
3. *Amaranthus retroflexus*	Redroot pigweed	1991	Photosystem II inhibitors
4. *Avena fatua*	Wild oat	1991	ACCase inhibitors
5. *Kochia scoparia*	Kochia	1994	ALS inhibitors
6. *Xanthium strumarium*	Common cocklebur	1994	ALS inhibitors
7. *Setaria faberi*	Giant foxtail	1996	ALS inhibitors
8. *Setaria viridis var. robusta-alba Schreiber*	Robust white foxtail	1996	ALS inhibitors
9. *Setaria lutescens*	Yellow foxtail (Lutescens)	1997	ALS inhibitors
10. *Ambrosia artemisiifolia*	Common ragweed	1998	ALS inhibitors
11. *Setaria viridis var. robusta-alba Schreiber*	Robust white foxtail	1999	ACCase inhibitors
12. *Setaria viridis var. robusta-purpurea*	Purple robust foxtail	1999	ACCase inhibitors
13. *Ambrosia trifida*	Giant ragweed	2006	EPSPS inhibitors

Species	Common Name	Year	Herbicide Mechanisms of Action
14. *Amaranthus tuburculatus (syn. rudis)*	Common waterhemp	2007	EPSPS inhibitors
15. *Ambrosia artemisiifolia*	Common ragweed	2008	EPSPS inhibitors
16. *Ambrosia trifida*	Giant ragweed	2008	ALS inhibitors
17. *Ambrosia trifida*	Giant ragweed	2008	EPSPS inhibitors
Montana			
1. *Kochia scoparia*	Kochia	1984	Photosystems II inhibitors
2. *Salsola iberica*	Russian thistle	1987	ALS inhibitors
3. *Kochia scoparia*	Kochia	1989	ALS inhibitors
4. *Avena fatua*	Wild oat	1990	Fatty acid synthesis inhibitor
5. *Avena fatua*	Wild oat	1990	Unknown
6. *Avena fatua*	Wild oat	1990	ACCase inhibitors
7 *Lolium persicum*	Persian darnell	1993	ACCase inhibitors
8. *Kochia scoparia*	Kochia	1995	Synthetic Auxins
9. *Avena fatua*	Wild oat	1996	ALS inhibitors
10. *Avena fatua*	Wild oat	2002	ACCase inhibitors
Nebraska			
1. *Sorghum bicolor*	Shattercane	1994	ALS inhibitors
2. *Amaranthus tuberculatus*	Common waterhemp	1996	Photosystem II inhibitors
3. *Conyza canadensis*	Horseweed	2006	EPSPS inhibitors
4. *Amaranthus tuberculatus*	Common waterhemp	2009	Synthetic Auxins
5. *Ambrosia trifida*	Giant ragweed	2010	EPSPS inhibitors
6. *Kochia scoparia*	Kochia	2010	Synthetic Auxins
7. *Amaranthus tuberculatus*	Common waterhemp	2011	HPPD inhibitors
8. K*ochia scoparia*	Kochia	2011	EPSPS inhibitors
North Dakota			
1. *Kochia scoparia*	Kochia	1987	ALS inhibitors
2. *Setaria viridis*	Green foxtail	1989	Dintroanilines and others
3. *Avena fatua*	Wild oat	1991	ACCase inhibitors
4. *Kochia scoparia*	Kochia	1995	Synthetic Auxins
5. *Avena fatua*	Wild oat	1996	ALS inhibitors
6. *Kochia scoparia*	Kochia	1998	Photosystem II inhibitors
7. *Amaranthus retroflexus*	Redroot pigweed	1999	ALS inhibitors

Species	Common Name	Year	Herbicide Mechanisms of Action
8. *Sinapis arvensis*	Wild mustard	1999	ALS inhibitors
9. *Solanum ptycanthum*	Eastern black nightshade	1999	ALS inhibitors
10. *Iva xanthifolia*	Marshelder	2003	ALS inhibitors
11. *Ambrosia artemisiifolia*	Common ragweed	2007	EPSPS inhibitors
12. *Amaranthus tuberculatus*	Common Waterhemp	2010	EPSPS inhibitors
13. *Kochia scoparia*	Kochia		EPSPS inhibitors [2]
Oregon			
1. *Lolium multiflorum*	Italian ryegrass	1987	ACCase inhibitors
2. *Avena fatua*	Wild oat	1990	ACCase inhibitors
3. *Avena fatua*	Wild oat	1990	Dintroanilines and others
4. *Kochia scoparia*	Kochia	1993	ALS inhibitors
5. *Lactuca serriola*	Prickly lettuce	1993	ALS inhibitors
6. *Salsola iberica*	Russian thistle	1993	ALS inhibitors
7. *Amaranthus retroflexus*	Redroot pigweed	1994	Photosystem II inhibitors
8. *Poa annua*	Annual bluegrass	1994	Thiocarbamates and others
9. *Poa annua*	Annual bluegrass	1994	Ureas and amides
10. *Poa annua*	Annual bluegrass	1994	Photosystem II inhibitors
11. *Senecio vulgaris*	Common groundsel	1995	Nitriles and others
12. *Bromus tectorum*	Downy brome	1997	ALS inhibitors
13. *Camelina microcarpa*	Smallseed falseflax	1999	ALS inhibitors
14. *Lolium multiflorum*	Italian ryegrass	2004	EPSPS inhibitors
15. *Bromus tectorum*	Downy brome	2005	ACCase inhibitors
16. *Capsella bursa-pastoris*	Shepherd's-purse	2007	Photosystem II inhibitors
17. *Lolium multiflorum*	Italian ryegrass	2010	EPSPS inhibitors
18. *Lolium multiflorum*	Italian ryegrass	2010	Glutamine synthase inhibitors
Washington			
1. *Senecio vulgaris*	Common groundsel	1970	Photosystem II inhibitors
2. *Salsola iberica*	Russian thistle	1987	ALS inhibitors
3. *Centaurea solstitialis*	Yellow starthistle	1988	Synthetic Auxins
4. *Kochia scoparia*	Kochia	1989	ALS inhibitors
5. *Avena fatua*	Wild oat	1991	ACCase inhibitors
6. *Amaranthus powellis*	Powell amaranth	1992	Photosystem II inhibitors

Species	Common Name	Year	Herbicide Mechanisms of Action
7. *Lactuca serriola*	Prickly lettuce	1993	ALS inhibitors
8. *Sonchus asper*	Spiny sowthistle	2000	ALS inhibitors
9. *Lactuca serriola*	Prickly lettuce	2007	Synthetic Auxins
Wyoming			
1. *Kochia scoparia*	Kochia	1984	Photosystem II inhibitors
2. *Kochia scoparia*	Kochia	1996	ALS inhibitors

Sources: (Heap, 2012), (Westra et al., 2011)[1] , (Stachler et al., 2010)[2].
1

Table 3–25 also includes an analysis of information from Table 3–9 as to whether glyphosate and/or an alternative herbicide with a mechanism of action different from the reported resistance is rated as providing fair to excellent control of the resistant weed species in either a preplant incorporated, pre-emergent, or post-emergent application.

Table 3–25 illustrates that herbicide-resistant biotypes have been selected in 19 major sugar beet weeds to herbicides representing all the mechanisms of action used on sugar beet: ACCase inhibitors, ALS inhibitors, mitosis inhibitors, synthetic auxin mimics, PS II inhibitors, fatty acid synthesis inhibitors, and EPSPS inhibitors. Because most of the weeds are resistant to non-glyphosate herbicides, H7-1 sugar beet provides the opportunity to add another tool, glyphosate, to control resistant weeds.

Glyphosate-Resistant Weeds That May Impact Sugar Beet. Since 1996, 22 weed species with glyphosate-resistant biotypes have been found globally (Heap, 2012). Thirteen of these glyphosate-resistant species have been found in the United States. Seven of the glyphosate-resistant weeds known globally are also known to be weeds in sugar beet (see section III.B.1.d for a list of weeds in sugar beet). At least 21 weeds that have natural tolerance to glyphosate exist (Table 3–26). Eight of these glyphosate-tolerant weeds are also listed as weeds in sugar beet in the U.S. Table 3–26 also lists the weeds known to be glyphosate-resistant or –tolerant and which are weeds in sugar beet.

The 15 weed species considered weeds of sugar beet that are either naturally tolerant to glyphosate or for which resistant biotypes have been reported (Table 3-26) potentially pose the greatest likelihood to become more prevalent and difficult to control in glyphosate-resistant sugarbeet cropping systems if recommended rates of glyphosate are ineffective and/or other herbicides or control practices are either not available or not used to control them.

Table III-25. Major Sugar Beet Weeds with Resistance to Herbicide Groups (USDA–APHIS, 2010a)

Weed Common Name	Herbicide Mechanism of Action for Resistant Biotype	States Reported and Year Reported or Confirmed	Crops Infested, Estimated Number of Sites and Acres (A). (+ indicates that either the # of sites or acres is increasing)	Effective Control Option with Glyphosate and/or Alternative Herbicide
Barnyardgrass	ACCase Inhibitor & Fatty acid synthesis inhibitor	CA 2000	Rice-11–50 sites, 101–500 A+	Glyphosate/Post-E
Kochia	PSII inhibitor	CO 1982, WY, MT 1984, ND 1998	CO-Corn, 501–1,000 sites, 1,001–10,000 A+; WY-Corn, 11–50 sites, 1,001–10,000 A stable; MT-railways, 6–10 sites, 501–1,000 A+, ND-Corn,1 site, 11–50 A.	Glyphosate/Pre-E, Post-E
Kochia	ALS inhibitor	ND 1987, WA, MT, CO, ID 1989, OR 1993, MN 1994, WY 1996, MI 2005	ND-Cropland & wheat, 501–1,000 sites, 1–2 million A+; WA-Cereals & wheat, 501–1,000 sites, 1,001–10,000 A+; MT- Cropland & wheat, 1,001–10,000 sites, 0.10–1.0 million A+; CO-Roadsides & wheat, 501–1,000 sites, 10,001–100,000 A+; ID- Roadsides & wheat, 501–1,000 sites, 10,001–100,000 A+; OR-Wheat, 51–100 sites, 1,001–10,000 A+; MN-Cropland & wheat, 11–50 sites, 1,001–10,000 A +; WY-Wheat, 2–5 sites, 501–1,000 A+; MI-Sugar beet, 2–5 sites, 101–500 A+	Glyphosate/Pre-E, Post-E
Kochia	Synthetic auxin	ND, MT 1995, ID 1997	ND-Wheat, 6–10 sites, 101–500 A+; MT-Cropland & wheat, 101–500 sites, 1,001–10,000 A+; ID-Roadsides, 1 site, 1–5 A+.	Glyphosate/Pre-E, Post-E
Kochia	EPSPS inhibitor[1]	ND, 2010	ND-	

Wild oat	ACCase inhibitor	MT 1990 & 2002; OR 1990; WA, MN, ND 1991; ID 1992; CO 1997	MT-Cropland, sugar beet and wheat. 51-–100 sites, 1,001–10,000 A+ OR-Wheat, 101–500 sites, 1,001–10,000 A+; WA- Wheat, 51–100 sites, 10,000 A+; MN- Sugar beet & wheat. 51–100 sites, 1,001–10,000 A+.; ND-Cereals & wheat. 101-500 sites, 1,001–10,000A+ ID - Cereals & wheat. 11–50 sites, 1,001–10,000A+ CO-Barley & wheat. 6–10 sites, 101–500 A+	Glyphosate/PPI, Pre-E, Post-E
Wild oat	Fatty acid synthesis inhibitor	MT 1990, ID 1993	MT-Barley. 501–1,000 sites, 10,001–100,000A+; ID-Cereals. 51–100 sites, 10,001–100,000A+	Glyphosate/Post-E
Wild oat	ALS inhibitor	MT & ND1996	MT-Cereals,. 2–5 sites, 11–50 A+; ND-Wheat. 2–5 sites, 501–1,000 A+.	Glyphosate/PPI, Pre-E, Post-E
Wild oat	Mitosis inhibitor	OR 1990	Cropland. 1 site, 11–50 A stable.	Glyphosate/PPI, Pre-E, Post-E
Lambsquarter	PSII inhibitor	MI 1975, MN 1982	MI -Corn, nurseries, soybean. 100,000 A. MN – Corn. 101–500 sites, 501–1,000 A. stable.	Glyphosate/PPI, Pre-E, Post-E
Lambsquarter	ALS inhibitor	MI 2001	Soybean. 2–5 sites, 101–500 A+.	Glyphosate/PPI, Pre-E, Post-E
Redroot pigweed	PSII inhibitor	CO 1982, MN 1991, OR 1994, ID 2005	CO - Corn, 501–1,000 sites, 10,000 A +; MN – Corn, 1 site, 11–50 A stabilized; OR-Mint, 6–10 sites, 101–500 A+. ID-Potato, 2–5 sites, 501–1,000 A.	Glyphosate/PPI, Pre-E, Post-E
Redroot pigweed	PSII inhibitor (incl. Ureas and Amides)	MI 2001	Asparagus. 6–10 sites, 51–100 A+	Glyphosate/PPI, Pre-E, Post-E
Redroot pigweed	ALS inhibitor	ND 1999	Soybean. 1 site. 1–5 A. stable.	Glyphosate/PPI, Pre-E, Post-E
Tall water hemp	ALS inhibitor	MI 2000	Soybean. 6–10 sites, 101–500 A.	Glyphosate/PPI, Pre-E, Post-E
Tall water hemp	EPSPS inhibitor	MN 2007	Soybean. 2–5 sites, 51–100 A +.	PPI, Pre-E, Post-E
Tall water hemp	PSII inhibitor	NE 1996	Corn – NA	Glyphosate/PPI, Pre-E, Post-E
Powell Amaranth	PSII inhibitor	WA 1992	Mint – NA	Glyphosate/PPI, Pre-E, Post-E
Powell Amaranth	PSII inhibitor, Urea and amides	MI 2001	Asparagus & nurseries. 11–50 sites, 101–500 A +.	Glyphosate/PPI, Pre-E, Post-E
Smooth pigweed	ALS inhibitor	MI 2002	Soybean. 2–5 sites, 101–500 A.	Glyphosate/PPI, Pre-E, Post-E
Velvetleaf	PSII inhibitor	MI 2004	Corn, nurseries, soybean. 2–5 sites, 101–500 A +.	Not rated

Velvetleaf	PSII inhibitor	MN 1991	Corn. 1 site, 11–50 A. Stabilized	Not rated but not a weed in SB rotation crops in MN.
Eastern Black nightshade	PSII inhibitor	MI 2004	Blueberry. 2–5 sites, 101–500 A.	Glyphosate/PPI, Pre-E, Post-E
Eastern Black nightshade	ALS inhibitor	ND 1999	Soybean. 2–5 sites, 501–1,000 A +	Glyphosate/PPI, Pre-E, Post-E
Giant Foxtail	ALS inhibitor	MN 1996; MI 2006	Corn & soybean. MN -1 site, 11–50 A. + MI -1 site, 101–500 A.	Glyphosate/PPI, Pre-E, Post-E
Robust White Foxtail	ALS inhibitor	MN 1996	Corn & soybean. 1 site, 11–50 A, +.	Glyphosate/PPI, Pre-E, Post-E
Robust White Foxtail	ACCase inhibitor	MN 1999	Soybean. 6–10 sites, 11–50 A, stabilized.	Glyphosate/PPI, Pre-E, Post-E
Robust Purple Foxtail	ACCase inhibitor	MN 1999	Soybean. 1 site, 11–50 A, stabilized.	Glyphosate/PPI, Pre-E, Post-E
Yellow Foxtail	ALS inhibitor	MN 1997	Soybean. 1 site,1–5 A, increasing.	Glyphosate/PPI, Pre-E, Post-E
Green Foxtail	Mitosis inhibitor	ND 1989	Sunflower and wheat. 501–1,000 sites, 1,001–10,000 A, increasing.	Glyphosate/PPI, Pre-E, Post-E
Common Ragweed	EPSPS inhibitor	ND 2007 MN 2008	Soybean, 11-50 sites, 501-100 A Soybean, 51-100 sites, 1001-10,000 A	Post-E
Giant Ragweed	EPSPS inhibitor	MN 2006	Soybeans. 2–5 sites, 101–500 A, increasing.	Post-E
Common Cocklebur	ALS Inhibitor	MN 1994	Soybeans. 2–5 sites, 11–50 A, increasing.	Glyphosate/Marginal Pre-E; Post-E
Spiny Sowthistle	ALS Inhibitor	WA 2000	Lentils and wheat. 6–10 sites and acres.	Pre-E; Post-E

[1]Glyphosate-resistant Kochia has been reported in ND (Stachler et al., 2010).

Table III-26. Glyphosate-Resistant and -Tolerant Weeds

Scientific Name	Common Name	Resistant Biotype (RB) Tolerant (NT) reported worldwide	Resistant Biotype Reported in U.S.	Sugar Beet Weed	Listed on Roundup® Label (Monsanto, 2007)	Source
Abutilon theophrasti	Velvet leaf[2]	NT	NA	Yes	Yes (mixture also recommended)	(Nandula et al., 2005); (Cerdeira and Duke, 2006)
Amaranthus palmeri	Palmer amaranth	RB	Yes	No.	Yes (with resistant biotype note)	(Heap, 2011)
Amaranthus tuberculatus (syn. rudis)	Tall waterhemp	RB	Yes	Yes	Yes (with resistant biotype note)	(Nandula et al., 2005); Heap, 2011
Ambrosia artemisiifolia	Common ragweed[2]	RB	Yes	Yes	Yes (with resistant biotype note)	(Heap, 2011)
Ambrosia trifida	Giant ragweed	RB	Yes	Yes	Yes (with resistant biotype note)	(Heap, 2011)
Bromus diandrus	Ripgut Brome	RB	No	No	No	(Heap, 2012)
Chamaesyce hirta	Pillpod sandmat	NT	NA	No	No	(Cerdeira and Duke, 2006)
Chenopodium album	Common lambsquarters	NT	NA	Yes	Yes (mixture also recommended)	(Nandula et al., 2005)
Chloris truncate	Australian gingergrass	RB	NA	No	No	(Heap, 2011)
Commelina benghalensis	Tropical spiderwort[2]	NT	NA	No	No	(Nandula et al., 2005)
Commelina communis	Asiatic dayflower	NT	NA	No	No	(Nandula et al., 2005)
Convolvulus arvensis	Field bindweed[2]	NT	NA	No	No (mixture recommended)	(Nandula et al., 2005)
Conyza bonariensis	Hairy fleabane	RB	Yes	No	Yes	(Heap, 2011) (Nandula et al., 2005)
Conyza canadensis	Horseweed[3]	RB	Yes	Yes	Yes (with resistant biotype note)	(Nandula et al., 2005); (Heap, 2011) (Sprague and Everman, 2011)
Conyza sumatrensis	Sumatran fleabane	RB	No	No	No	(Heap, 2011)
Cynodon dactylon	Bermudagrass[2]	NT	No	No	Yes (partial control notes)	(Cerdeira and Duke, 2006)
Cyperus spp.	Nutsedge[2]	NT	No	Yes	Yes	(Cerdeira and Duke, 2006)
Dicliptera chinensis	Chinese foldwig	NT	No	No	No	(Nandula et al., 2005)
Digitaria insularis	Sourgrass	RB	No	No	No	(Heap, 2011)

Scientific Name	Common Name	Resistant Biotype (RB) Tolerant (NT) reported worldwide	Resistant Biotype Reported in U.S.	Sugar Beet Weed	Listed on Roundup® Label (Monsanto, 2007)	Source
Digitaria sanguinalis	Large crabgrass	NT	No	Yes	Yes (mixture also recommended)	(Cerdeira and Duke, 2006)
Echinochloa colona	Junglerice	RB	No	Yes	Yes (mixture also recommended)	(Heap, 2011)
Eleusine indica	Goosegrass	RB	Yes	No	Yes	(Nandula et al., 2005); Heap, 2011
Erodium spp.	Filaree	NT	No	Yes	Yes (mixture also recommended)	(Van Deynze et al., 2004)
Euphorbia heterophylla	Wild poinsettia[2]	RB	No	No	No	(Heap, 2011)
Ipomoea purpurea	Morning glory[2]	NT	No	No	Yes (mixture also recommended)	Hilgenfeld et al., 2004; (Cerdeira and Duke, 2006)
Kochia scoparia	Kochia[2]	RB	Yes	Yes	Yes	(Heap, 2011)
Leptochloa virgata	Tropical sprangletop	RB	No	No	Yes	(Heap, 2012)
Lolium multiflorum	Italian ryegrass	RB	Yes	No.	Yes (with resistant biotype note)	(Nandula et al., 2005); (Heap, 2011)
Lolium perenne	Perennial ryegrass	RB	No	No	Yes (with resistant biotype note)	(Heap, 2011)
Lolium rigidum	Rigid ryegrass	RB	Yes	No.	Yes (with resistant biotype note) glyphosate, paraquat, and ACCase multiple resistance	(Nandula et al., 2005); Yu et al., 2007; (Heap, 2011)
Lotus corniculatus	Birdsfoot trefoil	NT	No	No	No	(Nandula et al., 2005)
Malva parviflora	Cheeseweed	NT	No	Yes	No (mixture recommended)	(Van Deynze et al., 2004)
Parietara debilis	Florida pellitory	NT	No	No	No	(Cerdeira and Duke, 2006)
Parthenium hysterophorus	Ragweed parthenium	RB	No	No	Yes (with resistant biotype note)	(Heap, 2011)
Plantago lanceolata	Buckhorn plantain[1,2]	RB	No	No	No	(Heap, 2011)
Poa annua	Annual bluegrass	RB	Yes	No	Yes	(Heap, 2011)
Portulaca oleracea	Purslane[2]	NT	No	Yes	Yes (mixture also recommended)	(Van Deynze et al., 2004)
Richardia brasiliensis	Tropical Mexican clover	NT	No	No	No	(Cerdeira and Duke, 2006)
Sesbania exalta	Hemp sesbania[2]	NT	No	No	Yes	(Cerdeira and Duke, 2006)

Scientific Name	Common Name	Resistant Biotype (RB) Tolerant (NT) reported worldwide	Resistant Biotype Reported in U.S.	Sugar Beet Weed	Listed on Roundup® Label (Monsanto, 2007)	Source
Sorghum halepense	Johnsongrass[2]	RB	Yes	Yes	Yes (mixture also recommended)	(Heap, 2011)
Spermacoce latifolia	Oval-leaf false buttonweed	NT	No	No	No	(Cerdeira and Duke, 2006)
Urochloa panicoides	Liverseedgrass[2]	RB	No	No	No	(Heap, 2011)
Urtica uren	Burning nettle	NT	No	Yes	No (mixture recommended)	(Van Deynze et al., 2004); Canevari et al., 2004

1 These 3 weeds are not fully controlled by any of the 16 herbicides listed in the University of California Pest Management Guidelines (Rogan and Fitzpatrick, 2004).

2 These weeds are on at least one State's noxious weed list (USDA-NRCS, 2010).

3 While previously not considered a weed of sugar beet, *Conyza canadensis* in Michigan has now been identified in sugar beet fields in two counties (Sprague and Everman, 2011). It has traditionally been controlled by tillage.Abbreviations: NA = Not available

Glyphosate-resistant weeds that occur in sugar beet producing states that may become problematic include:

Horseweed (Conyza canadensis). A glyphosate-resistant horesweed in Michigan has recently been observed in fields for soybeans and sugar beet (Sprague, 2011; Sprague and Everman, 2011). In 2011, glyphosate-resistant horseweed was observed in Cass County North Dakota. Horseweed is a winter annual and doesn't survive where fall/spring tillage is used. (Bruce and Kells, 1990). It is not expected to become a problem in the Midwest or Great Lake states butcould become a problem in areas where strip till and no till are practiced such as parts of the Northwest and Great Plains.

Common waterhemp ((*Amaranthus tuberculatus*) is a problem weed in sugar beet in Michigan, Minnesota, and North Dakota (Robert Wilson, personal communication). A glyphosate-resistant biotype was observed in soybean in Renville county Minnesota in 2007 ((Stachler and Christoffers, 2012)). By the time of the 2011 growing season, glyphosate-resistant common waterhemp had become very prevalent where it was estimated to be present in 50-70% of all sugar beet fields in Southern Minnesota. In order to control glyphosate-resistant waterhemp, Stachler recommends several additional herbicides that include a preplant incorporation of a residual herbicide such as ethofumesate, cycloate, cycloate plus EPTC, or metolachlor and then a tank mixture of glyphosate, phenmedipham plus desmedipham (Betamix), ethofumesate, and either metolachlor or dimethenamid-P (Stachler and Luecke, 2011) and Stachler personel communication (Stachler, 2012). The additional herbicide cost is estimated to be $133/acre more than glyphosate alone (Stachler, 2012). In addition to the use of residual herbicides and other herbicide mechanisms of action, American Crystal Sugar is recommending that growers use different rotation crops such as Liberty Link soybeans and conventional rotation crops, use more mechanical tillage, and use hand labor as necessary to prevent resistant weeds from going to seed http://www.crystalsugar.com/agronomy/agnotes/ViewArticle.aspx?id=272. While these combinations of herbicides resemble that used on conventional sugar beet in complexity and cost, the control is still superior because glyphosate is effective on most of the other problem weeds in sugar beet (Stachler, 2012). According to (Stachler et al., 2012a), in 2011:

> "the Roundup Ready® sugarbeet system continues to provide the most effective post-emergent weed control reported by growers in the history of this survey. Weeds were named most often as the most serious production problem by conventional sugarbeet survey respondents in

2011 but were named the most serious production problem by only 1% of RR sugar beet growers in 2011."

Waterhemp may become a serious problem due to its ability to develop resistance to multiple herbicides. Recently a waterhemp with resistance to four classes of herbicides, (photosystem II inhibitors, ALS inhibitors, protoporphyrionogen oxidase (PPO) inhibitors, and glyphosate was identified in Illinois(Tranel et al., 2011). A survey of multiple-herbicide resistance in waterhemp revealed that all populations resistant to glyphosate contained resistance to ALS inhibitors and 40% contained resistance to PPO inhibitors.

Common ragweed (*Ambrosia artemisiifolia).* Glyphosate-resistant biotypes were reported in Traill County North Dakota in 2007 and then in Cass County North Dakota, Clay County Minnesota, and Red Lake County Minnesota in 2008. By 2011, it has been confirmed in 7 counties and suspected in 8 other counties in North Dakota and Minnesota (Stachler and Christoffers, 2012)Stachler and colleagues (Stachler et al., 2009c), recommend a mix of glyphosate and clopyralid to provide control in sugar beet.

Giant ragweed (*Ambrosia trifida*). A glyphosate-resistant giant ragweed was observed in soybean in McLeod County Minnesota in 2006. In 2011, it was confirmed in 8 counties and suspected in six other counties mostly in Southern Minnesota (Stachler and Christoffers, 2012). (Fisher et al., 2009)recommends a mixture of glyphosate and clopyralid for control of glyphosate-resistant giant ragweed in sugar beet. It has also been confirmed in Eastern Nebraska in Butler, Nemaha, Richardson and Washington counties (Anonymous, 2011). None of these counties are in the sugar beet producing area of the State.

Kochia (*Kochia scoparia*) is a problematic sugar beet weed in the Northwest, Great Plains, and Midwest. A glyphosate-resistant kochia was confirmed in Kansas. In 2011 glyphosate-resistant kochia was confirmed in Dickey county North Dakota and is suspected in both Pierce and Ramsey counties (Stachler and Christoffers, 2012). Another unconfirmed report suggests that glyphosate-resistant kochia is present in the counties of Sargent and McIntosh, North Dakota (Hildebrant, 2011). Sugar beet are produced in Sargent County. There is also a report that glyphosate-resistant kochia is found in eastern Colorado along the Kansas border. (Westra et al., 2011). There is an unconfirmed report that glyphosate-resistant kochia is in Nebraska, too (Anonymous, 2011). Kochia may be particularly problematic as biotypes resistant to both ALS and PSII inhibitors already exist.

Junglerice (*Echinochloa colona*) is a problematic weed in sugar beet in the Imperial Valley. In 2008, a glyphosate-resistant biotype was discovered in California in corn, orchards, and roadsides (Heap, 2011). It is possible that the resistant biotype may disperse into the sugar beet production area where it would need to be controlled with grass herbicides. Currently, there are no U.S. biotypes of junglerice resistant to other herbicides though it has evolved resistance to PS II inhibitors, ACC inhibitors, ureas and amides, synthetic auxins, and ALS inhibitors in Australia and South America (Heap, 2011).

Johnsongrass (*Sorghum halepense)* can be a problem weed in sugar beet in the Imperial Valley. Glyphosate-resistant biotypes have been observed in Arkansas and Louisiana. If a glyphosate-resistant biotype evolved in California, it could be controlled by grass herbicides.

Because there already is a difficulty in controlling herbicide-resistant weeds with conventional herbicides, H7-1 sugar beet offers a new mechanism of action and hence a greater level of control than is currently possible especially when glyphosate is used in conjunction with other herbicides

c. Herbicide Drift to Non-target Plants

As a result of spraying herbicides onto crops, the potential exists for spray drift, inadvertent direct overspray, or transport (via wind or water flow from rainfall) of soil particles loaded with adsorbed herbicides to contact non-target terrestrial and aquatic plants (including non-target crops and non-agricultural plants) in the vicinity of sugar beet fields. As discussed in section III.B.1.d(3) (and presented in Table 3–11), the main methods of application of the herbicides used on sugar beet is either in bands, broadcast, or microrate. Growers producing sugar beet for the American Crystal Sugar Company, the Minn-Dak Farmers Cooperative, and the Southern Minnesota Beet Sugar Cooperative were surveyed about their weed control practices in Minnesota and eastern North Dakota and indicated that herbicides were broadcast-applied by air to 17 percent of the sugar beet acreage in 1998, 9 percent in 2000, 14 percent in 2002 and 7% in 2011 (Stachler et al., 2012a). Glyphosate is usually broadcast applied with a ground sprayer. In 2011, glyphosate was aerially applied to 4% of sugar beet acres (Stachler et al., 2012a). Herbicide application via ground-based methods to sugar beet results in less herbicide drift than aerial application.

d. Sugar Beet Weediness Potential in Non-agricultural Settings

Could problem weeds be the “unintended crop descendents from transgenic crops?” Ellstrand (2006) states, “The possibility of unintended reproduction by transgenic crops has raised questions about whether their descendents might cause problems. These problems have fallen into two broad categories: first, the direct feral descendents of the crops may prove to be new weeds or invasive plants, and second, that unintended hybrids between transgenic crops and other plants could lead to certain problems." This section discusses the weediness properties of H7-1 sugar beet, and addresses the concern of direct descendents of the crop that "may prove to be new weeds or invasive plants." Gene flow from sugar beet to wild relatives is discussed in section III.B.5.

In permitted trials, summarized below in III.C.3.d(2), no differences were observed between H7-1 lines and conventional lines with respect to the plants' ability to persist or compete as a weed (Monsanto and KWS SAAT AG, 2004); USDA–APHIS, 2005). In these evaluations, APHIS considered data on plant vigor, bolting, seedling emergence, seed germination, seed dormancy, and other characteristics (USDA–APHIS, 2005).

In a separate evaluation, the CFIA, whose responsibilities include regulating the introduction of animal food and plants (including crops) to Canada, reached the same conclusion about the weediness potential of H7-1 sugar beet compared with conventional sugar beet. In 2005, the CFIA authorized the "unconfined release into the environment and livestock feed use of the sugar beet H7-1" (CFIA, 2005). In its evaluation of H7-1 sugar beet, CFIA "determined that germination, flowering, root yield, susceptibility to plant pests and diseases typical to sugar beet and bolting percentage were within the normal range of expression of these traits currently displayed by commercial sugar beet hybrids" (CFIA, 2005). The CFIA reached the following conclusions (CFIA, 2005):

> "No competitive advantage was conferred to these plants, other than that conferred by tolerance to glyphosate herbicide. Resistance to Roundup® agricultural herbicides will not, in itself, render sugar beet weedy or invasive of natural habitats since none of the reproductive or growth characteristics were modified."

The above considerations, together with the fact that the novel traits have no intended effects on weediness or invasiveness, led the CFIA to conclude that the H7-1 sugar beet transformation event has no altered weed or invasiveness potential compared to currently commercialized sugar beet.

The USDA is not aware of any feral populations of sugar beet in the U.S. No *Beta* species are listed as weeds on any of the 12 weed lists from the USDA PLANTS database (USDA-NRCS, 2010). Below are these 12 weed lists:

- Plant Protection and Quarantine. 2006. *Federal noxious weed list* (24 May 2006). USDA Animal and Plant Health Inspection Service. Washington, DC. 2pp. (104 entries)

- Assorted authors. S*tate Noxious Weed Lists for 46 States.* State agriculture or natural resource departments. (661 entries)

- California Invasive Plant Council. 2006. *California Invasive Plant Inventory*. Cal-IPC Publication 2006-02 (February 2007). California Invasive Plant Council. Berkeley, California. (107 entries)

- Florida Exotic Pest Plant Council. 1999. *Invasive Plant List* (19 October 1999). Florida Exotic Pest Plant Council. Florida. (134 entries)

- USDOI (United States Department of the Interior), Geological Survey. 1999. *Information Index for Selected Alien Plants in Hawaii* (20 October 2003). Hawaiian Ecosystems at Risk Project, Biological Resources Division, Haleakala Field Station. Makawao, Hawaii. (197 entries)

- Haragan, P.D. 1991. *Weeds of Kentucky and Adjacent States: A Field Guide.* The University Press of Kentucky. Lexington, Kentucky. 278pp. (141 entries)

- Uva, R.H., J.C. Neal, and J.M. DiTomaso. 1997. *Weeds of the Northeast*. Cornell University Press. Ithaca, New York. 397pp. (237 entries)

- Stubbendieck, J., G.Y. Friisoe, and M.R. Bolick. 1994. *Weeds of Nebraska and the Great Plains.* Nebraska Department of Agriculture, Bureau of Plant Industry. Lincoln, Nebraska. 589pp. (287 entries)

- Southeast Exotic Pest Plant Council. 1996. *Invasive Exotic Pest Plants in Tennessee* (19 October 1999). Research Committee of the Tennessee Exotic Pest Plant Council. Tennessee. (140 entries)

- Southern Weed Science Society. 1998. *Weeds of the United States and Canada*. CD-ROM. Southern Weed Science Society. Champaign, Illinois. (411 entries)

- Hoffman, R., and K. Kearns (eds.). 1997. *Wisconsin Manual of Control Recommendations for Ecologically Invasive Plants*. Wisconsin Dept. Natural Resources. Madison, Wisconsin. 102pp. (75 entries)

- Whitson, T.D. (ed.) et al. 1996. *Weeds of the West*. Western Society of Weed Science in cooperation with Cooperative Extension Services, University of Wyoming. Laramie, Wyoming. 630pp. (344 entries)

e. Agronomic Characteristics of H7-1 Sugar Beet

Information on the agronomic evaluation of H7-1 sugar beet can be found in the *Petition for Determination of Nonregulated Status for Roundup Ready® Sugar Beet H7-1* (Monsanto and KWS SAAT AG, 2004). This reference includes information on H7-1 sugar beet and its disease and pest susceptibilities evaluated through nursery and field trials, agronomic characteristics, performance, phenotype, composition, and nutrient quality. Sections III.C.3.d(1) through III.C.3.d(4) are summaries of information in (Monsanto and KWS SAAT AG, 2004).

(1) Disease and Pest Susceptibilities of H7-1 Sugar Beet

During nursery trials, H7-1 sugar beet plots were observed for their susceptibility, as compared to conventional sugar beet varieties, to *Cercospora* leaf spots, *Aphanomyces* root rot, and curly top and *Rhizoctonia* root rot. The tables presented in Schneider and Strittmatter (2004) on this information include comparative analyses of observed disease ratings. H7-1 sugar beet was also tested in field trials established for the purpose of developing sugar beet varietals according to U.S. industry standards (i.e., proprietary performance trials, official yield performance and disease nursery trials, agronomic trials, growout field trials, steckling production trials, and seed multiplication trials), and again compared to conventional varieties. Schneider and Strittmatter (2004)reports H7-1 sugar beet response to the following diseases that impact sugar beet production: fungal seedling diseases (e.g., *Pythium ultimum, P. aphanidermatum*), beet necrotic yellow vein virus (*Rhizomania*), and powdery mildew (*Erysiphe betae*), in addition to the diseases mentioned earlier. Schneider and Strittmatter (2004) also reports observations of damage to H7-1 sugar beet after exposure to the following insects and nematodes that are also economically relevant to sugar beet production: sugar beet root aphid (*Pemphigus populivenae*), sugar beet root maggot (*Tetanops myopaeformis*), sugar beet cyst nematode (*Heterodera schachtii*), and root knot nematode (various *Meloidogyne spp.*).

Information on H7-1 sugar beet damage or injury from diseases and pests relevant to Europe, as observed in European field trials conducted in France and Germany, can also be found in Schneider and Strittmatter (2004). These include diseases and pests examined in the U.S. trials (i.e., powdery mildew, *Cercospora* leaf spot, *Rhizoctonia* root rot, fungal seedling diseases, *Rhizomania*, and cyst nematode) as well as additional diseases and pests relevant for both Europe and the United States (i.e., downy mildew (*Peronospora farinose*), *Ramularia* leaf spot, *Alternaria* leaf spot, sugar beet rust (*Uromyces betae*), and *Phoma* fungal seedling diseases).

The nursery and field trials showed that H7-1 sugar beet is comparable to conventional varieties with respect to disease and pest susceptibility, and the H7-1 trait does not affect plant-disease or plant-pest interactions (Monsanto and KWS SAAT AG, 2004).

(2) Agronomic Characteristics, Performance, and Phenotype of H7-1 Sugar Beet

All new sugar beet varietals must meet industry standards before they are approved for distribution on the market. Schneider and Strittmatter (2004)reports results from coded trials performed according to these industry standards to evaluate agronomic characteristics of H7-1 sugar beet, including vigor, percent of bolting plants, plant emergence average, yield tons per acre, recoverable sugar pounds per ton of sugar beet, and recoverable sugar pounds per acre, as compared to conventional varieties.

Plant phenotype characteristics of H7-1 sugar beet were compared to conventional varieties of sugar beet as well. Information on the hypocotyl color, leaf color, leaf chlorosis, and leaf size of H7-1 sugar beet is reported in Schneider and Strittmatter (Monsanto and KWS SAAT AG, 2004). Inflorescence and flowering traits examined and reported include ramification type, thousand kernel weight in grams, percent seed germination rate, seed dormancy, time for vernalization, bolting date, onset of flowering, seed harvest date, and the classification of plant development on a scale of 1 to 6.

Based on these evaluations and observations, H7-1 shows no meaningful differences in agronomic characteristics, performance, and phenotype when compared to conventional varieties, and the H7-1 trait does not alter weediness potential of the H7-1 variety (Monsanto and KWS SAAT AG, 2004).

(3) Compositional and Quality Component Analyses of H7-1 Sugar Beet

Tissue samples from H7-1 sugar beet roots and tops were collected from European field sites to evaluate compositional equivalence of H7-1 sugar beet to conventional varieties. Analyses reported in Schneider and Strittmatter (2004) include the amounts of polarization, potassium, sodium, invert sugar, and amino-N in root tissue, as well as percentages of dry matter, crude protein, crude fiber, crude ash, crude fat, and carbohydrates; the amount of saponin; and the percent of each amino acid found in both the top and root tissues.

In all of the analyses, the ranges reported for H7-1 sugar beet significantly overlapped or fell completely within the ranges reported for conventional varieties of sugar beet, indicating that H7-1 sugar beet are compositionally equivalent to conventional varieties with respect to key nutrients and components (Monsanto and KWS SAAT AG, 2004).

(4) Disease Susceptibility from Herbicide Stress

Environmental factors that contribute to severity of herbicide injury are discussed in section III.B.1.d(3).

The issue of increased disease susceptibility due to glyphosate treatment has been raised for both conventional and glyphosate-resistant plants in a number of different crop plants (Duke and Cerdeira, 2007; Johal and Huber, 2009). Research conducted in greenhouse studies suggested the possibility that Roundup Ready® sugar beet treated with glyphosate may have more sensitivity to *Rhizoctonia solani*, and *Fusarium oxysporum*, both serious diseases of sugar beet (Larson et al., 2006). The Larson 2006 experiments obtained statistically significant results that were both cultivar- and isolate-specific. The study looked at two glyphosate-resistant cultivars and four fungal isolates. Of the eight possible combinations of cultivar and isolate, they observed the glyphosate effect three times. This means that only some of the plants studied showed a response to glyphosate resulting in increased disease and only when challenged by certain types of the pathogens. In other words, there was not a uniform response of glyphosate-resistant sugar beet to have an increase in disease as a result of glyphosate application. The dataset was too limited to determine why the inconsistency existed (Larson, 2010). In addition the experiments were conducted on event GTSB77 sugar beet, not event H7-1 sugar beet (Larson, 2010). Larson (2010) attempted to replicate the greenhouse studies under natural field conditions, but failed to show significant differences in disease severity between glyphosate-resistant and conventional sugar beet. The small increases in disease severity following glyphosate application that were initially observed in some instances in the greenhouse were likely a result of stress to the plant induced by the application of an herbicide. In the greenhouse study, a benign surfactant was applied to the control plants prior to inoculation, which did not cause the plants the same stress that an application of an herbicide would cause. In the field tests, conventional herbicides were applied to the control plants, which were compared to the plants treated with glyphosate. Conventional herbicides are equally, if not more stress-inducing, to sugar beet than glyphosate. The results of field studies strongly indicate that stress, not glyphosate, was the cause of the increased disease severity observed in the initial greenhouse study (Larson, 2010). In industry conducted field trials, only six out of 98 trial sites over four growing seasons indicated a difference in disease susceptibility with no trend associated with event H7-1. In three of the six trial sites with observed differences in disease susceptibility, event H7-1 had increased resistance to powdery mildew compared to conventional varieties, which is in contrast to the increased susceptibility observed at the other three trials sites. These observations supports the conclusion that H7-1 sugar beet are not more susceptible to diseases than conventional sugar beet (Carson, 2010).

As noted in section III.B.1.b(4), all sugar cooperatives evaluate the disease resistance traits of sugar beet hybrids which are significant to their regional environments before their member-growers are permitted to purchase hybrid seed. Cooperatives evaluate hybrids through "Official Variety Trials," which take place over a two or three year period, for the overall disease tolerance of each hybrid to a wide array of pathogens. In these trials, referred to as disease nurseries, hybrids are either subjected to natural infection or artificial inoculation. Pathogens tested include *Rhizoctonia* (evaluated by American Crystal, Minn-Dak, Southern Minnesota, Western Sugar, and Michigan Sugar) and *Fusarium* (evaluated by American Crystal, Sidney Sugars, and Western Sugar) among others, and there are many commercially-available H7-1 hybrid varieties that have high levels of tolerance to these and other diseases (Larson, 2010). Hybrids classified as resistant in these disease nurseries have repeatedly shown tolerance in the field under commercial production. Sugar beet growers will not purchase hybrid seed that does not have the proven disease-resistance traits they need for their particular growing area (Meier, 2010).

4. Horizontal Gene Transfer

Horizontal gene transfer (HGT) is the movement of genetic material between non-sexually compatible, unrelated organisms. HGT has been studied intensively since the 1940s, gaining renewed attention after the commercial release of transgenic plants in the mid 1990s (Dröge et al., 1998). HGT has contributed to major transitions in evolution and occurs frequently between bacterial species, particularly in marine environments (McDaniel et al., 2010). One reason that HGT is thought to occur easily between bacteria or other single celled organisms is due to the relatively easy contact between nuclear genomes when single celled organisms fuse or consume other single celled organisms. It is thought that HGT into multicellular organisms, such as higher plants, with a defined germline is much less likely. HGT would have to occur between the two different species and specifically to germline cells in order for the HGT to permanently be incorporated into the receptor species (Richardson and Palmer, 2007). While there is no evidence of HGT occurring between plant chloroplasts, HGT can occur in plant mitochondria. In all of the cases of HGT between plants, the inferred result of the transfer is the movement of mitochondrial genes to other mitochondria, not between nuclear genomes (Richardson and Palmer, 2007). All known transfers between plants have occurred on an evolutionary time scale ranging from 60 million to 480 million years ago (Richardson and Palmer, 2007). Of the transfers, a common pattern is the observation that mitochondrial HGT in plants frequently involve transfers between flowering plants and parasitic plants. Most of the transferred genes are non-functional, though a few events of HGT have resulted in new gene sequence combinations that may result in functional genes (Keeling and Palmer, 2008).

Plants growing in nature have numerous opportunities to interact directly with other organisms such as fungi, bacteria, and parasitic plants. Despite this frequent interaction, there are no reports to date of significant HGT between sexually incompatible or evolutionarily distant organisms (as reviewed in (Keese, 2008). Accumulated evidence shows universal gene-transfer barriers exist, regardless of whether transfer occurs among closely or distantly related organisms (Kaneko et al., 2000; Koonin et al., 2001; Wood et al., 2001; Kaneko et al., 2002; Brown, 2003; Sorek et al., 2007). Many genomes (or parts thereof) have been sequenced from bacteria that are closely associated with plants, including *Agrobacterium* and *Rhizobium* (Kaneko et al., 2000; Wood et al., 2001; Kaneko et al., 2002). There is no evidence that these organisms contain genes derived from plants as would be expected if HGT occurred frequently. Regarding transgenic plants, a study of the interaction between transgenic corn (cultivated for 10 consecutive years and expressing an antibiotic resistance gene for ampicillin) and soil bacteria demonstrated that the growth of the transgenic corn did not affect the frequency of antibiotic resistance detected in the soil bacteria (Demanèche et al., 2008). These data indicate that HGT between GE corn and soil bacteria did not occur at detectable rates.

Studies examining the mechanisms of HGT between plants and bacteria have demonstrated that HGT can occur under optimized laboratory conditions at a low frequency (Pontiroli et al., 2007). Very few studies have demonstrated the presence of eukaryotic (e.g., plant or animal) genes in bacterial genomes (Keeling and Palmer, 2008), and some evolutionary analyses of the genetic changes in these presumably HGT genes indicate that the potential HGT occurred before the species divergence of the bacteria (millions of years before present) (Jenkins et al., 2002; Schlieper et al., 2005).

Where data indicate HGT might have taken place, these events are believed to have occurred on an evolutionary time scale on the order of millions of years (Koonin et al., 2001; Brown, 2003). Combined, the above studies indicate that inter-kingdom HGT (e.g., between plants and bacteria) is an extremely rare event in nature, and most of those rare events have occurred over millions of years of evolution. In addition, there has been no evidence of HGT occurring as a result of transgenes in crop species (Pontiroli et al., 2007). Keese (2008) concluded that "in most cases the occurrence of HGT from GM crops to other organisms is expected to be lower than background rates. Therefore, HGT from GM plants poses negligible risks to human health or the environment."

D. Socioeconomics

The socioeconomic resources described in this section are those potentially affected by the alternatives analyzed in chapter 4. The first is the production of sugar beet and its contribution to the U.S. sugar market. This involves the producers of sugar beet seed, producers of sugar beet roots, sugar processors, consumers, and traders. Sections III.D.1 and III.D.2 describe the production of sugar beet and its role in the U.S. sugar market detailing supply and demand from seed to consumer. The second resource is the organic and conventional markets for sugar beet and sugar. Although a segment of the general sugar beet and sugar markets, these markets are described separately in section III.D.3, given their relevance to the discussion in chapter 4. The third resource is the vegetable beet market, described in section III.D.4 to aid the analysis of impacts from potential cross-fertilization of sugar beet with vegetable beet. .

1. Sugar Beet Root Crop

a. The U.S. Sugar Market

Table 3–27 shows that demand for sugar in the United States (deliveries for domestic use) increased at an average annual rate of approximately 0.9 percent per year since 1997, similar to the growth rate in the U.S. population.[12] Exports typically absorbed an additional 1–4 percent of production. Between 50 and 60 percent of the U.S. sugar market is supplied by sugar from sugar beet in any given year, depending primarily on the share of the market supplied by imports (USDA-ERS, 2010b). Refined sugar from sugar cane or from sugar beet is typically 99.95 percent sucrose. Sucrose is identical irrespective of its sugar cane or sugar beet origin (The Sugar Association, undated).

A small fraction of domestic sugar demand is for nonhuman use such as for livestock feed (typically in the form of molasses) and polyhydric

[12] Average annual growth rate of the U.S. population was 0.9 percent between 2000 and 2009 U.S. Census Bureau, "Population Estimates," (2009), vol.).

alcohol production and for the sugar-containing products re-export program in which U.S. companies produce sugar containing products that they then export. The remainder of domestic sugar demand is used in foods and food products for human consumption within the United States.

Table III-27. The U.S. Sugar Market, Historic Data, Fiscal Years 1997-2011 (1,000 tons, raw value value[1])

	FY97	FY98	FY99	FY00	FY01	FY02	FY03	FY04	FY05	FY06	FY07	FY08	FY09	FY10	FY11
Total Production[2]	7,204	8,021	8,366	9,050	8,769	7,900	8,426	8,649	7,876	7,399	8,445	8,152	7,531	7,968	8,230
Total Imports	2,774	2,163	1,823	1,636	1,590	1,535	1,730	1,750	2,100	3,443	2,080	2,620	3,082	3,320	2,744
Total Exports	211	179	230	124	141	137	142	288	259	203	422	203	136	211	150
Change in Stocks[3]	4	-191	40	-577	36	652	-142	-227	566	-366	-101	135	130	34	236
Miscellaneous[4]	30	-1	-67	-126	123	-24	161	23	94	-67	-132	0	0	-22	0
Deliveries for Domestic Use	9,742	9,815	10,066	10,111	10,132	9,974	9,711	9,862	10,188	10,340	10,135	10,704	10,607	11,133	11,060
Total Use	9,983	9,992	10,238	10,090	10,396	10,087	10,014	10,172	10,542	10,476	10,424	10,907	10,743	11,321	11,210

Source: (USDA-ERS, 2010b), Table 24a.

1 Raw value: equivalent in weight of raw sugar with an average content of sucrose of 96 degrees, as determined by polarimetric testing.

2 Production reflects processors' estimates compiled by the Farm Service Agency.

3 Includes stock held privately and by the Commodity Credit Corporation (CCC).

4 Mostly a statistical adjustment calculated as a residual and largely consisting of change in invisible stocks.

In FY 2010, almost 98 percent of domestic sugar demand was for human use (USDA FSA (Farm Services Agency), 2010). In that same FY, about 26 percent of sugar deliveries for human use or re-export went to wholesale grocers, jobbers, and dealers, while 25 percent went to bakeries and producers of cereal and related products. Beet sugar deliveries were especially concentrated among bakeries and producers of cereal and related products, which accounted for 34 percent of beet sugar deliveries for human use or re-export (Table 3–28).

Table 3–29 shows U.S. exports of sugar to selected destinations. United States exported sugar to over 120 countries since 1997. However, Mexico is the main importer of U.S. sugar, importing more than half of the total value of U.S. raw and refined sugar exports since 1997, with Canada a distant second at under 10 percent.

The domestic sugar market is closely managed by USDA's sugar program and therefore not governed solely by supply and demand. USDA is required by section 156 of the Federal Agriculture Improvement and Reform Act of 1996, as amended by the Food Conservation, and Energy Act of 2008 (the 2008 Farm Act) and the Harmonized Tariff Schedule of the United States (HTS) to establish a range of acceptable market conditions – maintain a price floor in potentially oversupplied situations by removing surplus supply and maintain "adequate supply" in potentially undersupplied market situations. To maintain a price floor, USDA provides loans to processors of sugar from sugar beet and sugar cane with processed sugar provided as collateral at established rates. USDA must accept sugar at those rates, if processors choose to forfeit their loan collateral at loan maturity (Colacicco, 2010a). The current loan rates for refined sugar from sugar beet are:

- 22.9 cents per pound in FY2009,
- 23.5 cents per pound in FY2010,
- 23.8 cents per pound in FY2011, and
- 24.1 cents per pound in FY2012–13 (USDA-ERS, 2009b).

To the maximum extent possible, the price support loans program must work at no cost to the Federal government. For this reason, the Federal government manages other policy instruments to control supply in order to keep domestic sugar prices high enough to avoid having to take title of forfeited sugar. The main instruments in place with this aim are marketing allotments and import tariff-rate quotas (TRQs).

Table III-28. Sugar Deliveries for Human Consumption and Product Re-Exports by Type of User, Fiscal Year 2010[1]

Product or Business of Buyer	Beet Sugar (tons)[2]	Percent of Beet Sugar Deliveries (%)	Cane Sugar (tons)[2]	Percent of Cane Sugar Deliveries (%)	All Sugar (tons)[2]	Percent of All Sugar Deliveries (%)
Bakery, Cereal, and Related Products	1,420,264	33.8	974,387	18.0	2,394,650	24.9
Confectionery and Related Products	393,988	9.4	669,856	12.4	1,063,844	11.0
Ice Cream and Dairy Products	232,417	5.5	367,041	6.8	599,458	6.2
Beverages	224,588	5.3	188,529	3.5	413,117	4.3
Canned, Bottled and Frozen Foods	254,232	6.0	141,125	2.6	395,357	4.1
Multiple and All Other Food Uses	324,395	7.7	270,512	5.0	594,906	6.2
Nonfood Uses	27,483	0.7	78,805	1.5	106,288	1.1
Hotels, Restaurants, Institutions	61,337	1.5	64,500	1.2	125,837	1.3
Wholesale Grocers, Jobbers, Dealers	708,094	16.8	1,748,976	32.3	2,457,070	25.5
Retail Grocers, Chain Stores	423,233	10.1	836,375	15.4	1,259,608	13.1
Government Agencies	2,846	0.1	28,455	0.5	31,301	0.3
All Other Deliveries	133,514	3.2	54,368	1.0	187,883	2.0
Total Deliveries	**4,206,392**		**5,422,929**		**9,629,321**	

Source: Farm Service Agency. Database can be accessed at http://www.fsa.usda.gov/FSA/webapp?area=home&subject=ecpa&topic=dsa. FY 2010: Yearly Sweetener Market Report, Table 9

[1] Excludes from domestic deliveries those for nonhuman consumption and those from nonreporters.

[2] Actual weight.

Table III-29. U.S. Raw and Refined Sugar Exports, 1997-2009 (USD 1,000)

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Raw and Refined Sugar[1]	61,524	53,561	50,270	39,849	51,967	52,045	41,007	69,171	90,402	157,133	194,184	139,557	104,725
Share of Total U.S. Exports of Raw and Refined Sugar (%)													
Mexico	17.3	18.0	16.6	23.1	23.5	28.3	51.1	70.8	54.9	63.4	65.1	66.8	70.8
Canada	5.1	14.2	12.3	20.4	14.2	10.6	11.6	8.6	16.0	10.7	10.6	12.0	8.5
Netherlands Antilles	2.3	3.1	2.4	2.7	2.3	2.4	5.5	2.9	3.4	1.9	1.4	1.3	2.2
Netherlands	1.4	1.8	2.7	3.4	2.1	3.0	3.2	1.7	1.3	1.2	0.7	2.0	2.2
Germany	0.5	0.8	1.0	0.5	2.7	0.6	1.7	1.2	1.0	1.0	1.0	1.7	2.2
Bahamas	3.0	3.3	3.9	4.5	4.8	5.4	5.7	2.6	3.0	1.6	1.1	0.8	1.4
Japan	1.0	1.3	0.9	1.6	1.6	1.5	1.6	0.9	0.8	0.3	0.4	1.1	0.7
Haiti	6.3	5.7	4.8	0.0	3.8	0.0	0.0	0.0	0.1	0.1	0.1	0.2	0.3
Jamaica	25.7	21.1	22.6	29.3	17.6	7.4	1.4	0.2	1.5	0.4	0.1	0.1	0.1
Peru	11.7	11.6	3.5	0.0	9.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Source: U.S. Census. Database can be accessed at http://www.fas.usda.gov/gats/default.aspx.
1 U.S. exports in U.S. Harmonized Tariff Schedule (HTS) codes 170111, 170112, 170191 and 170199. Includes exports and re-exports.
[1] Harmonized System code 170111, 170112, 170191 and 170199. Includes exports and re-exports.

Marketing allotments establish maximum amounts of sugar allowed to be sold domestically by refined beet sugar processors (54.35 percent of the Overall Allotment Quantity [OAQ]) and raw cane sugar processors (45.65 percent of the OAQ) (USDA-ERS, 2009b). The initial FY2011 OAQ was 9,235,250 short tons, raw value (STRV), the allotment for beet sugar is 5,019,358 STRV (75 FR 60715). The OAQ was increased to 9.4 million on June 21, 2011. Allotments are further broken down for individual processors. The 2008 Farm Act allows reallocation of allotments under various circumstances but has no provision for reallocation of allotments between the beet and cane sugar sectors (USDA-ERS, 2009b).

Import TRQs are used to limit the amount of imported sugar entering the U.S. market. A minimum of 1.256 million STRV of sugar must be allowed to enter each year, per commitments made within the World Trade Organization (WTO), but the USDA may set a higher quota (Jurenas, 2007; USDA-ERS, 2009b). Within this quota, foreign sugar pays a low or no import tariff, depending on established trade agreements, and allocations are made by the U.S. Trade Representative to approximately 40 countries (USDA-ERS, 2009b). Above this quota, foreign sugar may be imported in any amount as long as a typically prohibitive over-quota tariff is paid, currently 16.3 cents per pound for refined sugar (USITC (United States International Trade Commission), 2010). Within the quota, smaller quotas exist for refined sugar – 24,251 STRV – and specialty sugar (including organic sugar)[13] – 86,825 STRV for FY2011 (Jurenas, 2007; USDA-ERS, 2009b; USDA-FAS, 2010e). In addition to the TRQs established by the WTO, the United States has separate TRQs in place; for various countries under the Dominican Republic-Central American Free Trade Agreement (DR-CAFTA); and for Peru, Columbia, and Panama under separate trade agreements. Imports from these countries count toward the WTO TRQ but continue to receive low or no tariffs until their respective TRQs have been reached, even if the WTO TRQ has been exceeded (Jurenas, 2007; USDA-ERS, 2009b). Under the North American Free Trade Agreement (NAFTA), Mexico has unlimited access to the U.S. sugar market.

U.S. sugar policies also allow for imported raw sugar to replace sugar that has been exported as refined sugar or in sugar-containing products, not subject to the TRQ (Re-Export Programs and Feedstock Flexibility Program, a program to allow excess sugar production to be reallocated to ethanol production) (USDA-ERS, 2009b).

Total U.S. production of sugar has fluctuated between 7.2 million STRV and 9.1 million STRV since FY1997 due to various conditions, mostly

[13] Specialty sugar includes organic sugar, brown slab sugar, pearl sugar, vanilla sugar, rock candy, fondant, caster sugar, golden syrup, golden granulated sugar, cake decorations, and sugar cubes (USDA–FAS, 2008).

weather-related (Table 3–27). Imports have added another 1.5–3.4 million STRV to domestic sugar supplies during that same period, responding to whatever quantity was necessary to fill demand requirements (Table 3–27). Most imported sugar consists of raw sugar from sugar cane and originates in a diverse set of countries, with the largest volume coming from Mexico. About 80 percent of the refined sugar imported in 2009 originated in Mexico (USDA-FAS, 2010b). The main suppliers of the total raw and refined sugar imported in 2009 were (in United States Dollar (USD) value) Mexico (42.5 percent), Brazil (7.2 percent), Dominican Republic (6.3 percent), and the Philippines (6.2 percent) (Table 3–30). Seven sugar beet processors and eight sugar cane processors received sugar allotments in FY2010 and FY2011 (75 FR 60715).

b. Demand for Sugar Beet Roots

Because the primary use of sugar beet is for production of sugar from its root, the demand for sugar beet is derived from the demand for sugar. In any FY, the demand for sugar from sugar beet will typically correspond to 54.35 percent of the OAQ established for domestic sales by the U.S. sugar policy. As shown in the previous section, exports are typically not an important component of U.S. sugar demand. Exports are even less important for U.S. sugar beet: in 2009, beet sugar exports totaled approximately USD 19 thousand (USDA-FAS, 2010b).

Sugar beet production, more than most field crops, requires close coordination between the grower and the processor. The crop is of little value without a processor to extract the sugar, and a sugar processing facility cannot stay in business without a reliable supply of sugar beet (Kaffka and Hills, 1994). Because sugar beet is 75 percent water (Michigan Sugar Company, 2010b) and highly perishable (USDA-ERS, 2009b), sugar beet is typically grown within 60 miles of a processing facility. However, sugar beet can be grown up to 100 miles away (Western Sugar Cooperative, 2006). Therefore, for any given producer, the demand for sugar beet typically originates from one nearby processor.

As of 2010, there are 22 processing plants for sugar beet, belonging to 7 processors,[14] and located in 5 regions: the Great Lakes, Red River Valley (Midwest), Great Plains, Northwest, and Imperial Valley (California). As of 2000, about 93 percent of sugar beet farms in the Red River Valley (located in Minnesota and North Dakota) and the Northwest were part of grower-owned cooperatives.

[14] Two additional processors are sometimes counted separately: Sidney Sugars Inc., operated by American Crystal Sugar Company; and Spreckels Sugar Company, a subsidiary of Southern Minnesota Beet Sugar Cooperative.

Table III-30. U.S. Raw and Refined Sugar Imports, 1997-2009 (USD 1,000)

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Raw Sugar[1]	956,417	715,264	556,663	461,485	480,420	494,605	534,052	516,316	705,675	862,187	675,720	614,677	776,202
Refined Sugar[2]	38,042	40,645	51,873	41,116	33,599	63,496	40,201	51,801	158,492	487,164	150,270	483,217	416,468
Total	**994,459**	**755,909**	**608,536**	**502,601**	**514,019**	**558,101**	**574,253**	**568,117**	**864,167**	**1,349,351**	**825,990**	**1,097,894**	**1,192,670**
Mexico	1.5%	3.1%	5.8%	4.8%	10.1%	14.2%	2.2%	3.6%	14.8%	28.4%	12.4%	37.2%	42.5%
Brazil	11.9%	12.7%	11.9%	11.6%	14.7%	9.1%	11.3%	10.8%	15.7%	9.4%	13.2%	8.7%	7.2%
Dominican Republic	19.0%	15.0%	10.8%	15.5%	12.7%	12.5%	13.5%	13.0%	9.0%	8.3%	12.3%	6.1%	6.3%
Philippines	10.2%	10.9%	10.7%	7.0%	7.2%	5.6%	10.5%	9.6%	6.6%	6.8%	8.6%	5.8%	6.2%

Source: U.S. Census. Database can be accessed at http://www.fas.usda.gov/gats/default.aspx
[1] U.S. Imports in Harmonized System codes 170111 and 170112.
[2] U.S. Imports in Harmonized System codes 170191 and 170199.

Sugar beet farms in the Great Lakes and Great Plains regions typically were not organized in cooperatives as of 2000 (Ali, 2004). However, those regions have since transitioned to the use of cooperatives, and all sugar beet processors in the United States are now structured as cooperatives, except Wyoming Sugar Growers, which has all the attributes of a cooperative but is set up as an LLC, and Spreckles Sugar Company, whose growers have no ownership interest in the Brawley factory. The cooperatives own the processing facilities, and the sugar beet farmers are members of the cooperatives. The members own shares of stock that require them to grow a specified acreage of sugar beet in proportion to their stock ownership in the cooperative and guarantee processing for their sugar beet. Cooperatives are owned by growers who are principally family farmers.

The Michigan Sugar Company has over 1,000 members and has become the third-largest sugar beet processor in the United States, processing all the sugar beet in the Great Lakes region, as well as sugar beet from Ontario, Canada. The cooperative has over 1,000 grower-shareholders who grow sugar beet on 150,000 acres each year. The sugar beet are processed into sugar at four factories in Bay City, Sebewaing, Caro, and Croswell. The cooperative employs 450 year-round and 1,200 seasonal employees, generates nearly USD 400 million in direct economic activity annually in the local communities in which it operates, and annually produces nearly one billion pounds of sugar(Michigan Sugar Company, 2010a).

Three cooperatives operate in the Upper Midwest: American Crystal Sugar, Minn-Dak Farmer’s Cooperative, and Southern Minnesota Beet Sugar Cooperative. American Crystal Sugar Company, the largest beet sugar producer in the United States, is owned by approximately 3,000 shareholders who raise 500,000 acres of sugar beet in the Red River Valley of Minnesota and North Dakota. The company operates five sugar processing facilities in the Red River Valley: three in Minnesota (Crookston, East Grand Forks, and Moorhead) and two in North Dakota (Drayton and Hillsboro). American Crystal also operates a sugar beet processing facility in eastern Montana at Sidney, under the name Sidney Sugars Incorporated. American Crystal’s FY2009 Red River Valley crop averaged 25.4 tons per acre with 17.6 percent sugar content. In 2009, the company produced approximately 1.7 million tons of sugar (American Crystal Sugar Company, 2009). Minn-Dak Farmers Cooperative, with 450 shareholders, operates a processing facility in Wahpeton, in the far southeastern corner of North Dakota. Minn-Dak also operates a yeast factory that uses the molasses from sugar beet processing (Minn-Dak Farmers Cooperative, 2010). The Southern Minnesota Beet Sugar Cooperative has approximately 600 shareholders who farm 120,000 acres and operates a processing facility near Renville, Minnesota (Cooperative, 2011)

The Western Sugar Cooperative, with 135,000 acres and 5 factories, processes most of the Great Plains sugar beet. Processing facilities are in Fort Morgan, Colorado; Billings, Montana; Scottsbluff, Nebraska; and Lovell and Torrington, Wyoming. Wyoming Sugar Growers, LLC is structured like a cooperative. It is owned mostly by local producers and landlords and works through the Washakie Farmers Cooperative to acquire sugar beet for its plant in Worland, Wyoming (Boland, 2003).

The Amalgamated Sugar Company LLC processes all of the sugar beet produced in Idaho, Oregon, and Washington. Amalgamated is owned by Snake River Sugar Company, a grower-owned cooperative, and is headquartered in Boise, Idaho with processing plants in Paul, Twin Falls, and Nampa, Idaho (Snake River Sugar Company, 2009).

Spreckels Sugar Company, a subsidiary of Southern Minnesota Beet Sugar Cooperative, operates a sugar beet processing facility in Brawley, California, in the Imperial Valley. Yields in the Imperial Valley are higher than anywhere else in the United States, averaging approximately 40 tons per acre (Spreckels Sugar, 2009).

Although existing facilities have been upgraded, no new currently operating processing facilities have been built in the United States since 1975. An estimated cost for an average-sized new facility in 1991 was USD 100 million (Cattanach et al., 1991). Accounting for inflation, a USD 100 million plant in 1991 would cost approximately USD 160 million in 2010.[15] There is actually a recent history of closures. Since 1996, 13 sugar beet processing plants have shut down. There have also been sugar cane mill and refinery closures (Table 3–31). The closures were part of a consolidation process in the industry, with gains in efficiency: production of sugar did not decline thanks to increased production by the remaining facilities. Sugar production from sugar beet also yields pulp and molasses as co-products. Sugar beet pulp is dried sugar beet fiber residue left over from sugar extraction. Sugar beet pulp is used in plain dried, molasses dried (containing 25 percent molasses), and pelleted forms (SMBSC (Southern Minnesota Beet Sugar Cooperative), Undated). Drying sugar beet pulp can require significant fossil fuel inputs. To reduce fuel consumption, the pulp can be pressed and ensiled (stored in a silo) rather than dried (Sporndly, 2008).

[15] Cost adjusted to 2010 dollars using the Bureau of Labor Statistics Consumer Price Index.

Table III-31. Sugar Mill and Refinery Closures Since 1996

Beet Mill Closures	Cane Mill Closures		Cane Refinery Closures
Spreckels Sugar **Manteca, California—1996**	Ka'u Agribusiness Hawaii, 1996	Caldwell Sugar Cooperative Louisiana, 2001	Aiea, C & H Hawaii, 1996
Holly Sugar **Hamilton City, California—1996**	Waialua Sugar Hawaii, 1996	Glenwood Sugar Cooperative Louisiana, 2003	Everglades, Imperial Florida, 1999
Western Sugar **Mitchell, Nebraska—1996**	McBryde Sugar Hawaii, 1996	New Iberia Sugar Cooperative Louisiana, 2005	Sugarland, Imperial Texas, 2003
Great Lakes Sugar **Fremont, Ohio—1996**	Breaux Bridge Sugar Louisiana, 1998	Jeanerette Sugar Company Louisiana, 2005	Brooklyn, Domino New York, 2004
Holly Sugar, **Hereford, Texas—1998**	Pioneer Mill Company Hawaii, 1999	U.S. Sugar, Bryant Florida, 2005	
Holly Sugar **Tracy, California—2000**	Talisman Sugar Company Florida, 1999	Cinclare Central Facility Louisiana, 2005	
Holly Sugar **Woodland, California—2000**	Amfac Sugar, Kekaha Hawaii, 2000	Atlantic Sugar, Belle Glade Florida, 2005	
Western Sugar **Bayard, Nebraska—2002**	Amfac Sugar, Lihue Hawaii, 2000	South Louisiana Sugar Cooperative Louisiana, 2007	
Pacific Northwest **Moses Lake, Washington—2003**	Hawaiian Commercial & Sugar, Paia Hawaii, 2000	Gay & Robinson, Kaumakani, Hawaii, 2009	
Western Sugar **Greeley, Colorado—2003**	Evan Hall Sugar Cooperative Louisiana, 2001		
Amalgamated Sugar **Nyssa, Oregon—2005**			
Michigan Sugar **Carrollton, Michigan—2005**			
Spreckels Sugar **Mendota, California—2008**			

Source: ASA, 2011.

Sugar beet pulp is used as a feed primarily for dairy cows but also for cattle and sheep intended for meat production (Southern Minnesota Sugar Cooperative, undated). Sugar beet pulp has comparable feeding value to and acts as substitute for corn silage (Park et al., 2001). A dairy cow's diet can include up to 25 kg of sugar beet pulp per day, while beef cattle can consume 35 kg per head per day. Sheep and pigs can consume about 3 kg per head per day (KW Alternative Feeds, 2008). Data on domestic consumption of sugar beet pulp are not available.

The United States is an exporter of sugar beet pulp and exported approximately 500,000 tons of sugar beet pulp each year from 2006 to 2009. The level of sugar beet pulp exports was higher in the first half of the decade, peaking at about 700,000 tons in 2001. More than half of U.S. sugar beet pulp exports go to Japan, and considerable amounts also are exported to Morocco and Spain (USDA-ERS, 2010b).

Sugar beet molasses contains about 50 percent sugar and is used for yeast, chemical, and pharmaceutical production. Sugar beet molasses is also used in mixed cattle feeds. (SMBSC (Southern Minnesota Beet Sugar Cooperative), Undated). Sugar beet currently are not used for ethanol production in the United States, but they could be used for that purpose in the future, especially if the introduction of GE plants increases sugar beet yields (McKee and Boland, 2007). Sugar beet molasses could also be used to produce high fructose corn syrup (Atiyeh and Duvnjak, 2002). Data on consumption of sugar beet molasses are not available.

c. Production of Sugar Beet Roots

Annual production of sugar beet has oscillated around 30 million tons since 1997, with no clear tendency of growth or decrease. The number of harvested acres has fallen since 2007. However, since 2006, production has benefited from higher yields,[16] averaging over 26 tons per acre between 2006 and 2010, compared to 22 tons per acre for the preceding 5-year period (Table 3–32). In 2011, production was down to 23.7 tons per acre. This decline has been attributed to heavy spring rains that delayed planting and exacerbated weed pressure (Imperial Sugar Company, 2011).

Over half of the U.S. production of sugar beet occurs in the Midwest, with almost 40 percent in Minnesota alone. The remainder is mostly distributed among the Northwest, the Great Plains, and the Great Lakes with a small share of production in California (3.1 percent), although California obtains the highest average yield due to a much longer growing season (Table 3–33). Imports of sugar beet are typically negligible, not

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[16] According to Haley and Dohlman S. Haley and E. Dohlman, "Sugar and Sweeteners Outlook," (United States Department of Agriculture, Economic Research Service, 2009), vol. SSS-256. the rise in yields was due mainly to the use of *Rhizomania*-resistant seed varieties and the use of Poncho Beta to control for Curly Top.

counting sugar beet produced in Canada and processed in Michigan, and there were no imports in 2009 (USDA-FAS, 2010a).

Table III-32. Sugar Beet Crop Production,1997-2011

Year	Acreage (1,000)		Yield per Harvested Acre (tons)	Production (1,000 tons)	Price per Ton (USD)	Value of Production (USD 1,000)
	Planted	Harvested				
1997	1,459	1,428	20.9	29,886	38.80	1,160,029
1998	1,498	1,451	22.4	32,499	36.40	1,181,494
1999	1,561	1,527	21.9	33,420	37.20	1,242,895
2000	1,564	1,373	23.7	32,541	34.20	1,113,030
2001	1,365	1,241	20.7	25,708	39.80	1,023,054
2002	1,427	1,361	20.4	27,707	39.60	1,097,329
2003	1,365	1,348	22.8	30,710	41.40	1,270,026
2004	1,346	1,307	23.0	30,021	36.90	1,109,272
2005	1,300	1,243	22.1	27,433	43.50	1,193,151
2006	1,366	1,304	26.1	34,064	44.20	1,506,985
2007	1,269	1,247	25.5	31,834	42.00	1,337,173
2008	1,091	1,005	26.8	26,881	48.10	1,292,976
2009	1,186	1,149	25.9	29,783	50.40	1,499,676
2010	1,171	1,156	27.6	32,034	61.70	1,968,292
2011	1,233	1,213	23,7	28,789		

Source: (USDA-NASS, 2011b); ERS/USDA data, Table 17
http://ers.usda.gov/Briefing/Sugar/data.htm (yearbook)

After a demonstration planting in Idaho in 2006, commercial production of H7-1 sugar beet varieties started in 2007 (ASSBT (American Society of Sugar Beets Technologists), 2007) and grew quickly in subsequent years. Colacicco (2010b) reports that 95 percent of the 2009 crop was of H7-1 sugar beet varieties and estimates a similar share in 2010 (most of the production outside California). In 2011, the sugar beet industry estimated that 92% of the crop was planted to H7-1 sugar beet (Schwartz, 2012). The decline could be due to the uncertainty of the regulatory status of H7-1 sugar beet resulting from the litigation described in section I.D.3. or the additional regulatory requirements from the interim measures discouraged some growers.

Table III-33. Sugar Beet Production by Region

Region	State	Harvested Acreage (1,000 acres)	Yield (tons/ acre)	Productio n (1,000 tons)	Share of Total (%)	
					Harvested Acres	Production
Imperial Valley	California	25.0	40.0	1,000	2.2	3.1
Northwest	Idaho	170.0	30.3	5,151	14.7	16.1
	Oregon	10.3	35.1	362	0.9	1.1
Midwest	Minnesota	442.0	27.0	11,934	38.3	37.4
	North Dakota[1]	211.0	26.5	5,592	18.3	17.5
Great Lakes	Michigan	147.0	26.5	3,896	12.7	12.2
Great Plains	Montana	42.6	29.5	1,257	3.7	3.9
	Nebraska	47.5	22.6	1,074	4.1	3.4
	Colorado	27.8	29.5	820	2.4	2.6
	Wyoming	30.3	28.0	848	2.6	2.7
United States		1,153.5	27.7	31,934	100.0	100.0

Source(USDA-NASS, 2010c), forecasted.
[1] Western counties of North Dakota belong to the Great Plains region but are included in the Midwest region here for lack of county level data.

As in the case of sugar beet processing plants, sugar beet farms have also decreased in number in the last two decades. Table 3–34 shows how the number of farms growing sugar beet decreased between 1992 and 2007 from 8,810 to 4,022. Production was maintained by increases in the average acreage planted in the remaining farms and to some increase in yields (Table 3–32).

Table III-34. Number of Farms Growing Sugar Beet, 1992-2007

	1992	1997	2002	2007
Great Lakes	1,745	1,198	1,010	737
Midwest	2,350	2,437	2,063	1,800
Great Plains	2,076	1,678	960	747
Northwest	1,554	1,099	766	583
Imperial Valley	723	456	228	155
Other[1]	362	0	0	0
Total	**8,810**	**6,868**	**5,027**	**4,022**

Source: (USDA-NASS, 1999; USDA-NASS, 2004; USDA-NASS, 2009c)
[1] Texas, except for 5 farms whose location the 1992 census does not identify.

d. Production Costs and Returns for Sugar Beet Roots

The average total economic costs (which include operating costs, ownership costs, opportunity costs, and overhead) of sugar beet production in 2000, as reported to the 2000 Agricultural Resources Management Survey (ARMS), was USD 835.58 per planted acre. These costs varied considerably by region; as shown in Table 3–35 the highest total economic cost was in the Northwest (Washington and Oregon) where sugar beet production cost was USD 1,166.44 per acre, while the lowest total economic cost was in the Red River Valley (Midwest: Minnesota and Eastern North Dakota) where production cost was USD 670.14. Operating costs, which include all inputs that are consumed in one production period (e.g., seed, fertilizer, chemicals, hired labor), accounted for 45–51 percent of the total economic costs in all four production regions as shown in Table 3–35. Chemicals, including herbicides and insecticides, accounted for a significant share of costs in all regions, ranging from 15 to 32 percent of operating costs by region, as shown in Table 3–36.

Table III-35. Sugar Beet Production Operating Costs By Region, 2000 (USD/acre)

	Great Lakes	Midwest[2]	Great Plains	North-west	All ARMS[3]
Seed	38.93	44.89	48.13	41.44	44.21
Fertilizer	66.5	28.74	53.73	71.87	46.86
Chemicals	74.17	109.03	77.68	88.64	94.28
Hired Labor	29.1	51.76	52.4	95.36	58.7
Custom Operations	28.52	23.49	35.86	50.46	36.04
Fuel, Lube and Electricity	50.19	24.86	54.26	109.89	50.9
Other Operating Costs[1]	81.24	57.54	84.52	126.04	80.47
Total Operating Costs	**368.65**	**340.31**	**406.58**	**583.7**	**411.46**
Total Economic Cost	**799.16**	**670.14**	**889.38**	**1166.44**	**835.58**

Source: (Ali, 2004).
[1] Other operating costs include: repairs, purchased irrigation water, freight, and dirt hauling, hauling allowance, interest on operating capital, and other miscellaneous costs.
[2] Appears in source as "Red River."
[3] Data exclude Imperial Valley region (California) due to insufficient data for disclosure.

Table III-36. Sugar Beet Production Costs as a Share of Total Operating Costs, 2000

	Great Lakes (%)	Midwest[2] (%)	Great Plains (%)	Northwest (%)	All ARMS[3] (%)
Seed	10.6	13.2	11.8	7.1	10.7
Fertilizer	18.0	8.4	13.2	12.3	11.4
Chemicals	20.1	32.0	19.1	15.2	22.9
Hired Labor	7.9	15.2	12.9	16.3	14.3
Custom Operations	7.7	6.9	8.8	8.6	8.8
Fuel, Lube and Electricity	13.6	7.3	13.3	18.8	12.4
Other Operating Costs[1]	**22.0**	**16.9**	**20.8**	**21.6**	**19.6**
Total Operating Costs	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Source: (Ali, 2004).
[1] Other operating costs include: repairs, purchased irrigation water, freight, and dirt hauling, hauling allowance, interest on operating capital, and other miscellaneous costs.
[2] Appears in sources as "Red River."
[3] Data excludes Imperial Valley region (California) due to insufficient data for disclosure.

Chemical costs varied substantially by region and were actually highest in the Red River Valley (Midwest), where total costs were the lowest. Hired labor, fertilizer, and fuel, lubricant and electricity costs also varied significantly and were highest in the Northwest. Seed costs were relatively consistent across regions (Ali, 2004).

Other studies have found differing production costs for sugar beet. A study conducted by the University of California Cooperative Extension (at UC Davis) found the total economic costs of sugar beet production in Imperial County, California in 2004 to be USD 1,428.79 USD per acre. For comparison with the ARMS data, this total economic cost is equivalent to USD 1,302 in 2000.[17]

The UC Davis study assumes that all mechanical operations are hired out (i.e., as custom operations) (Meister, 2004b), while the ARMS study shows less reliance on custom operations and accounts for capital costs of machine ownership (Ali, 2004). Because of this difference, operating costs as a share of total economic costs were 78 percent according to the UC Davis study but only 49 percent according to the ARMS study. Discounting custom operations, the relative share of operating costs accounted for by seed, fertilizer, and labor are approximately consistent

[17] Price adjusted to 2000 dollars using the Bureau of Labor Statistics Consumer Price Index.

between the studies. The UC Davis study shows a chemical cost of USD 185 per acre (equivalent to USD 169 in 2000), 36 percent of operating costs discounting custom operations, and significantly higher than the chemical costs reported in the ARMS study. Herbicide alone cost USD 75 per acre (equivalent to USD 68 in 2000) in the UC Davis study (Meister, 2004b).

Another study conducted by WSU found the total economic cost of sugar beet production in the Columbia Basin, Washington, in 1996 to be between USD 925.19 and USD 1,015.05 per acre (equivalent to between USD 1,015 and USD 1,114 in 2000). This total economic cost depends on the method of irrigation (Hinman and Kulp, 1996). These totals are slightly lower than those found in the ARMS survey for the Northwest. The WSU report includes expenditures of USD 143.75 per acre (equivalent to USD 158 in 2000) for custom operations (Hinman and Kulp, 1996), higher than the amount reported in the ARMS study but lower than that reported in the UC Davis study. Unlike the UC Davis study, the WSU report does include capital costs for machinery and does not assume that all mechanized operations were hired out. The seed, fertilizer, and labor costs reported in the WSU study are approximately consistent with the costs reported in the other studies. The reported chemical costs of USD 138.20 per acre (equivalent to USD 152 in 2000) (Hinman and Kulp, 1996) are comparable to those reported in the UC Davis study and are substantially higher than those reported in ARMS study.

The above studies all deal with the production of conventional sugar beet. The production costs for sugar beet from H7-1 sugar beet seed might differ from the costs estimated in those studies. An annual survey of sugar beet weed control and production practices has been conducted for over 40 years in North Dakota and Minnesota (for a detailed review, see section III.B.1.d). This survey indicates that the adoption of H7-1 sugar beet has been accompanied by a reduction in hand weeding and row crop cultivation, reducing labor costs and sugar beet injury (Stachler et al., 2009b; Stachler et al., 2011). Similar results were found for Montana and western North Dakota in the Great Plains region (Stachler et al., 2009a). As discussed in section III.B.1.d, there is also some evidence that the use of H7-1 sugar beet seeds has encouraged the use of strip tillage, as opposed to conventional tillage in the Great Plains region (Wilson Jr, 2012). Use of strip tillage might reduce fuel inputs to tillage operations, fertilizer applications, labor costs (Overstreet et al., 2007) and water costs (Norberg, 2010; Washington State University, 2010; Strauch, 2011).

Table III-37. Hand weeding cost difference from adoption of H7-1 sugar beet[1]

	% H7-1	$/acre	acres	total $
2001	0	11.15	723,000	8,061,450
2002	0	15.95	723,000	11,531,850
2003	0	13.75	729,000	10,023,750
2004	0	12.61	721,672	9,100,284
2005	0	10.78	725,611	7,822,087
2006	0	14.37	744,330	10,696,022
2007	0	15.5	723,659	11,216,715
AVG$_{2001\text{-}2007}$		**13.44**		**9,778,880**
2008	49	11.32	637,564	7,217,224
2009	88	4.78	676,345	3,232,929
2010	93	0.63	652,552	411,108
2011	90	2.23	693,740	1,547,040
AVG$_{2009\text{-}2011}$		**2.55**		**1,730,359**
Cost Difference		**10.89**		**8,048,521**

Source: (Stachler et al., 2012a).
http://www.sbreb.org/research/weed/weed02/2surveyofweed.pdf

Adoption of H7-1 sugar beet has resulted in a significant reduction in labor costs for handweeding. An estimate of the amount growers spent on handweeding in Eastern North Dakota and Minnesota is shown in Table 3-37. In the seven years prior to the introduction of H7-1 sugar beet, growers spent on average $13.44/acre and $9.8 million regionally for handweeding. In 2009-2011, growers planted approximately 90% H7-1 sugar beet while spending on average $2.55/acre and $1.73 million for handweeding. Therefore, on handweeding alone in the Midwest, growers save on average $10.89/acre and $8 million regionally.

Herbicide costs have decreased with the adoption of H7-1 sugar beet and the switch to glyphosate from other herbicides. Table 3–38 shows the price of glyphosate relative to that of the commonly used herbicides in conventional sugar beet production in Minnesota in 2008, as well as average use rates and resulting dollars per application per acre. The average cost per application per acre of glyphosate is comparable to that of each of the other herbicides shown in the table. However, H7-1 sugar beet farmers often use only glyphosate per application, while conventional sugar beet farmers often apply several herbicides in combination during a single application (Stachler et al., 2008). As shown in Table 3–39, costs of herbicides on H7-1 sugar beet range from about $7–$22/acre whereas cost of herbicides on conventional sugar beet range from $45–$55/ acre. The table illustrates that the use of glyphosate on H7-1 sugar beet can reduce herbicide costs under common herbicide practices in some regions.

e. Production costs from glyphosate-resistant weeds

Currently, glyphosate-resistant weeds are not a problem in sugar beet fields though they are beginning to be detected in sugar beet fields in the Mid-West (Stachler and Christoffers, 2012). As glyphosate-resistant weeds become more prevalent, the cost of weed control is expected to increase. This topic is discussed more fully in Section V.G.

Table III-38. Costs per Application per Acre of Herbicides Commonly Used in Conventional and H7-1 Sugar Beet Production

	Glyphosate	Progress	Betamix®	Betanex®	Stinger®	Upbeet®	Select®
Average Herbicide Price (USD/lb)[1]	4.85–9.95	54.30	66.60	66.60	152.20	1509.65	123.40
Average lb/applic./acre, When Used – Conventional[2]	0.39	0.06[3]	0.05	0.07	0.03	0.008	0.04
Average Herbicide Cost USD/applic./acre), When Used – Conventional	1.89–3.88	3.26	3.33	4.66	4.57	12.08	4.94
Average lb/applic./acre, When Used – H7-1[2]	0.75–1.12[3]	0.06[4]	0.05	0.07	0.03	0.008	0.04
Average Herbicide Cost (USD/applic./acre), When Used – H7-1	3.64–11.14	3.26	3.33	4.66	4.57	12.08	4.94

[1] University of Minnesota, 2009. Price of glyphosate varies by brand.
[2] (USDA-NASS, 2008) (except for glyphosate applied to H7-1).
[3] (Stachler et al., 2008).
[4] The application rate for Progress was assumed to be similar to those of Betamix® and Betanex.®

Table III-39. Costs per Acre of Herbicide Mixtures Commonly Used in Conventional and H7-1 Sugar Beet Production

	Common Herbicide Mixtures Used On Conventional Sugar Beet, 2008[1]			Common Herbicides Used On H7-1 Sugar Beet, 2008[1]		
	Progress + Stinger® + Upbeet® + Select®	Betamix® + Stinger® + Upbeet® + Select®	Betanex® + Stinger® + Upbeet® + Select®	Glyphosate 0.75 lb/applic./acre	Glyphosate 1.0 lb/applic./acre	Glyphosate 1.12 lb/applic./acre
Average Number of Applications[1]	1.90	2.20	1.70	2.00	2.20	1.60
Average Herbicide Cost (USD/application/acre)[2]	24.84	24.91	26.24	3.64–7.46	4.85–9.95	5.43–11.14
Average Herbicide Cost (USD/acre)	47.19	54.80	44.61	7.28–14.93	10.67–21.89	8.69–17.83

[1] (Stachler et al., 2008).
[2] Sum of the cost per application per acre (see Table 3–38) for each included herbicide. Costs for conventional sugar beet herbicides exclude the cost of oil adjuvants.

A recent study comparing costs and returns for H7-1 sugar beet production and conventional sugar beet production in Wyoming produced comparable results, concluding that the average cost of herbicide in H7-1 production was lower than in conventional production: USD 20 per acre in H7-1 sugar beet production (ranging from USD 16 per acre to USD 28 per acre) compared to USD 62 per acre in conventional sugar beet production (ranging from (USD 23 per acre to USD 159 per acre) (Kniss, 2010b). However, actual costs may vary considerably from region to region and from farmer to farmer. Because in the ARMS study, the Great Plains region had the highest absolute and relative chemical costs, it is possible that other regions have not seen the same benefits in herbicide cost reduction.

Although production cost savings might be associated with H7-1 sugar beet varieties, farmers adopting H7-1 sugar beet seed must pay the technology fee charged for the H7-1 sugar beet seed. This technology fee is currently USD 106 per 100,000 seeds. At approximately 123,500 seeds per ha, this amounts to USD 131 per ha (Kniss, 2010b).

In addition to potential production cost effects, the H7-1 trait could also affect the yields and sugar content of sugar beet and impact net returns to farmers. Kniss (2010b)compared 22 sugar beet fields (11 H7-1 and 11 conventional) in Wyoming in 2007. These were commercial fields and were paired so that the fields would resemble each other as much as possible, with the only difference being the choice of conventional or H7-1 seed. The study reports that yields of H7-1 sugar beet were 15 percent higher than those of conventional varieties, while the sugar content was similar. When cost savings related to labor and herbicides were added, the net economic benefit to farmers of H7-1 sugar beet adoption was USD 576 per ha (USD 233 per acre) after considering the technology fee. Sexton (2010a) conducted a survey in early 2010 with 123 sugar beet growers from nine States, gathered at the American Sugarbeet Growers Association meeting. Growers were asked to report expected gross profits per acre for their sugar beet production when adopting conventional or H7-1 sugar beet seed. Average expected gross profits for growing H7-1 sugar beet were USD 276 per acre more than the average expected gross profits for conventional sugar beet seed. In a follow-up survey with processors, Sexton (2010b) estimated that the total reduction in grower profits from planting conventional as opposed to H7-1 sugar beet amounted to approximately USD 144 million. If this number is divided by the total sugar beet acreage in 2010 (almost 1.2 million acres), the decreased gross profit would be about USD 120 per acre. The differences in estimates might reflect, at least in part, regional differences. Because the USD 120 per acre is the result of a processor survey, weighted by the acreage planted in each region, and because it is lower than the previous estimates, grower profit per acre is likely lower in the largest production region (Midwest) than in other parts of the country.[18] Given the over 95 percent rate of adoption of H7-1 sugar beet by root growers, however, returns should be positive in all major regions of production.

2. Sugar Beet Seed Crop

a. Demand for Sugar Beet Seeds

Demand for sugar beet seed is derived from the demand for sugar beet root crop, which in turn is derived from the demand for sugar from sugar beet, which is an allotted share of the U.S. sugar market under U.S. sugar policies. Farmers may plant anywhere from 1 to 10 pounds of seed per acre depending on row width, distance between seeds and type of seed (http://www.beeteed.com/agronomy/growing1.php). An estimate for the domestic demand for sugar beet seed in weight could, therefore, be anywhere between 1 and 12 million pounds a year (see Table 3–32 for sugar beet acreage data). In 2010, U.S. farmers planted approximately 1.15 million acres of sugar beet (USDA-NASS, 2010c) suggesting that sugar beet farmers consumed between 1.15 million and 11.5 million pounds of sugar beet seed in 2010 (575 tons to 5,750 tons). Demand for sugar beet seed from exports is also important and was above 700 tons (1.4 million pounds) a year during 2005–2009, having increased from the previous 5-year period mostly due to increased exports to Canada and Mexico (Table 3–40).

The production of sugar from sugar beet and the resulting demand for sugar beet seed, however, occurs in a multi-year cycle requiring several years of planning and involving sugar beet processors, sugar beet producers, and seed suppliers. Fig. 3–20 below illustrates this multi-year cycle starting in 2006, the first year of widespread planting of the H7-1 sugar beet for seed. Sugar beet seed suppliers plant the commercial sugar beet seed crop in the fall of Year 1, which produces the commercial seeds harvested in the fall of Year 2. The commercial seed is processed over the winter and sold to sugar beet growers who plant it in the spring. Sugar beet growers harvest the sugar beet root in the fall of Year 3 and deliver them to sugar beet processing facilities owned by the sugar beet processors. Beet sugar is extracted by sugar beet processors beginning in the fall of Year 3 and throughout Year 4. The sugar produced from this sugar beet is purchased by food manufacturers and consumers (Colacicco, 2010b). Therefore, there is almost a 2-year lag between the planting of seed for commercial hybrid seed production by seed suppliers to the purchase and planting of seed by sugar beet producers. There is at least

[18] Results for specific regions are not reported for business confidentiality reasons.

another 0.5 to 1 year before sugar produced from this sugar beet reaches the market.

Sugar beet processors have seed committees that develop the policies and procedures for the conduct of the official trials as well as the rules for determining which varieties achieve approval. The seed varieties that sugar beet growers may choose are limited to varieties on the company's approved variety list. While the number of approved varieties varies from year to year, the average sugar beet grower has the ability to choose from among 10–20 different approved varieties.

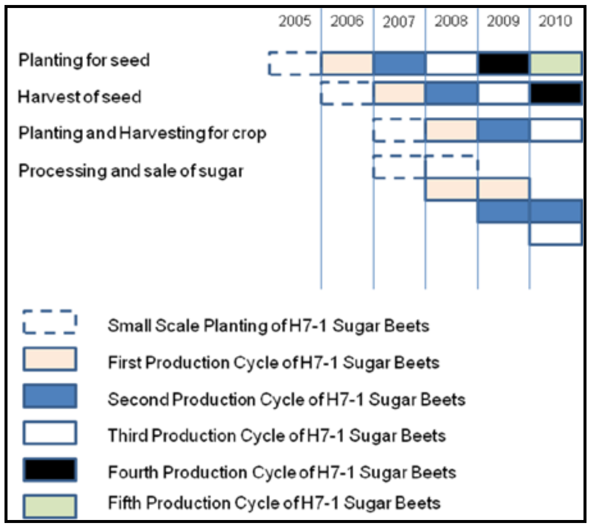

Figure 3-20. Production cycle of sugar from H7-1 sugar beet.

(Source: (Colacicco, 2010b))

Sugar beet farms require a diversity of hybrid varieties depending on their specific climates, pests, and disease risks. The varieties can be tailored to the specific customer (http://www.beeteed.com/agronomy/growing1.php). The approved varieties have undergone extensive multi-year planting trials to determine how well each variety tolerates exposure to particular diseases and pests known to infest the growing region, particular growing conditions such as exposure to particular weather conditions, and the variety's ability to deliver acceptable yields per ton and sugar content (Manning, 2010). Sugar beet varieties that do not make the approved variety lists cannot be delivered to the processor for sugar production because they do not meet the standards set forth by the processor (Manning, 2010).

The demand for sugar beet seed is satisfied by domestic production and imported seed. Table 3–41 shows sugar beet seed imports between 1997 and 2009. Although imports have fluctuated considerably, the domestic use of imported seed is usually challenged by the compatibility of existing varieties to local conditions and the potential presence of weed beet seeds.

Table III-40. Sugar Beet Seed Exports, 1997-2009 (tons)

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Total	480	529	567	422	630	735	683	544	1,003	706	798	718	797
Share of Total U.S. Sugar Beet Seed Exports (%)													
Canada	67.3	77.9	79.7	77.1	80.7	66.1	63.7	72.1	64.5	67.2	82.1	70.8	84.3
Mexico	2.0	1.4	1.8	0.9	0.3	3.6	0.0	1.3	4.0	2.7	3.4	15.3	4.8
Hong Kong	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	20.3	11.0	0.0	4.2	0.5
Netherlands	2.5	0.3	0.0	6.0	3.6	0.5	1.1	0.0	0.0	3.1	1.0	2.5	1.9
Malaysia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.7	2.5
Sweden	0.2	0.1	0.2	0.0	0.0	0.5	1.0	4.3	1.3	1.2	0.5	0.2	0.8
UK	0.0	0.5	0.9	1.6	0.4	0.0	0.3	0.9	0.0	0.0	0.0	0.0	1.3
Australia	0.0	0.0	0.1	1.7	0.5	0.7	0.6	0.7	0.2	0.5	0.0	0.0	1.2

Source: (USDA-FAS, 2010b), Harmonized System code 120911 (1997–2001) and 120910 (2002–2009).

Table III-41. Sugar Beet Seed Imports, 1997-2009 (tons)

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Total	1,190	1,126	3,952	8,417	14,097	3,265	2,290	2,862	3,429	12,422	9,057	121	31
Share of Total U.S. Sugar Beet Seed Imports (%)													
France	0.0	1.1	10.3	0.0	1.3	0.1	21.5	0.0	0.1	30.3	12.5	0.0	47.0
Italy	50.1	0.0	55.0	17.3	6.5	11.7	10.3	36.5	3.9	1.1	6.0	71.9	0.0
Belgium	3.7	2.2	34.4	79.2	86.4	87.9	36.3	0.0	22.3	67.5	78.5	26.7	9.3
Germany	0.4	60.7	0.1	1.7	5.5	0.1	0.1	0.1	48.3	0.0	0.0	0.9	10.0
Netherlands	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	3.9
Canada	0.0	0.0	0.0	0.0	0.0	0.0	0.9	0.0	0.0	0.0	0.0	0.0	29.2
Chile	0.0	0.0	0.0	0.0	0.0	0.0	23.0	63.3	16.5	0.0	2.4	0.0	0.0

Source: (USDA-FAS, 2010b), converted from Metric tons. Harmonized System code 120911 (1997–2001) and 120910 (2002–2009).

b. Production of Sugar Beet Seeds

Complete data on sugar beet seed production are not readily available. In 2011, nearly the entire H7-1 sugar beet seed crop was produced in Oregon and Eastern Washington with about half the crop produced in each State (APHIS proprietary data) (see section III.B.1.b (1)). Additional acreage might exist for conventional seed, but the information is not publicly available. Miller (2010) suggests sugar beet planted for seed production occupy less than 0.5 percent of the total sugar beet acreage. This would mean a maximum annual acreage of 5,500 to 7,200 acres since 1997 (see Table 3–32). Data from the Agricultural Census indicate that in 2007, harvested acreage of sugar beet seed totaled 3,199 down from 4,335 in 2002. This corresponded to a production of 7,000,504 pounds in 2007 and 9,542,593 pounds in 2002, with 93 farms producing sugar beet seed in 2007 and 130 in 2002 (USDA-NASS, 2009c).

Most U.S. sugar beet seed is produced, processed, and marketed by five private entities (Manning, 2010):

(1) Crystal Beet Seed, a division of American Crystal Sugar Company;

(2) Betaseed, Inc., a subsidiary KWS SAAT AG;

(3) Syngenta Seeds, Inc.;

(4) SES VanderHave Sugarbeet Seed; and

(5) Holly Hybrids, owned by Spreckels Sugar Inc., shares an alliance with SES VanderHave.

American Crystal Sugar, Syngenta, SES VanderHave, and Holly Hybrids are members of the West Coast Beet Seed (WCBS) cooperative. The American Crystal Sugar Company produces seed that is marketed to its grower owners in the Red River Valley. Betaseed, Syngenta, SES VanderHave and Holly Hybrids develop products to serve all U.S. beet seed markets. Betaseed, Syngenta, and SES VanderHave are owned by larger seed companies who together encompass most of the global beet seed business. When H7-1 sugar beet seed was deregulated in 2005, the industry began full production of H7-1 sugar beet (Manning, 2010). According to (Manning, 2010)seed producers have not engaged in conventional seed development since 2006–2007, and most seed production from those years onward has been of H7-1 sugar beet varieties. This may or may not still be the case: given the current regulatory uncertainty regarding the future availability of H7-1 sugar beet seed, it is possible that sugar beet seed companies are once again developing and producing conventional varieties. For business confidentiality reasons, this information is not currently available to APHIS.

3. Organic and Non-Genetically Engineered Sugar Beet and Sugar Markets

a. Organic and Non-Genetically Engineered Sugar and Sugar Beet Root Markets

The organic sector is rapidly growing both in the United States and the EU. Together, consumer purchases in these two regions made up 95 percent of estimated world retail sales of organic food products in 2003 (Dimitri and Oberholtzer, 2005). In 2009, world retail sales of organic products were estimated to be on the order of USD 54.9 billion, up from $50.9 billion in 2008 (Organic Monitor, 2006).

In reporting the results of their annual manufacturer survey, the (Organic Trade Association, 2011a) reports that U.S. organic food sales were estimated to be USD 26.7 billion in 2010. Sales in 2010 represented 7.7 percent growth over 2009 sales. Experiencing the highest growth in sales during 2010 were organic fruits and vegetables, up 11.8 percent over 2009 sales. Organic fruits and vegetables represented over 11 percent of all U.S. fruit and vegetable sales (Organic Trade Association, 2011a). Organic food and beverage sales represented approximately 4 percent of overall food and beverage sales in 2010 (Organic Trade Association, 2011a).

The demand for organic sugar in the United States was projected to be over 110,000 tons (approximately 100,000 MT) in 2008, having increased steadily since 2001 (Willerton, 2008). This would amount to roughly 1 percent of the domestic sugar market estimated at about 10 million tons (Table 3–28). The vast majority of the organic sugar sold in the United States is cane sugar imported under the specialty sugar quota,[19] the leading suppliers being Paraguay, Brazil, and Argentina (Willerton, 2008). The Organic Trade Association is predicting an organic sugar shortage for FY2011 based on very strong demand growth and an insufficient replenishment due to weather related issues in the key producing countries. USDA increased the FY2010 Specialty Sugar quota by 13 percent over the prior year but the organic industry is still predicting an organic sugar shortage (Association, 2011).

[19] In addition to organic sugar, the specialty sugar quota includes: brown slab sugar (also known as slab sugar candy), pearl sugar (also known as perl sugar, perle sugar, and nibs sugar), vanilla sugar, rock candy, demerara sugar, dragees for cooking and baking, fondant (a creamy blend of sugar and glucose), ti light sugar (99.2% sugar with the residual comprised of the artificial sweeteners. aspartame and acesulfame K), caster sugar, golden syrup, ferdiana granella grossa, golden granulated sugar, muscovado, molasses sugar, sugar decorations and sugar cubes (15 CFR 2011 subpart B).

Because refined sugar from sugar cane is 99.95 percent identical to refined sugar from sugar beet (The Sugar Association, Undated), any domestic demand for organic sugar can be met with sugar produced from organic sugar beet or from organic sugar cane. Organic cane sugar is primarily available though imports though at least one U.S. company, Florida Crystal[20]produces organic cane sugar grown and harvested in the U.S. Traditionally, the demand for sugar beet comes from 9 sugar beet processors operating 22 plants. Existing processors have not shown an interest in producing organic beet sugar and it is currently not considered to be economically viable (Organic Trade Association, 2011b). APHIS is aware of attempts to produce organic sugar beets in California and Minnesota (Beet Sugar Development Foundation et al., 2011). Both failed after 1-year due to difficulty with weed control. Another challenge for a fledgling organic sugar beet industry would be securing access to a processing plant. Dedicated processing plants have a very high upfront cost estimated at 160 million USD (see section III.D.1.b) and need enough throughput to make them economical. As 13 plants have shut down since 1996 (see section III.D.1.b), it might be possible to aquire and restart one of the closed plants for less. Alternatively, it might be possible for operational plants to be used prior to processing conventional sugar beet. However, shared plants might require substantial process alterations to be compatible with organic production. Lastly, organic beet sugar would need to compete with organic cane sugar which is already being produced in the U.S. and abroad. Because the growth of the organic market demand for sugar is outrunning the TRQ, the growth of organic demand may eventually provide economy of scale for viable domestic organic sugar production and refining. It is possible that the increased demand for organic sugar will make organic beet sugar production economically feasible in the future.

Less than 5 percent of the 2009 sugar beet crop was estimated to be of conventional sugar beet varieties (Colacicco, 2010b). Private certification standards and labeling for conventional beet sugar also exist through the Non-Genetically Modified Project Working Standard, although no such beet sugar seems to be currently available (Non-GMO Project, 2010). The conventional sugar beet root crop is typically not identity preserved after harvest. The demand for conventional sugar beet seed is derived mainly from the California plant, because varieties with the H7-1 trait have not yet been made available for this region. APHIS expects varieties of H7-1 to be available for California in the near future (2011). Some demand from export destinations such as Mexico may also be for conventional varieties.

[20] http://www.floridacrystals.com/Products.aspx?id=1 (accessed June 15, 2011).

In general, demand for GE foods or for foods free of GE content is difficult to estimate. and no estimate of consumer demand for GE-free food products appears to be available (Noussair et al., 2004). A summary of 25 valuation studies relating to GE food suggests some preference for non-GE foods in the United States, although possibly less than in Europe, based on various estimates of willingness to pay for GE-free foods (Lusk and Rozan, 2005).

A report by Hallman (2003) found that support for GE foods is slipping where 59% of Americans said they thought GE foods would make their lives better in 2001 but only 39% had a similar response in 2003 and 35% felt it would make their life worse. The same report found that 45% of respondents believe it is safe to consume GE foods while 18% say they don't know. The Hallman (2003) report found that 94% of respondents were in favor of labeling.

(Fernandez-Cornejo and Caswell, 2006) noted that while opinion surveys give some indication of whether or not consumers are concerned about foods containing GE ingredients, they give little indication of the level of concern. Some researchers have attempted to quantify this concern through studies in which consumers are asked how much they would be willing to pay for foods made with GE ingredients, and for foods without GE ingredients. Researchers then use these data to measure whether or not there is a difference between these two hypothetical prices.

According to (Fernandez-Cornejo and Caswell, 2006) "In most of these studies consumers indicated that they were willing to pay more on average for GE-free foods or to avoid foods containing GE ingredients. However, in many of the studies, at least some consumers did not require a discount to buy foods containing GE ingredients, while some expressed that they would not be willing to buy foods containing GE ingredients at all. Some respondents were willing to pay more for certain characteristics, such as improved nutrition and environmental benefits."

(Fernandez-Cornejo and Caswell, 2006) also reported that "while surveys and willingness-to-pay studies provide some insight into consumer opinion, they often do not reflect how consumers will behave in a real market situation when purchasing goods and services. In the United States, many products contain GE ingredients, and the demands for these products apparently have been unaffected by negative opinions about biotechnology expressed in surveys." However it could be argued that US consumers are not aware that the products they purchase contain GE ingredients because they are not labeled.

Kalaitzandonakes (2005) conducted a study in the Netherlands that found that even when products are labeled as containing GE ingredients, a majority of consumers did not shift away from the purchase of processed foods containing GE ingredients in the presence of alternatives in stark contrast to findings based on opinion surveys. His study used national level, syndicated point of purchase grocery store scanner data over a 5-year period from 1997–2002. Over that period, mandatory labeling of processed foods was instituted and he compared population purchase behavior before labeling, after labeling, and after GE foods were voluntarily removed from the marketplace in 2000. Over the time period of the analysis, Dutch consumers expressed a decreasing willingness to purchase GE food where 32% of Dutch consumers indicated they would buy GE food in 1996, 30% were willing in 1999, and 15% were willing in 2001 ((Kalaitzandonakes et al., 2005) and references therein). Despite the trend in the stated preferences of the population to avoid GE foods, consumers continued to purchase these foods at the same rate before labeling was instituted or after GE ingredients were no longer used. In other words, at a time when consumers overwhelmingly said they would not purchase GE foods, consumers continued to purchase labeled GE products to the same degree as before they were labeled and when people expressed more of a willingness to purchase them. This data further supports the idea that the link between the elicited attitudes expressed in surveys and product demand is weak.

Some suggest that the demand for food free of GE content can be found in the growth of the organic market. A unique attribute of organic foods, and one possible reason consumer demand for organic foods is increasing, is the intended absence of GE ingredients in the process of producing them (Larue et al., 2004; Dhar and Foltz, 2005; Anderson et al., 2006). Because the organic standard is process and not product based, organic food may contain LLP. Manufacturers have been active in creating a market for GE-free foods. From 2000 to 2004, manufacturers introduced over 3,500 products that had explicit non-GE labeling (Fernandez-Cornejo and Caswell).

Recently, an initiative, the Non-GMO Project, evolved out of consumer demand for products that lack GE ingredients. It was started by the North American organic and natural product industry to focus specifically on whether food contains GE content. It's goal is to create an industry-wide standard for "non-GMO" and to provide labeling, "Non-GMO Project Verified", for products that meet the non-GMO standard. Like the Organic standard, the non-GMO project is also a process based standard. However it differs in that its focus is on avoidance of ingredients from GMOs while the organic standard is much broader. While both standards include traceability and segregation practices, the non-GMO project also includes testing of ingredients at certain points in the process. Ingredients must test below a threshold of 0.9% to be used in a non-GMO project verified product. Thus, such products also may contain LLP. Several hundred products are now non—GMO project verified. Many of these products are not organic (http://www.nongmoproject.org accessed July 6, 2011) indicating the market for organic and non-GMO are not completely overlapping.

The organic standard is broader than the absence of GE content, involving the prohibition of many substances commonly used in conventional agriculture and specific processes and procedures. From a survey conducted by the organic industry ranking the most important reasons consumers buy organic products, the most important reasons were, in order of importance, to avoid pesticides, to avoid artificial hormones, to avoid antibiotics, to avoid GMOs, and to avoid artificial colors and flavors (Organic Trade Association, 2010) The maximum allowable prohibited pesticide residue for organic food is 5% of the tolerance standard set by EPA. (AMS, 2011). A threshold does not exist however for GE ingredients. As described in the preamble to the USDA organic regulation, the inadvertent presence of GE material in an organic crop does not constitute a violation of the organic rule as long as the organic operation has not used excluded methods and has taken reasonable steps to avoid contact with GMOs. The preamble to the National Organic Program Final Rule at 7 CFR Part 205 (USDA-AMS, 2000):

> "prohibits the use of excluded methods in organic operations. The presence of a detectable residue of a product of excluded methods alone does not necessarily constitute a violation of this regulation. As long as an organic operation has not used excluded methods and takes reasonable steps to avoid contact with the products of excluded methods as detailed in their approved organic system plan, the unintentional presence of the products of excluded methods should not affect the status of an organic product or operation."

The main export markets for U.S. sugar and sugar beet seed are Canada and Mexico. Both have approved H7-1 sugar beet for food and feed (USDA-FAS, 2010d; USDA-FAS, 2010a). Canada has approved H7-1 for planting. Mexico has not yet approved GE seed for commercial planting, and Mexico's legislation requires GE seed for planting to be labeled as such (USDA-FAS, 2010d). Japan is the main export destination for sugar beet pulp and has also approved the food and feed use of H7-1 sugar beet varieties (USDA-FAS, 2010c).

b. Organic and Non-Genetically Engineered Sugar Beet Seed Markets
Demand for organic sugar beet seed derives from the demand for an organic sugar beet root crop, as the NOP requires the use of organic seeds (7 CFR § 205.204).[21] APHIS is not aware of any current organic sugar

[21] An exception is made to the requirement of using organic seeds in cases where these are not available. In these cases, untreated conventional seeds or seeds treated with substances included in

beet root crop production in the U.S. Although there are no data on exports of organic sugar beet seed, demand for organic sugar beet seed from abroad is likely limited by an organic sugar market that is currently supplied by sugar from sugar cane. APHIS is not aware of any domestic organic sugar beet seed production in 2011. APHIS was informed that 200 pounds of organic sugar beet seed were produced as part of a pilot in 2009 by Seeds of Change (Reiten, 2010). In 2011, APHIS made several unsuccessful attempts to follow-up with the commenter as to the fate of this purported organic sugar beet seed pilot.

4. Vegetable Beet Markets

a. Vegetable Beet Root Markets

In the USDA database, “beet” include table beet, Swiss chard, and spinach beet (grown for the leaves). In this document, these nonsugar beet crops are referred to collectively as vegetable beet. The demand and supply of vegetable beet are described in this section to aid the analysis of socioeconomic impacts from potential cross-fertilization of sugar beet with vegetable beet.

Table 3–42 shows trade in vegetable beet and other edible roots since 1997. Data for U.S. consumption of vegetable beet are not readily available. Production estimates based on acreage and yields suggest a decline of U.S. vegetable beet production (Table 3–43, Table 3-44). Because trade in vegetable beet is relatively small, consumption has likely declined as well. Although imports have increased, more detailed data for imports (not available for exports) suggest much of this increase has been in imports of radishes and total trade volumes remain small relative to estimated domestic production declines.

Demand for U.S. vegetable beet from foreign countries is small and more than 85 percent of U.S. exports of beet, radish, and other edible vegetable roots are destined to Canada (USDA-FAS, 2010b).

Data on U.S. vegetable beet production are also not readily available. However, until 2001, USDA–NASS estimated production of vegetable beet for processing. Table 3–43 shows these data for the period 1997–2001. Production fluctuated somewhat with a tendency toward reduction. More recent data for production of vegetable beet for processing in the

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the National List of synthetic substances allowed for use in organic crop production are typically allowed. The exception is not permanent and may change.

State of New York[22] suggest this tendency toward reduction in processing might have continued after 2001 (USDA-NASS, Various Years).

An estimate of total vegetable beet production is shown in Table 3-44 and data from the Agricultural Census on vegetable acreage in 1997, 2002 and 2007 is shown in Table 3-45. Fresh vegetable beet production was calculated from the average rate of production for fresh vegetable beet (7 tons per acre (Schrader and Mayberry, 2003)) [23] and an estimate of the amount of acreage planted to fresh vegetable beet. For the estimate of fresh vegetable beet acreage planted in 1997, we used 38%, the average of acreage planted to fresh market vegetable beet in 2002 (39%) and 2007 (37%) (Table 3-45). In 1997, 11,303 acres of vegetable beet were planted of which an estimated 4295 acres were used for fresh market. At 7 tons/acre, the vegetable beet production is estimated to be 30,065 tons in 1997. Total production for that year is estimated to be just over 152,000 tons (30,065 + 122,000). Vegetable beet production for processing was not available for 2002 and 2007. Using an average rate of processed vegetable beet production of 18 tons/acres (Schrader and Mayberry, 2003), and the acreages for processed and fresh market vegetable beet production shown in Table 3-45, total production of vegetable beets was estimated to be 124,000 tons in 2002 and 117,000 tons in 2007 (Table 3-44).

In 2007, the most recent year for which published data are available, 8,413 acres of vegetable beet were harvested in the United States, on 2,768 farms, for an average of 3 acres per farm (USDA-NASS, 2009b). As shown in Table 3-45, both the number of farms growing vegetable beet and the number of acres/farm have been declining in the decade from 1997 to 2007.

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[22] As of 2007, New York and Wisconsin had more than 90 percent of the harvested acreage of vegetable beet for processing USDA-NASS, "Acreage. United Stated Department of Agriculture, National Agricultural Statistics Service," (2009b), vol.
[23] Schrader and Mayberry (2003) report average yields for processed beet to be much higher and close to 18 tons/acre.

Table III-42. Trade in Vegetable Beet and Other Edible Roots, 1997-2009 (tons) [1]

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Exports	17,031	14,654	16,122	15,628	15,760	16,944	18,227	16,243	15,125	14,703	16,095	14,818	15,898
Imports	17,024	22,188	19,080	21,995	18,326	20,726	21,548	25,078	25,587	29,092	30,886	31,102	28,491

Source: (USDA-FAS, 2010b).

[1] Harmonized System Code 706900. Includes beet, radish, horseradish and other edible roots, fresh or chilled (carrots and turnips not included). Converted from metric tons.

Table III-43. Vegetable Beet Production for Processing, 1997-2001

	1997	1998	1999	2000	2001
Production (tons)	122,000	103,530	117,200	113,160	111,180
Value (USD 1,000)	8,153	6,361	6,976	6,965	7,317

Source: (USDA-NASS, Various Years).

Table III-44. Total Vegetable Beet Production Estimates, 1997-2007 (tons) [1]

	1997	2002	2007
Production	152,000	124,000	117,000

[1] Estimates explained in preceding paragraph.

Table III-45. Vegetable Beet Acreage, Farms and Acres Harvested, 1997-2007

	1997	2002	2007
Acres Harvested	11,303	9,092	8,413
For Processing	7008[1]	5,510	5,275
For Fresh Market	4295[1]	3,582	3,138
Farms	2,333	2,123	2,768
Acres/Farm	4.8	4.3	3.0

Source: (USDA-NASS, 2004; USDA-NASS, 2009b).
[1]Estimated assuming 62 percent of vegetable beet acreage used for processing

b. Vegetable Beet Seed Markets

Demand for vegetable beet seed is derived from the demand for vegetable beet. As discussed above, U.S. demand for vegetable beet likely declined after 1997. As of 2001, the last year for which vegetable beet seed export data are available, there was no sign that foreign demand would increase to compensate for such decline in U.S. demand (Table 3–46).

Table III-46. Trade in Vegetable Beet Seed, 1997-2001 (tons)

	1997	1998	1999	2000	2001
Exports	900.9	779.7	865.7	770.8	725.9
Imports	2.5	6.8	18.9	4.5	17.2

Source: (USDA-FAS, 2010b).
[1] Harmonized System Code 120919: Other Beet Seed (other than sugar beet). Converted from metric tons. Not reported after 2001.

USDA does not systematically collect data on vegetable beet seed production. Based on publications from the Washington State Extension Office and personal communications with State Extension Officers in Oregon and Washington and commercial seed producers, APHIS estimates that approximately 550 acres of table beet seed were planted in 2011, mostly in the State of Washington, but also in California and Oregon (see section III.B.3.a(1)). Swiss chard seed was grown on approximately 600 acres, in the states of Oregon, Washington, California (and 1 county in Arizona) (see section III.B.2.a(1)).

E. Physical Environment

Four physical environment resources are described in this section: land, soil, air, and water. The land discussion describes land use: where sugar beet is currently grown and how much land is currently used for this crop. The soil discussion describes the preferable soil traits for growing sugar beet and crop management methods that affect soil, including tillage and chemical treatments. The third discussion concerns air quality and climate change: how the production of sugar beet generates air emissions. The fourth discussion concerns surface water and groundwater quality: how much water is required in the production of sugar beet, and runoff from cropland.

1. Land Use

Although GE crops have become available in recent years, crop data provide no indication that the introduction and widespread planting of GE crops has resulted in any substantial change to the total U.S. acreage devoted to agricultural production. The acreage in the United States that is planted in principal crops, which include corn, sorghum, oats, barley, winter wheat, rye, durum, spring wheat, rice, soybean, peanuts, sunflower, cotton, dry edible beans, potatoes, canola, proso millet, and sugar beet, has remained relatively constant over the past 25 years (USDA-NASS, 2010b). From 1983 to 1995, the average yearly acreage of principal crops was 328 million (USDA-NASS, 2010b). Biotechnology-derived crops, including several principal crops such as soybeans, corn, and cotton, were introduced in 1996. In 2009, 319 million acres of principal crops were planted, of which about half were GE(USDA-ERS, 2010a). Overall the amount of cropland planted has declined less than 3-percent since 1996 (USDA-NASS, 2010b)

Sugar Beet Production: Acreage and Location

According to USDA–NASS (2010e), the acreage planted in sugar beet in the United States has changed little over the past 50 years. In 1961, total planted acreage was approximately 1.13 million acres and in the 2009–2010 production year, the planted acreage was approximately 1.18 million acres (a 5 percent increase) (USDA-NASS, 2010b). Fig. 3–21 shows the national planted acreage of sugar beet from 1913 to 2010. For more detailed discussion about the land used for sugar beet production see sections III.1.b.(1) and III.1.c.(1).

2. Soil Quality

This section discusses influences on soil quality by sugar beet production. Sugar beet are well adapted to a wide range of soil types (Draycott, 2006). In the United States, sugar beet is produced on coarse textured sandy soils to high organic matter, high clay content, silty clay, or silty clay loam soils (see Table 3–47 for definitions for a variety of soil types and textures). Soil with high water holding capacities is desired (Cattanach et al., 1991).

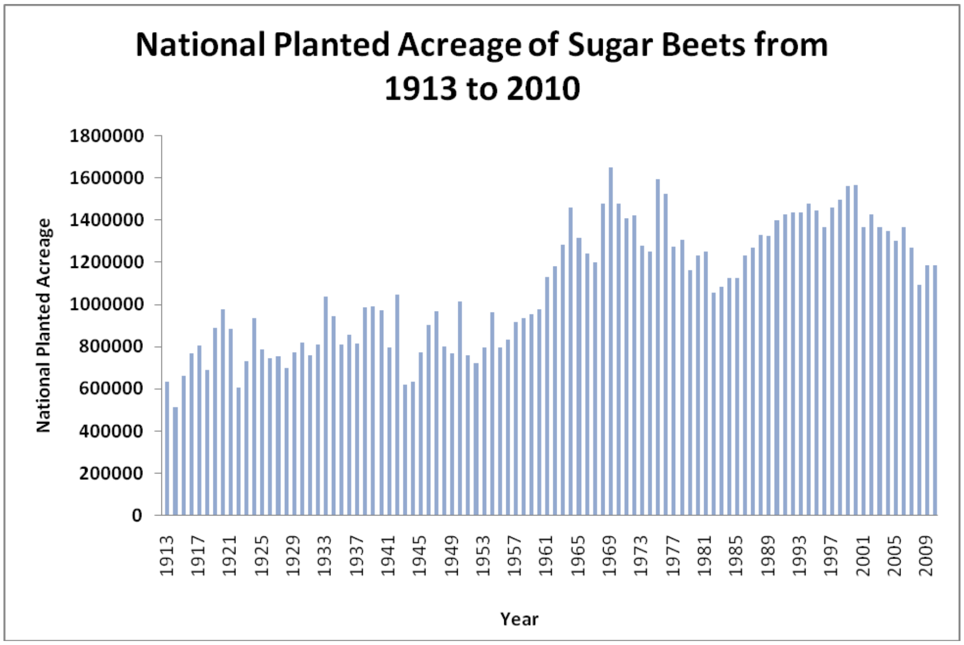

Figure 3- 21. National planted acreage of sugar beet from 1913 to 2010 (Source: (USDA-NASS, 2010b))

The soil environment in and around agricultural fields contains numerous micro-organisms (Bot and Benites, 2005). Typically, bacteria, followed by fungi, are the most abundant micro-organisms found in soil. As discussed in section III.C.2, sugar beet soils contain both beneficial and pathogenic micro-organisms. These micro-organisms play several important roles in soil ecology, including decomposition of plant litter, which maintains soil structure and releases nutrients (that are required for plant growth) back into the soils. Certain micro-organisms can also contribute to the protection of the root system against soil pathogens (Morillo-Velarde and Ober, 2006).

A soil that is free, or nearly free, of stones is particularly desirable as stones cause problems for planting, thinning, harvesting, and processing equipment (Cattanach, Dexter et al., 1991). The sugar beet plant has a taproot system that uses water and soil nutrients to depths of 5-8 feet (Cattanach et al., 1991). Sugar beet are very sensitive to low pH and will only produce full yields in soil near the neutral point, 7, of the pH scale (Christenson and Draycott, 2006). Observations in the United Kingdom and the United States indicate that sugar beet grow best on soils of pH between 6.5 and 8.0 (Christenson and Draycott, 2006).

Table III-47. Soil Types and Textures–Definitions and Particle Sizes

Name	Definition	Particle Size
Soil Types		
Sandy	Soil material that contains 85% or more of sand; percentage of silt, plus 1.5 times the percentage of clay, shall not exceed 15.	Sand: 0.2 to 0.02 mm Clay: <0.002 mm Silt: 0.05 to 0.002 mm
Clay	Soil material that contains 40% or more clay, <45% sand, and <40% silt.	Sand: 0.2 to 0.02 mm Clay: <0.002 mm Silt: 0.05 to 0.002 mm
Loam	Family particle-size class for soils with textures finer than very fine sandy loam (soil material that contains 50% or more very fine sand) but <35% clay and <35% rock fragments in upper subsoil horizons.	Very Fine Sandy Loam Consists of: Coarse Sand – 2.0 to 0.2 mm Medium Sand – 0.5 to 0.25 mm Fine Sand – 0.2 to 0.02 mm Clay: <0.002 mm Rock Fragments: 2.0 mm to 12.5 mm
Peat	An organic soil in which the plant residues are recognizable. The sum of the thicknesses of the organic layers are usually greater than the sum of the thicknesses of the mineral layers. See also peat, muck, muck soil, and Histosol.	N/A
Light Sand	Soil material that contains 50% or more fine sand (or) <25% very coarse, coarse, and medium sand and <50% very fine sand.	Coarse Sand: 2.0 to 0.2 mm Medium Sand: 0.5 to 0.25 mm Fine Sand: 0.2 to 0.02 mm Very Fine Sand: 0.10 to 0.05 mm
Soil Textures		
Coarse	Texture group consisting of sand and loamy (silt, clay, and sand) sand textures.	Sand: 0.2 to 0.02 mm Loam Consists of: Silt – 0.05 to 0.002 mm Clay – <0.002 mm Sand – 0.2 to 0.02 mm
Light	A coarse-textured soil; a soil with a low drawbar pull and hence easy to cultivate.	N/A
Fine	A broad group of textures consisting of or containing large quantities of the fine fractions, particularly of silt and clay. (Includes all sandy clay, silty clay, and clay textural classes).	Silt: 0.05 to 0.002 mm Clay: <0.002 mm
Homogeneous	Of uniform structure or composition throughout (Merriam-Webster)	N/A

Source: (Soil Science Society of America, 2011).

Sugar beet is almost always grown in rotation with other crops to reduce the risk from a wide variety of weeds, diseases and other pests (Dewar and Cooke, 2006). Rotations can be particularly effective against relatively immobile pests with narrow host ranges (e.g., beet cyst nematode) or insect pests with at least one stage that is restricted to the soil (e.g., pygmy beetle and wireworm) (Dewar and Cooke, 2006).

Agronomic and nutritional needs of sugar beet crops depend on specific soil conditions, the preceding crop, and regional conditions (Kockelmann and Meyer, 2006). Thus, the types and amounts of fertilizers, soil amendments, and pesticides (fungicides, herbicides, and insecticides) applied to produce a healthy crop each year can vary by region and crop rotation.

As discussed in section III.B, sugar beet is a biennial plant, meaning it takes 2 years of field growth to complete the plant lifecycle (from a seed to the production of new seed). Sugar beet that is grown for root production is harvested after 1 year of growth.

Sugar beet that is grown for seed production need to complete the 2 year growth cycle. Two methods are used for seed production: the direct "field" method where seeds are planted where they will flower and the indirect "steckling" method where seedlings are grown in a nursery and then transplanted to the flowering location. The best soils for both direct "field" and indirect "steckling" are loamy, with 40–70 percent of silt and 20–50 percent of clay, with neutral to slightly alkaline pH (6.5–8.0, typically) (Kockelmann and Meyer, 2006). Alkaline soils can be treated by adding lime or lime slurries, and spent lime can be used on acidic soils to help adjust the pH level to an optimal level for sugar beet production (Sims et al., 2005). Further, fertilizer is important to soil quality because it helps balance the nutrients needed during seed development and germination which can affect seed quality (Chastain, 2010). Nitrogen levels in particular are important to keep in balance as too little nitrogen in the soil can lead to low crop yield and too much nitrogen can reduce the sugar content of the crop (Lamb et al., 2008). Thus, to attain a suitable nutrient balance in soils, including nitrogen, phosphorous, and potassium, fertilizers could be applied based on the results of a soil analysis for a particular area (Kockelmann and Meyer, 2006). Sugar beet seed crops require 125–150 percent of the fertilizer nutrients that sugar beet root crops require (Desai, 2004).

Most sugar beet seed production in the United States uses the steckling method. The steckling seed production method involves harvesting the plants (which have produced small beet roots called stecklings) at the end of a short first growing year and then replanting them the second year for flowering. The steckling method involves more passes through the production fields to accommodate the harvesting and replanting between seasons and, therefore, has a larger effect on soil than the direct seed method. Soil preparation and quality of transplanting are key factors for high seed yield and seed quality in the steckling method. Cultivation of soil must ensure a structure that enables plants to settle their roots easily in the soil and preserve soil moisture (Kockelmann and Meyer, 2006).

a. Sugar Beet Tillage Methods

(1) Purposes for Tillage

Sugar beet crops usually require a fine, homogeneous (see Table 3–47 for definition of soil types) seedbed (Häkansson et al., 2006). Thus, some form of tillage, either conventional, conservation, or reduced tillage is used prior to planting most sugar beet crops (conventional or H7-1 sugar beet) in the United States

The intensity of tillage, the number of operations, the types of implements used, the timing of operation, and the purposes for tillage encompass a wide range. The tillage system and the individual field operations within this system should have specific purposes that contribute to the harvest size and quality of the crop (Smith, 2008). These purposes commonly include:

- controlling weeds prior to planting,
- incorporating crop residue, manure, nutrients or herbicides into the soil,
- reducing soil compaction,
- facilitating a cover crop or manipulating the soil surface to minimize soil erosion,
- enabling the grower to provide consistent seed depth and spacing,
- conserving soil moisture,
- enabling soil moisture below the seed to move up to the seed as the soil surface loses moisture, and
- minimizing soil clods at seed depth for maximum seed-soil contact while providing some clods on the surface to minimize soil erosion and soil crusting.

The right type of tillage conducted at the right time with the right implement is a necessary and important part of sugar beet production (Smith, 2008). Most soil problems, including clods, compaction, soil crusting, and lack of good tilth (soil structure suitable for seeding), are caused by or at least aggravated by tillage and machinery traffic (Smith, 2008).

When sugar beet crops are grown with conventional tillage methods, the soil surface remains unprotected from wind for a prolonged period after sowing. Particularly on poorly structured soils, such as light sands and peats, wind erosion during this period can be a serious problem (Häkansson et al., 2006). The seedbed, and even the seed, can be blown away or re-deposited. After emergence, abrasion by wind-blown soil particles can damage seedlings, which may also become covered by soil. In severe cases, re-sowing might be necessary (Häkansson et al., 2006). Fig. 3–22 shows where excessive erosion from wind and water is occurring on croplands across the United States. It can be seen that there are regions of excessive erosion in all the sugar beet root crop growing areas.

In many sugar beet production areas, the most relevant method to protect soil from wind erosion is a cultural practice that leaves an adequate amount of crop residues on the soil surface (Fornstrom and Miller, 1998), which usually means some form of reduced or conservation tillage (see following subsections for a detailed discussion). On light soils, reduced/conservation tillage is desirable because it decreases the risk of erosion. It also reduces the risk of surface-layer hardening, which is of interest particularly for soils with high silt content (Häkansson et al., 2006). On fine-textured soils with a more stable structure, reduced/conservation tillage can be profitable because it saves time and energy. Sandy soils, on the other hand, are easily compacted, and relatively deep annual tillage could be a prerequisite for normal root development. As a result of a large series of trials on various soils in Sweden, Håkannson (2006) citing Rydberg, 1987) reported mainly negative effects of reduced/conservation tillage on various crops on sandy soils and positive effects on silty soils. On clay soils, the results varied but were often positive (Häkansson et al., 2006). In the United States, soils are sandy or fine textured/silty within the northern Great Plains along the Yellowstone River and its tributaries which are major sugar beet growing area (Mikkelson and Petrof, 1999); in the Northwest most sugar beet production is focused around the sandy loam soil of the Snake River Valley in Idaho (Traveller and Gallian, 2000); within the Great Lakes region sugar beet is commonly grown on medium- and fine-textured soils (Häkansson et al., 2006); in the Midwest within Red River Valley production area the soil is characterized as a clay to silty-clay composition (Schwert, 2003); and in the Imperial Valley sugar beet production region the crop acreage primarily consists of heavy clay and clay loam soils (California Beet Growers Association, 1999).

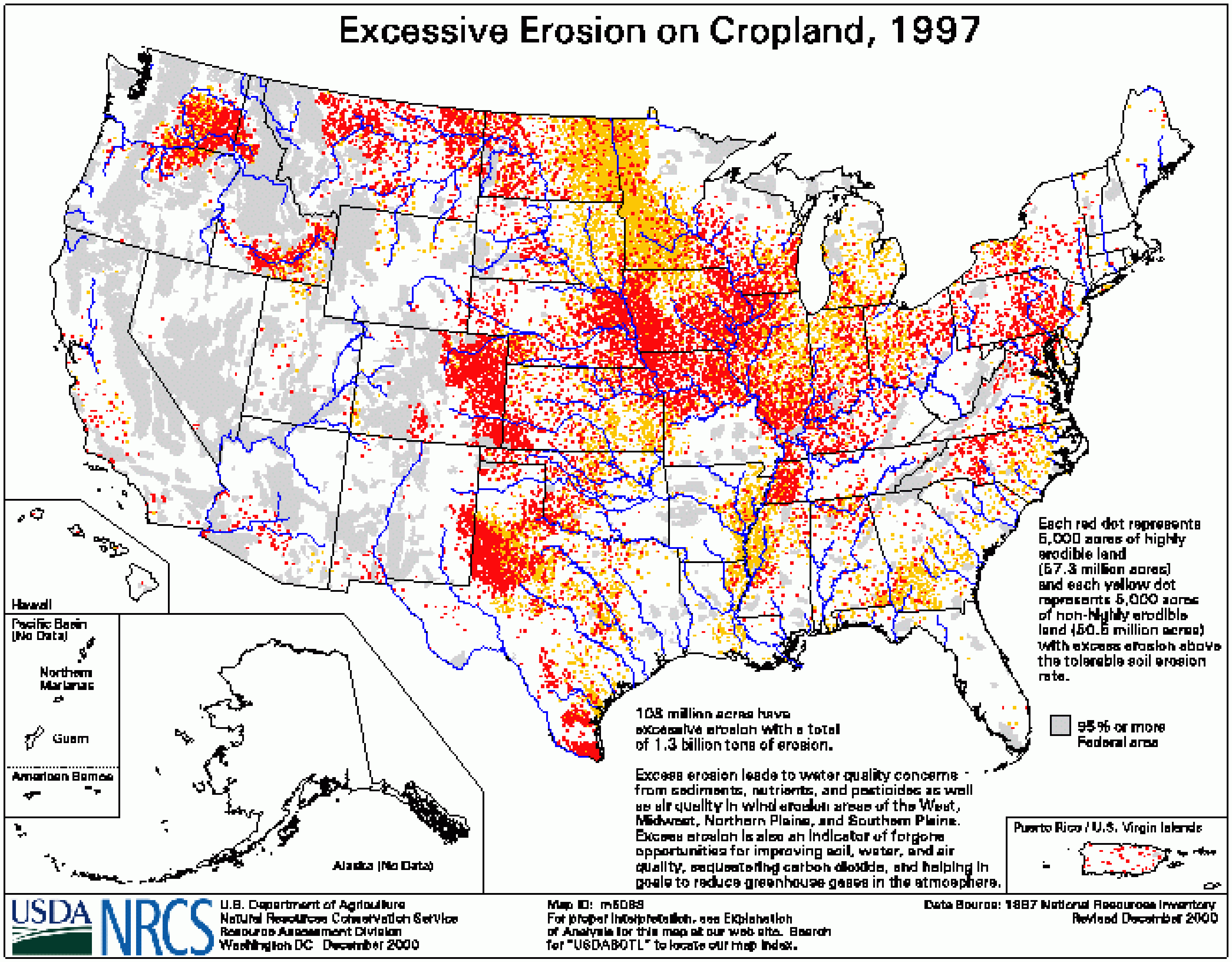

Figure 3- 22. Excessive wind erosion on U.S. cropland, 1997

(USDA-NRCS, 2011a)

(2) Tillage Methods

Tillage methods for sugar beet production were introduced in section III.B.1. Additional details regarding tillage methods, their influence on soil quality, and regional variations are discussed in this section.

Tillage helps in seedbed preparation by assisting in crop residue management, improvement of soil structure, elimination of early weeds, and reduction in erosion risks presented by compacted soils. However, tillage which can be done in the fall and spring, can also by itself exacerbate erosion problems, release more carbon into the atmosphere, and can also result in increased moisture loss from the soil as compared to no tillage or strip tillage (Cheesman, 2004; Nowatzki et al., 2008).

The following sections discuss conventional or traditional tillage, conservation tillage, reduced tillage, and strip tillage methods used in sugar beet production across the United States. Conventional tillage using moldboard plowing has traditionally been the most common primary tillage method in sugar beet production. However, other methods of tillage, such as conservation tillage and reduced tillage are included under Crop Residue Management (CRM) have been used increasingly for sugar beet crops (Häkansson et al., 2006). CRM includes preserving residue from the previous crop and reducing the number of times equipment passes over a field and is designed to protect soil and water resources and to provide additional environmental benefits (Anderson and Magleby, 1997). A cover of crop residue helps cut soil losses from wind and water erosion.

Conventional Tillage. The USDA–ERS defines conventional tillage as a full-width tillage that is performed prior to and/or during planting, and generally involves plowing with a moldboard plow and/or other intensive tillage equipment. Conventional tillage leaves less than 15 percent residue cover on the soil surface after planting and weed control is accomplished with crop protection products and/or cultivation (Anderson and Magleby, 1997). It results in 100 percent soil disturbance (USDA-NRCS, 2008) and is primary tillage followed by one or more secondary tillage(s), planting, and row cultivation operations that bury virtually all previous crop residue (see section III.B.1.c for further detail).

In the United States, the trend among northern Great Plains farmers is toward using less tillage to produce field crops with more residue left on the soil surface (Nowatzki et al., 2008). Since the widespread adoption of H7-1 sugar beet in 2008, the use of conventional tillage has decreased in sugar beet in the Great Plains (Wilson Jr, 2012), largely due to improved weed control through the use of glyphosate applications (Duke and Cerdeira, 2007; Wilson Jr, 2009; NRC, 2010).

Conservation Tillage. As discussed in section III.B.1.c(2), conservation tillage as defined by the USDA–ERS is a cultural operation that maintains at least 30-percent cover of the soil surface by plant residue at the time of planting (Anderson and Magleby, 1997). The crop residue protects the soil from both wind and water erosion (Häkansson et al., 2006). Conservation tillage systems require more planning, and better management than conventional tillage (Cattanach et al., 1991).[24]

According to USDA–ERS, the three types of conservation tillage are no till, ridge-till, and mulch-till.

No till as defined by USDA–ERS (Anderson and Magleby, 1997) is a method that leaves previous crop residue undisturbed from harvest to planting except for nutrient injection or narrow strips, and planting or drilling is accomplished in a narrow seedbed or slot. Weed control is primarily accomplished with herbicides and cultivation may be used for emergency weed control.

Under ridge-till, residue from the previous crop is left undisturbed from harvest to planting except for nutrient injection. Planting is completed in a seedbed prepared on 4 to 6 inch high ridges that are formed and rebuilt during row cultivation for weed control and residue is left on the surface between ridges.

Mulch-till is a full-width tillage system that usually involves one to three tillage passes over the field performed prior to and/or during planting, and after planting leaves at least 30 percent of the soil surface covered with residue. Weed control under ridge-till and mulch-till is accomplished with herbicides and/or cultivation (USDA-ERS, 2006).

Reduced Tillage. Reduced tillage as defined by the USDA–ERS is a full-width tillage that usually involves one or more tillage passes over the field prior to and/or during planting, and leaves 15–30 percent residue cover after planting (USDA–ERS, 2006).

Strip Tillage. Strip till is a field tillage system that combines no till and full tillage to produce row crops. The seed and fertilizer are placed in narrow strips, 6–12 inches wide, which are tilled in crop stubble, with the area between the rows left undisturbed (Nowatzki et al., 2008). The

[24] The USDA–ERS defines conservation tillage and reduced tillage as distinct tillage systems with conservation tillage leaving at least 30 percent soil cover and reduced tillage leaving between 15–30 percent soil cover. However, some authors do not always make a distinction between conservation tillage and reduced tillage, and appear to use the terms interchangeably. Others use the term 'reduced' tillage to mean 'less intensive' tillage and not the USDA–ERS definition of reduced tillage of 15–30 percent soil cover. Draycott A.P. Draycott, "Sugar Beet," (Oxford, United Kingdom: Blackwell Publishing Ltd., 2006), vol. World Agricultural Series. uses reduced tillage to mean conservation tillage and it is assumed so do many contributing authors to the book edited by Draycott *World Agricultural Series. Sugar Beet* Draycott, "Sugar Beet," vol.. In such instances it is assumed reduced tillage can also mean conservation tillage and they are referred to as reduced/conservation tillage.

spacing between the rows varies with crops, but research indicates that strip tillage works well with crops grown with 30-inch row spacing; however, narrower row spacings also work (Nowatzki et al., 2008). Often, fertilizer is injected into the tilled area during the strip tilling operation, and seeds are planted directly into the tilled strips. Strip tilling normally is done in the fall after harvest, but also can be done in the spring before planting (Nowatzki et al., 2008). Section III.B.1.c(2) discusses the advantages of a strip till system. As described by Sandretto (2001) in the USDA–ERS Agricultural Outlook, benefits of conservation tillage include improved soil quality by reducing soil erosion, building soil organic matter, improving soil tilth (to aid root penetration), increasing soil moisture (through reduced water runoff, enhanced water infiltration, and suppressed evaporation), and minimizing soil compaction. For a discussion of tillage impacts on air quality and water quality, see sections III.E.3.a(1) and III.E.4.c, respectively.

University research to evaluate the utility of conservation tillage has been underway at North Dakota State University. NDSU research with sugar beet grown with 22-inch row spacing was conducted during 2005–2007 at several Red River Valley locations (Overstreet et al., 2007). Sugar beet yields were similar among tillage systems in 2 of the 3 years (Table 3–48). Strip till yields were approximately the same as conventionally tilled plots (Nowatzki et al., 2008).

(3) Regional Variations in Sugar Beet Tillage Methods

With the introduction of H7-1 sugar beet in 2005 and the adoption of the crop, differences in tillage methods have been observed across the sugar beet growing regions. Since H7-1 sugar beet have not been cultivated in the Imperial Valley region and that region is unlikely to adopt conservation tillage due to widespread use of furrow irrigation, that region is not discussed here. As stated in section III.B.1.c(2) due to a lack of sufficient data for all regions, not all differences are described for all regions.

Section III.B.1.c(2), describes a national survey conducted in 2000 (in 2000, the Great Lakes sugar beet growing region included Michigan and Ohio; sugar beet was last produced in Ohio in 2004), that found that 73 percent of sugarbeet farms in the Great Lakes used conventional tillage (with and without moldboard plow) (Ali, 2004) and 28 percent of the sugar beet farms used reduced or mulch tillage. In subsequent years, Michigan sugar beet farms have shown an increase in the percentage of fields that have been planted into stale seedbeds (where fields are tilled in the fall and then weeds that subsequently germinate are either destroyed by tillage or herbicide treatment (Taylor, 2009). Currently 25 percent of Michigan's sugarbeet fields are being planted into stale seedbeds, up from less than 5 percent in 2006–2007 (Lilleboe, 2011) and the trend has been to use glyphosate to manage weeds before planting rather than tillage (Sprague, 2011).

Table III-48. Sugar Beet Yields (Tons/Acre) with Various Tillage Systems

Tillage System[1]	Fargo, ND 2005	Fargo, ND 2006	Fargo, ND 2007	Prosper and Moorhead, MN 2007	3-Site Average (Fargo)	5-Site Average (Fargo, Prosper and Moorhead)
Conventional	12.9	24.0	22.1	30.0	19.7	22.3
No Till	16.6	23.4	22.1	–	20.7	–
Strip Till	15.0	23.9	22.7	29.6	20.5	22.8
Least Significant Difference (0.05)	3.2	Not significant	Not significant	Not significant	–	–

Source: (Nowatzki et al., 2008)
[1] Previous crops: Fargo- soybeans; Prosper and Moorhead- wheat.

Since 2008, when H7-1 sugar beet varieties became widely adopted, sugar beet growers in some areas, such as western North Dakota and eastern Montana, have converted to nearly 100 percent H7-1 sugar beet varieties (Stachler et al., 2009a). According to the 2000 national survey, with only conventional sugarbeet growing in the Midwest, 64 percent of sugar beet farms in the Midwest used conventional tillage, while 36 percent of the farms used reduced tillage or mulch tillage (Ali, 2004). As discussed in section III.B.1.c(2) recent studies at NDSU have found strip tillage is a viable option for sugar beet production that reduces fuel and fertilizer costs and susceptibility to wind erosion (Overstreet et al., 2009). Ridge tillage has only been used on a limited number of acres (less than 1000) in the region, and strip tillage and no tillage are rarely used (Overstreet, 2011). However, reportedly there have been changes in the amount of postemergence tillage required for H7-1 sugar beet. For example, a member of the Minn-Dak Farmers Cooperative, who farms about 1,100 acres of sugar beet annually, has found that instead of three postemergence tillage trips across the fields, with H7-1 he now needs “little to no tillage postemergence” (Mauch, 2010).

Ninety-four percent of sugar beet farms in the Great Plains used conventional tillage according to the 2000 national survey, and 0.1 to less than 5 percent of farms used reduced or mulch tillage for sugarbeet production (Ali, 2004). A 2007 study in Warland, Wyoming, comparing H7-1 sugar beet production to similar, nearby fields of conventional sugar beet production found that in crop tillage was reduced by 50 percent in the H7-1 sugar beet fields as compared to the conventional sugar beet fields (Kniss, 2010b). According to an Agriculture Manager at Western Beet Sugar Cooperative, strip tillage increased from 15-20% of sugar beet acreage to 75-80% in the four years after adoption of H7-1 sugar beet and some sugar beet farms are now using no-till (Wilson Jr, 2012).

Similar to the Great Plains region, according to the 2000 national survey, 96 percent of farms in the Northwest used conventional tillage for sugar beet production and 0.1 to less than 5 percent of farms used reduced or mulch tillage for sugarbeet production (Ali, 2004) (the Imperial Valley was not included in the survey as data were insufficient). Further, researchers in Idaho found that while conventional tillage was necessary for weed control with conventional beet, the practice has little to no benefit with H7-1 sugar beet (Miller and Miller, 2008). All sugar beet crops in the Northwest region are irrigated. Both furrow and pivot irrigation are used. Although conservation tillage is not likely to be used with furrow irrigation, there is likely to be adoption on farms that use pivot irrigation.

Conservation Tillage. Conservation tillage has been widely used for other U.S. crops, such as soybean, corn, sorghum, and small grains (Sandretto, 2005). The percentage of conservation tillage-managed land in the United States increased from 26 percent in 1990 to 41 percent in 2004 (Sandretto and Payne, 2006). The emergence of glyphosate-resistant weeds has led to an increase in tillage in areas where such weeds are widespread. It is possible that the increasing trend in adoption of conservation tillage will be reversed by a need to control herbicide-resistant weeds with tillage.

Soil Compaction. Soil compaction is a form of soil degradation typically caused by heavy machinery and livestock trampling. Soils with low organic matter are particularly vulnerable. Compaction can make tillage costly, impede emergence of seedlings, and decrease water infiltration, causing higher runoff of rainwater and increasing water erosion (WRI, 1992).

Seedbed preparation and sowing operations normally lead to a considerable decrease in the depth of the plow layer.[25] The central and deeper parts of the plow layer are compacted by the wheels of the tractors, and only the shallow seedbed remains loose. In sugar beet cultivation, the number of vehicle passes used in field preparation increase compaction risk and are particular sources of concern (Cheesman, 2004). For sugar beet crops, growers employ a combination of tillage, hand labor and chemical weed control, requiring multiple passes through the field with equipment. Additional passes across the field could be required after seedbed preparation, and throughout the growing season, to apply herbicides, fungicides, insecticides, etc., or to conduct mechanical

[25] The plow layer means soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from about 4 to 10 inches (10 to 25 centimeters). Also designated as the 'surface layer'. (USDA NRCS, 2011c)

weeding, which could further compound compaction. In some instances, as indicated in section III.B, ranchers and farmers have been known to allow livestock to graze beet tops, which could lead to localized areas of compaction. Soil compaction results in increased bulk density and soil strength ((Cheesman, 2004) citing Martin 1979 and Soane et al., 1982) and decreased porosity, permeability and water infiltration rates ((Cheesman, 2004) citing Hansen 1982). Compaction can also lead to surface sealing, which reduces infiltration rates and increases runoff and can thus exacerbate erosion problems (Cheesman 2004 citing Morgan 1986, Schwertmann 1986, and Hartemink 2003).

b. Crop Rotation

Crop rotations have been shown to have a positive impact on soil quality. Benefits include an increase in soil organic matter, higher crop yields, and soil salinity control (USDA-NRCS, 1996).Crop rotations can help minimize the impacts of certain soil-borne diseases, nematodes (parasitic, microscopic worms) and weeds (Mikkelson and Petrof, 1999); (Hirnyck et al., 2005; USDA-ERS, 2009b). Depending on the type of crop rotation and tillage operation used benefits could include a decrease in soil erosion and there could be a reduction in the amount of pesticide buildup (USDA-NRCS, 1996).

Sugar beet root crops are usually grown with other crops in 3- to 5-year rotations to improve the soil and reduce the presence of weeds, diseases, and pests (Dewar and Cooke, 2006). The length of the rotation and the type of crops that are rotated with sugar beet vary by region, and may include other glyphosate-tolerant crops, such as corn or soybeans. However, in no regions are sugar beet rotated to other beet crops such as Swiss chard or table beet. Sugar beet seed production and steckling production is carried out on a 5- to 8-year rotation with other crops (American Crystal Sugar Company, 2010). Common rotation crops include cereals such as wheat and barley, dry beans and alfalfa (Table 3-6).

c. Herbicides and Soil

Herbicide influence on soil quality and persistence in soil depend on various site-specific facts as well as the characteristics of the specific herbicide being used. In general, soil factors affecting herbicide persistence include the composition of the soil, micro-organism activity in the soil, and soil chemistry. Soil composition is a physical factor determined by the relative amounts of sand, silt, and clay in the soil, as well as by the organic-matter content. An important chemical property of soil that can influence herbicide persistence is pH. The microbial aspects of the soil environment include the types and abundance of soil micro-organisms present in the soil (Curran, 1998). Systemic herbicides such as glyphosate can accumulate in resistant plants and gradually move into the soil (Laitinen et al., 2007). Depending on how much resistant vegetation is present at the time of spraying largely influences the degree to whether glyphosate translocation from plants to soil constitutes a significant proportion of residue (Laitinen et al., 2007). In the case of H7-1 sugar beet, most glyphosate sprays are applied prior to canopy closure when plants are small so the majority of herbicide is expected to result from direct spray. Some of the more important elements of soil composition in relation to sugar beet production is discussed in the following three sections.

d. Micro-organism Contribution to Soil Quality

Soil biota play a critical role in several ecosystem processes that are essential for crop production, soil resource quality, and environmental health (Gupta and Roget, 2010). The interactions between micro-organisms and organic matter in the soil largely determine the fertility and overall quality of the soil. Some functions of soil micro-organisms in agricultural systems include (Kennedy et al., 2004):

- release plant nutrients from insoluble inorganic forms,
- decompose organic residues and release nutrients,
- produce plant growth-promoting compounds,
- transform atmospheric nitrogen into plant-available nitrogen,
- improve soil aggregation, aeration, and water infiltration, and
- help in pesticide degradation.

Management practices used in crop production affect soil micro-organisms either through direct effects on populations and activity or indirectly through the modification of the soil environment. Both can be either beneficial or detrimental to the soil biota. Agricultural practices that favor build-up of soil organic matter can lead to higher micro-organism diversity, whereas practices that involve high disturbance and reliance on chemical additives can result in limited microbial diversity or elimination of some biological groups (Kennedy et al., 2004). Management practices that can influence microbial populations and their activities include (Kennedy et al., 2004; Gupta and Roget, 2010):

- tillage practices,
- irrigation practices,
- crop rotations (both crop and variety types),
- application of fertilizers and pesticides,

- residue cover,
- cover cropping, and
- soil compaction.

Severe disturbances, such as those caused by heavy tillage, can reduce microbial growth and activity (Kennedy et al., 2004).

Differences in farm machinery use and labor have been observed since the introduction of H7-1 sugar beet. On Minnesota and North Dakota farms growing H7-1 sugar beet, the rotary hoe or harrow was used on 15 percent of acres in 2008 compared to 25 percent in 2007, 41 percent in 2006, 56 percent in 2005, and 64 percent in 2004. This equates to a reduction of 49 percent between 2004 and 2008. Because the trending decrease began prior to the adoption of H7-1 sugar beet it is not possible to predict the extent to which H7-1 adoption contributed to the decline in rotary hoe and harrow use. The decline in hand weeding is directly attributable to the increased adoption of H7-1 sugar beet varieties (Stachler et al., 2009b)(Table 3-37).

Crop rotation can improve conditions for diversity in soil micro-organisms because of variability in type and amount of organic inputs (Kennedy et al., 2004). Crop rotation enhances beneficial micro-organisms and increases microbial diversity (Kennedy et al., 2004). Studies have long shown the positive effects of crop rotation on crop growth, attributing these to changes in composition of microbial community (Kennedy et al., 2004) citing Shipton 1977, Cook 1981, and Johnson et al., 1992). In general, yields and quality are highest when sugar beet follow barley or wheat in a crop rotation. Yields are also high when sugar beet follow corn, potatoes, or summer fallow in rotation; however high levels of residual nitrogen in the soil can reduce sugar beet quality (Cattanach et al., 1991). As discussed in section III.B the pattern of wheat, barley, or corn crops preceding the sugar beet crop is relevant for both conventional sugar beet and H7-1 sugar beet plantings.

Herbicide use is a key component of modern agriculture, particularly under reduced till systems which are prone to weediness (Cattanach et al., 1991). With increased implementation of stubble retention and reduced till practices and the introduction of new herbicides, herbicide use would remain an essential practice in the near future (Gupta and Roget, 2010). Non-target effects of herbicides on soil biological activities can cause undesirable effects on essential transformation processes (e.g., reduced nitrification and nitrogen mineralization)(Gupta and Roget, 2010).

e. Manganese in Soil

Manganese is an essential plant micronutrient required by a large number of enzymes as a cofactor (Christenson and Draycott, 2006). Soil conditions promoting manganese deficiency are high pH and low soil moisture. In many soils, high pH is an inherent characteristic of the soil, and not a result of over-liming, so it is not always managed by adjusting the soil pH. Higher organic matter content is also associated with increased manganese deficiency. Rainfall can alter the severity of manganese deficiency within and between growing seasons; the wetter the soil, the greater the manganese availability. Therefore, manganese deficiency symptoms will often disappear during periods of high rainfall and get more severe with drought (Camberato et al., 2010).

Soil-applied manganese fertilizer is relatively ineffective at correcting manganese deficiency because it becomes unavailable soon after application. Foliar-applied manganese is the more effective method for correcting manganese deficiency. Tank mixing manganese with glyphosate is not recommended as it interacts with glyphosate in a tank mix, resulting in reduced herbicide efficacy and lower manganese availability. Another option to remedy manganese deficiency is to apply foliar manganese in a separate application 7–10 days after the glyphosate application. When sprayed alone (without glyphosate), most manganese fertilizers are equally effective. The delay in manganese application can result in yield loss (due to manganese deficiency), however, negating some of the benefit of separate manganese fertilizer and glyphosate applications (Camberato et al., 2010).

Shortly after the introduction of glyphosate-resistant soybean, questions arose whether these varieties or glyphosate applications to them alter manganese relations compared to conventional soybean varieties. It is well documented that certain cations,[26] including manganese, can reduce the performance of glyphosate when the cations are tank mixed. The complexes formed between glyphosate and metal cations are not absorbed as efficiently as free glyphosate, resulting in reduced weed control (Hartzler, 2010). However it is not well documented that glyphosate has any impact on the manganese or cation relations in the plant. This topic is discussed further in Section IV.E.2.

f. Nitrogen Availability in Soil

The three main nutrients typically applied to sugar beet are nitrogen, phosphate and potassium (Christenson and Draycott, 2006). However, nitrogen is the most limiting nutrient in sugar beet production, and proper nitrogen management is critical (Davis and Westfall, 2009). Several

[26] A “cation” is a positively charged ion. The cations used in largest amounts by plants are calcium (Ca^{++}), potassium (K^{+}), and magnesium (Mg^{++}). The ionic forms of Ca and Mg have two positive electrical charges while K has one G. Rehm, "Soil Cation Ratios for Crop Production," North Central Regional Extension Publication 533 (2009).).

factors including, genotype, soil fertility, the availability of water, nitrogen supply, and plant population density, have been shown to influence the cell size of the sugar beet root ((Milford, 2006) citing Milford and Watson 1971). Crops that are well supplied with nitrogen tend to product larger yields of beet containing a lower concentration of sugar than crops grown with less nitrogen ((Draycott, 2006) citing Draycott and Christenson 2003). Sugar beet absorb nitrogen in a mineralized form, mainly as nitrate and partly as ammonium. This "mineral" nitrogen stems from three major sources: unstable organic matter in soil, organic manure (e.g., slurry from animal breeding or non-agricultural sources), and unused nitrogen fertilizers left from previous crops. The availability of mineral nitrogen in soil depends directly on microbial processes (Cariolle and Duval, 2006). These processes determine mineralization, which results in ammonium nitrogen production from organic matter, and ensure nitrification (transformation of ammonium nitrogen into nitrate). Micro-organisms also consume mineral nitrogen for their own use. These processes are simultaneous and balanced, depending on climate factors (e.g., temperature and moisture) and trophic factors (e.g., availability of carbon and nitrogen in soil (Cariolle and Duval, 2006).

Nitrogen requirements for sugar beet (both conventional and H7-1 sugar beet varieties) depend on the microbial balance responsible for mineralization and nitrification, the previous crop and fertilizer residue, and the organic supply naturally occurring in the soil. Therefore, soil characteristics alone are not sufficient to predict the nitrogen available in the soil before and after growing a sugar beet crop (Cariolle and Duval, 2006). Although most of the nitrogen taken up by sugar beet was long considered to come from fertilizer, these observations indicate that mineral fertilization provides only part of the supply, complementing that supplied by the soil (Milford, 2006). Soil amendments in the form of nitrogen fertilizer, livestock manure, and wastewater treatment plant sewage sludge are typical options for replenishment of nitrogen stores in soil. The difficulty remains to estimate the optimal soil amendment dosage: not too low risking a reduction in sugar yield, and not too high risking a decrease in sugar content and juice purity (Cariolle and Duval, 2006).

Cariolle and Duval (2006) suggest that the H7-1 sugar beet varieties are capable of both substantially higher yields and more efficient recovery and utilization of available nitrogen. To date, no conclusive studies demonstrate a significant difference between conventional sugar beet and H7-1 sugar beet in nitrogen recovery and utilization.

3. Air Quality and Climate Change

Air quality and climate change can affect public health and welfare and the natural environment. The Clean Air Act (CAA) (42 USC §7401–7671g) is the primary Federal legislation that addresses air quality. Under the authority of the CAA and its amendments, the EPA has established National Ambient Air Quality Standards (NAAQS) for six "criteria pollutants" (40 CFR part 50).[27] The criteria pollutants are carbon monoxide, nitrogen dioxide (one of several oxides of nitrogen), ozone, sulfur dioxide, particulate matter with an aerodynamic diameter equal to or less than 10 microns equal or less than 2.5 microns (fine particles), and lead. Ozone is not emitted directly by plants or farm equipment, but is formed in the atmosphere by chemical reactions of precursor pollutants in the presence of the ultraviolet component of sunlight (U.S. EPA 2010b). Thus, potential effects of ozone are evaluated based on emissions of the precursor pollutants nitrogen oxides and volatile organic compounds (VOCs). Gases that trap heat in the atmosphere, and cause climate change, are often called greenhouse gases (GHGs). The GHGs relevant to the proposed action are carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) (U.S. EPA 2010b).

Agriculture in general, including sugar beet farming, involves activities that produce emissions that can affect air quality and climate in a variety of ways. Emissions associated with sugar beet farming may have changed over time as cultivation of H7-1 sugar beet became more widespread. In order to provide perspective on these changes that may have occurred in the affected environment over time, and to support the air quality and climate impact analysis in section IV.E.3, this section discusses the emission sources associated with sugar beet farming.

Emissions associated with sugar beet farming can include criteria pollutants, VOCs, GHGs, pesticides, odors, and airborne allergens. One source of emissions is the use of tractors and other farm equipment during typical tillage, harvesting, and pesticide application. This equipment use results in fuel combustion emissions, dust, and soil compaction (Fawcett and Towery, 2002). Other potential impacts on air quality and climate can arise from traffic and harvest emissions, pesticide drift from spraying, smoke from agricultural burning, and nitrous oxide emissions from the use of nitrogen fertilizer (Fawcett and Towery, 2002), as well as odors and allergens. Agricultural practices for both conventional and GE crops have the potential to directly and indirectly affect air quality and climate change. Odors and agricultural burning would not differ between conventional and H7-1 sugar beet farming and are not assessed in this EIS. Allergens are discussed in section III.F. The remainder of this section discusses criteria pollutants, pesticide drift, and GHGs.

[27] "Criteria pollutants" is a term used by EPA, other regulatory agencies, industry, and the public to collectively describe the six common air pollutants for which the CAA requires the EPA to set NAAQS. The EPA calls these pollutants "criteria" air pollutants because it regulates them by developing human-health based or environmentally-based criteria (science-based guidelines) for setting permissible levels (Section 108 of the CAA, 42 USC §7408).

a. Air Quality

(1) Tillage and Particulates

Tilling and other agricultural activities (e.g., seedbed preparation, planting, and harvesting) can introduce soil particulates into the air (Holmen et al., 2006). For example, peak levels of particulate concentrations are known to coincide with the peak agricultural harvest season in California's Central Valley (Giles and Downey, 2006). Tillage contributes to the release of GHGs because carbon is lost as carbon dioxide to the atmosphere, and because soil organic matter is exposed and subsequently is oxidized (Baker et al., 2005). Emissions released from agricultural equipment used for tillage and other activities (e.g., irrigation pumps and tractors) include carbon monoxide, nitrogen oxides, particulate matter less than 2.5 micrometers in diameter and less than 10 micrometers in diameter, sulfur oxides, volatile organic compounds, and GHGs (U.S. EPA 2010b).

Conservation tillage can reduce particulates arising from soil by 85 percent (Madden et al., 2008). Dust production can be reduced by both limiting the number of passes through a field and by changing key soil properties. These changes include increasing water-holding capacity and aggregate stability, both improved by accumulation of soil organic matter typical of no-till production. Additionally, reduced tillage can potentially limit the loss of carbon dioxide to the atmosphere by preventing exposure and oxidation of soil organic matter (West and Wilfred, 2002).

As mentioned in section III.E.2, the USDA–ERS defines conservation tillage as cultural operations that maintain at least 30-percent cover of the soil surface by plant residue at the time of planting (Anderson and Magleby, 1997). Conservation tillage can encompass a range of management practices, from no till (defined by USDA–ERS as maintaining at least 67 percent cover) to ridge- and strip till cultivation to minimum tillage systems that restrict equipment traffic to dedicated zones. Special tillage field equipment can often perform the equivalent functions of several standard implements, reducing the necessity for multiple passes through the field. Implementing conservation tillage practices can lead to both economic and production quality benefits, as well as having positive environmental impacts. For further information on tillage practices for conventional and H7-1 sugar beet see section III.E.2. For additional discussion of regional variations in tillage practices see section III.E.2.a.

The amount of machinery exhaust emissions, as well as soil particulate emissions, would vary with the type of equipment used and the number of passes made across the field. The number of passes differs among tillage practices, with conservation or reduced tillage systems generally requiring fewer passes than conventional tillage systems, as discussed above.

(2) Pesticide Applications

Agricultural pesticides enter the atmosphere through volatilization from soil and plant surfaces, through drift (the movement of herbicide through the air to unintended sites), and through wind erosion. Pesticides consist of insecticides, fungicides, and herbicides. Overall, as discussed in section III.B.1, insecticide and fungicide options and applications vary regionally according to pest and disease pressure and needs, but do not appear to vary between conventional sugar beet and H7-1 sugar beet. Herbicide usage, however, does vary between conventional sugar beet and H7-1 sugar beet and accordingly the remainder of this section focuses on herbicides.

Airborne pesticides can partition between gas and particle phase, be transported through wind, and then be deposited again by rainfall or particulate settling (Vogel et al., 2008). The concentrations of pesticides in the atmosphere are highest within the treatment area and the immediate vicinity (Vogel et al., 2008). The distance traveled by airborne pesticides and their ultimate fate depends on their chemical and physical nature, method of application, and the atmospheric conditions at time of treatment.

Though volatilization of pesticide from a soil or plant surface is affected by many factors, such as surface characteristics and local meteorology, its vapor pressure provides an indicator of its propensity to enter the atmosphere (Spencer et al., 1988). Table 3–49 provides a comparison of the vapor pressures of several common pesticides. Although the herbicide glyphosate is essentially nonvolatile (Monsanto and KWS SAAT AG, 2010) and was not thought to be an atmospheric contaminant (Cerdeira and Duke, 2006)it has recently been reported as a contaminant of air (<0.01 to 9.1 ng/m^3) and rain (from <0.1 to 2.5mg/L) (Chang et al., 2011). Section IV.E.3 contains further discussion of pesticide volatilization and air quality.

H7-1 sugar beet have been engineered to tolerate exposure to glyphosate, which is “more environmentally benign than the herbicides that it has displaced, product toxicity not withstanding” (Fernandez-Cornejo and McBride, 2002; NRC, 2010). As shown in Table 3–18, as glyphosate usage has increased, the use has decreased of all other herbicides used on sugar beet. These herbicides are more volatile than is glyphosate, are applied more frequently, and are more likely to be applied with aerial applications (see section III.B.1.d). All these factors are associated with higher air contaminants both from the pesticides themselves and indirectly from the machinery exhaust resulting from more frequent application.

b. Climate Change

There is robust scientific evidence that human-induced climate change is occurring. The Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report states with “very high confidence” that human activities have altered the global climate (IPCC (Intergovernmental Panel on Climate Change), 2007).

Climate change affects average temperatures and temperature extremes; timing and geographical patterns of precipitation; snowmelt, runoff, evaporation, and soil moisture; the frequency of disturbances, such as drought, insect and disease outbreaks, severe storms, and forest fires; atmospheric composition and air quality; and patterns of human settlement and land use change (Backlund, 2008).

Table III-49. Volatility Data for Herbicides

Active Ingredient	Vapor Pressure (mm Hg at 25 ºC unless otherwise noted)	Reference
Clethodim	$<3.5 \times 10^{-7}$ at 20 ºC	(U.S. EPA 2007b)
Clopyralid	3.99×10^{-7}	(U.S. EPA 2009a)
Cycloate	6.2×10^{-3}	(U.S. EPA 2004)
Desmedipham	$>10^{-5}$	(U.S. EPA 1996b)
EPTC (S-Ethyl dipropylthiocarbamate)	2.4×10^{-2}	(U.S. EPA 1999)
Ethofumesate	5.9×10^{-8}	(U.S. EPA 2005f)
Glyphosate	9.8×10^{-8}	(NLM, 2011)
Phenmedipham	9.75×10^{-12}	(U.S. EPA 2005g)
Pyrazon	4.5×10^{-7} at 20 ºC	(NLM, 2011)
Quizalofop-p-ethyl	6.49×10^{-9} at 20 ºC	(NLM, 2011)
Sethoxydim	1.6×10^{-7}	(U.S. EPA 2005d)
Trifluralin	$>1.0 \times 10^{-5}$	(U.S. EPA 1996c)
Triflusulfuron-methyl	$<1 \times 10^{-7}$	(U.S. EPA 2002a)

(1) Agricultural Sources of GHGs

Methane (CH_4) and nitrous oxide (N_2O) are the primary GHGs emitted by agricultural activities in the United States (U.S. EPA 2010b). Agricultural activities contribute directly to emissions of GHGs through a variety of processes, including enteric fermentation in domestic livestock (CH_4), livestock manure management (CH_4), rice cultivation (CH_4), agricultural soil management such as fertilizer application (N_2O) and other cropping practices (N_2O and CO_2), and field burning of agricultural residues (CO_2) (U.S. EPA 2010b). Fossil-fuel use during farm production contributes GHG emissions (primarily CO_2) (U.S. EPA 2010b). Land use changes, either to or from agricultural lands, also affect agricultural GHG emissions

(U.S. EPA 2010b). Of these potential GHG sources, fertilization, tillage practices, and fossil-fuel use (machinery exhaust) are relevant to sugar beet farming.

Fertilizer application is expected to be the largest source of N_2O emissions associated with H7-1 sugar beet farming. More than half (69–94 percent) of nitrous oxide emissions occur during two periods – immediately after application of nitrogen fertilizers and during the winter when soil water-filled pore space exceeds 90 percent (Dusenbury et al., 2008). Nitrous oxide is produced in soils through the microbial processes of nitrification and denitrification. Several agricultural activities increase mineral nitrogen availability in soils, thereby increasing the amount available for nitrification and denitrification, and ultimately the amount of nitrous oxide emitted (U.S. EPA 2010b). These activities include fertilization, application of livestock manure and sewage sludge, production of nitrogen-fixing crops, retention of crop residues, irrigation, drainage, tillage practices, and fallowing of land (U.S. EPA 2010b). Weather and soil properties also influence nitrous oxide emissions from croplands.

(2) Climate Trends in the United States

In the United States during the 20th century, the country warmed and became wetter overall, with changes varying by region. For example, southern regions have cooled, while northern regions have warmed. Much of the eastern and southern United States now receive more precipitation than 100 years ago, while other areas, especially in the southwest United States, receive less. Heat waves have increased in frequency and duration, and there is some evidence of increased frequency of heavy rain falls (Backlund, 2008).

These trends would likely continue, with predicted temperature increases of 1 ºC (1.8 ºF) to more than 4 ºC (7.2 ºF) by 2100 (Backlund, 2008). The western and southwestern United States are likely to become drier, while the eastern United States is likely to experience increased rainfall. Heat waves are likely to be hotter, longer, and more frequent, and heavy rainfall is likely to become more frequent. Even under the most optimistic climate change scenarios, changes in regional and super-regional temperatures and precipitation patterns could have profound effects, especially on agriculture (Backlund, 2008). Impacts could include changes in crop yields, need for modification of irrigation methods, and changes in the latitudes and altitudes at which prime farmland occurs.

(3) Climate Change and Regional Sugar Beet Yield

Given the complex interactions between global climate change, increased weather variability, regional effects, and local climates, accurately predicting how sugar beet production might change as a result of climate change in a given region is difficult. The discussion below provides a general indication of how the affected environment may evolve as a result of climate change.

Thomson (2005) simulated dryland agriculture of five crops (corn, soybeans, winter wheat, alfalfa, and clover hay) in the United States under different climate change scenarios to assess potential future agricultural production. This model was considered relevant to sugar beet production because, while it doesn't include sugar beet per se, the model includes crops that are major rotation crops of sugar beet. In general, study results showed that higher temperatures reduced production and higher carbon dioxide concentrations increased production. Overall, national production of the five crops changed by ±5 percent from current levels, depending on the climate model used. Impacts were more notable regionally, with crop production varying by more than ±50 percent from baseline levels.

Analysis indicated that the regions most likely to be affected by climate change are those on the margins of the areas in which the five crops investigated in the study are currently grown (Thomson et al., 2005). Crop yield variability was found to be primarily influenced by local weather and geographic features rather than by large-scale changes in climate patterns and atmospheric composition (Thomson et al., 2005).

c. Air Quality and Climate Change Before and After Introduction of H7-1 Sugar Beet

The difference in the air quality-affected environment between the pre-H7-1 sugar beet period and the period after H7-1 sugar beet introduction is uncertain. As discussed above, some reports suggest that H7-1 sugar beet can be grown with conservation tillage or reduced tillage and with consequent savings in fuel and labor, because weeds can be effectively controlled with glyphosate applications. Use of postemergence herbicides helps to promote an increase in the practice of no-till farming, which can lead to a decrease in tractor use and to subsequent benefits in terms of reduced fuel use and emissions (Fawcett and Towery, 2002). In a study of conventional compared to H7-1 sugar beet in Idaho, H7-1 sugar beet required fewer cultivation passes, fewer herbicide applications, and less fuel, with an estimated 5.8–23.7 pounds less of carbon dioxide released per acre (Hirnyck, 2007). Emissions related to climate change, ozone depletion, summer smog, and carcinogenicity, among others, are typically lower as a result of reduced tillage (Bennett et al., 2004; Mortenson et al., 2004; Derpsch et al., 2010). Such emission reductions, if achievable, would be realized only to the extent that sugar beet growers implement and properly manage reduced tillage practices.

Scientists, however, have found little or no significant difference between soil carbon (a key factor in climate change potential) in no-till soils and conventional-till soils, depending on the soil, climate, and other factors (Bergstrom et al., 2001; Angers et al., 2009). Studies have shown that no-till soils result in elevated N_2O emissions for a variety of reasons including elevated moisture levels and soil characteristics (Linn and Doran, 1984; MacKenzie et al., 1998; Mkhabela et al., 2008).

4. Surface and Groundwater Quality

a. Water Use and Irrigation

This section discusses effects on water resources by sugar beet production and processing. According to a USDA survey (Ali, 2004) about 40 percent of U.S. sugar beet acres are irrigated. The Great Lakes region sugar beet producers do not irrigate, and the Red River Valley sugar beet producers irrigate less than 5 percent of their crops (Ali, 2004). The Great Plains and Northwest region producers irrigate nearly 100 percent of their crops (Ali, 2004). In three States, Michigan (Great Lakes region), North Dakota (Midwest Region), and Colorado (Great Plains Region), water is derived fairly equally from surface water and groundwater (USDA-NASS, 2007b). In Minnesota (Midwest Region) and Nebraska (Great Plains Region), irrigation water comes predominantly from groundwater sources (USDA-ERS, 2003). In Idaho (Northwest Region), Montana (Great Plains Region), Oregon (Northwest Region), Washington (Northwest Region), and Wyoming (Great Plains Region), irrigation water is derived predominantly from surface water sources (USDA-ERS, 2003). In the Imperial Valley region (California), approximately one-third of the irrigation water comes from groundwater and two-thirds from surface water (USDA-ERS, 2003).

Sugar beet turns out to be a very efficient user of water compared to many other crops when comparing the amount of water required to produce the digestible portion of sugar beet to other crops (Kaffka and Hills, 1994). Kaffka and Hill noted “because beet are efficient at accumulating photosynthate in a useful form, they are also efficient convertors of agricultural inputs such as water and nitrogen” (Kaffka and Hills, 1994). Morillo-Velarde and Ober (2006) found that sugar beet plants can use from 350 mm of water in temperate areas to more than 1,000 mm in arid areas, and that sugar beet consume no more or less than other common crops. Kaffka and Hills (1994) found that irrigation water requirements range from 450 mm of water per hectare per season in a cool climate where the soil is filled with plentiful winter rain, to as much as 1,400 mm per hectare in a hot, dry climate with limited winter rain; their study found that barley’s water use efficiency was about half of sugar beet. Seed production water needs are generally less than root production water needs, but this varies greatly depending on other factors such as climate and soil moisture (Morillo-Velarde and Ober, 2006). It is likely that H7-1 sugar beet have the same water requirements and efficiency levels as conventional sugar beet because the genetic alteration does not affect the water needs and efficiency of the plant.

b. Water Quality

Agriculture contributes to the presence of several types of chemicals or pollutants in water resources. These include nitrogen, phosphorus, sediment, and various pesticides that can move with surface runoff and lead to eutrophication of surface waters and other deleterious consequences. Areas of concern are groundwater and aquifers where nitrogen levels are either approaching or have exceeded the maximum contaminant level (10 mg per L) (Klocke et al., 1999) defined under the Federal Safe Drinking Water Act of 1974. In areas, such as Nebraska, where soybean and corn are grown in rotation and where groundwater is a principal source of water for human consumption, this can be a critical issue. In other areas, surface water movement of contaminants is of concern, and agricultural tile drainage systems have been shown to be a source of nitrate entering streams and rivers (Randall and Mulla, 2001). In areas where water retention in fields is high, periodically impeding crop production, such subsurface drainage systems are commonly used (Hoeft et al., 2000a; Hoeft et al., 2000b). Because sugar beet is often grown as part of a crop rotation plan, identifying water quality impacts directly related to sugar beet production is difficult (Cheesman, 2004).

Rain and irrigation water percolate down through the soil into groundwater, and in turn, the groundwater level can affect soil moisture and thus sugar beet growth and health. Herbicides used on sugar beet have varying chemical fates, with glyphosate and its primary degradation product aminomethyl phosphonic acid (AMPA) generally being less persistent and characterized by lower mobility in soils. Herbicides can enter surface waters through two routes during sugar beet application – directly from spray drift and indirectly from surface runoff. Due to the strong adsorptive characteristics of glyphosate and AMPA, leaching of these chemicals is more limited compared to other herbicides, and they are much less likely to leach to groundwater from the soil (Cerdeira and Duke, 2006). (For more information on herbicides and water infiltration and runoff, see section III.E.4.d below.).

Adequate soil fertility is one of the requirements for profitable sugar beet production (Davis and Westfall, 2009). Selection of fertilizer type and application is done according to soil analysis, taking into account the preceding crop and regional experiences in production (Cariolle and Duval, 2006). Sugar beet seed crops require 125–150 percent of the fertilizer nutrients that root crops require (Desai, 2004). Generally, two applications of fertilizer are made during production of sugar beet seed crops to maximize net sucrose. Sugar beet growers are encouraged to have sufficient soil nitrogen to attain maximal sugar content, with premiums paid for crops with higher than average sugar content (Michigan Sugar Company, 2010a; Michigan Sugar Company, 2010b). However, as presented in section III.E.2., excessive nitrogen can injure beet, reduce sugar content, and juice purity. Previous crops can also affect the total amount of nitrogen that should be applied to the new beet crop (Michigan Sugar Company, 2010a; Michigan Sugar Company, 2010b). Methods of reducing pollution from fertilizer applications during sugar beet production include cultivation of intermediate crops and reducing amounts of fertilizer applications (Cariolle and Duval, 2006). Intermediate crops act as nitrogen traps by absorbing mineral nitrogen present in soil and locking it up in the vegetation produced; therefore, providing a long term sustainable reduction of nitrogen fertilizers (Cariolle and Duval, 2006).

Sugar beet processing facilities produce wastewater that is used for irrigation or discharged to land or surface waters (Cheesman, 2004). Effluent from the sugar beet processing facilities tends to be largely organic and consist of soils and sugar beet solid waste (Cheesman, 2004), which is removed in settling ponds prior to discharge. Sugar beet processing facilities consume fresh water to rinse the excess dirt from sugar beet but this water is often recycled and used for other purposes (such as cooling towers and spray ponds), reducing the overall amount of effluent wastewater (Cheesman, 2004). Any processing facility wastewater discharged to a surface water would be required to meet the Clean Water Act water quality standards outlined in the facility's National Pollutant Discharge Elimination System (NPDES) permit. There is no difference in the processing methods for conventional sugar beet and H7-1 sugar beet.

c. Tillage and Water Infiltration and Runoff

The amount and type of tillage necessary for successful sugar beet seed and root production vary greatly and highly depend on several factors, including previous crops present in the rotation, soil type, climate, and amount of weed infestation present (Häkansson et al., 2006). See section III.E.2.a above for more information on tillage practices for sugar beet. Use of conservation tillage compared to use of conventional tillage in many soils could allow 10 to 40 percent greater water infiltration into soils (Hoeft et al., 2000a; Hoeft et al., 2000b). Crop residues established by conservation tillage on soil surfaces slow water runoff, increase porosity by increasing numbers of wormholes and by means of remnants of crop residue, and reduce evaporation through the insulating ability of surface mulches. Conservation and strip till techniques also reduce soil erosion by 90 percent on highly erodible lands (Zhou et al., 2009), and no till can reduce runoff volume 35-fold compared to conventional tillage (Gregory et al., 2005).

d. Herbicides and Water Infiltration and Runoff

Three herbicide characteristics are important in determining the potential for an herbicide to leach into groundwater or move with surface runoff after application. These characteristics include: (1) solubility in water (water solubility), (2) tendency to adsorb to the soil (soil adsorption), and (3) herbicide persistence in the environment (half-life). Water solubility is a measure of how easily a chemical dissolves in water. The lower a chemical's solubility, the less likely the chemical would move with water through the soil. Soil adsorption is the tendency for an herbicide to attach to soil particles, and is measured by the adsorption coefficient (K_{oc}). High K_{oc} values indicate a very strong tendency for an herbicide to attach to soil and, therefore, is less likely to move unless soil erosion occurs. An herbicide's half-life is a measure of persistence; it is the time (in days) it takes for an herbicide to degrade in soils to 50 percent of its original amount. In general, the higher the half-life of an herbicide, the higher potential for movement in the environment.

Several factors can influence the fate and transport of an herbicide, such as the characteristics of the soil that the herbicide is sprayed on, the slope of the land, rain, and irrigation volumes. Steeper sloped land would increase the potential for transporting herbicides, and increased rain or over-irrigation can increase the movement of herbicides.

No one factor—adsorption, water solubility, or persistence—can be used to predict herbicide behavior, and it is the interaction of these factors and their interaction with the particular soil type and environmental conditions that determines herbicide behavior in the field (Wright et al., 1996). Because sugar beet are grown in five different regions in the United States over vast areas, the characteristics of soil may vary greatly from field to field. However, an herbicide's adsorption, water solubility, and persistence characteristics provide relative risk estimates, and allow for some general comparisons between various herbicide products. The (2011c)has developed a pesticide environmental risk screening tool (WIN-PST) to evaluate the potential of pesticides to move with water and eroded soil/organic matter, and potential to affect non-targeted organisms. Part of the database that NRCS has compiled for WIN-PST includes creating algorithms that provide a rating of potential risks from herbicide leaching, herbicide surface runoff potential, and herbicide adsorbed runoff potential, which is summarized in Table 3–50 for the 13 common sugar beet herbicides. The algorithms use each herbicide's half-life, solubility, and K_{oc} values to determine a rating for each herbicide.

Table III-50. USDA-NRCS WIN-PST Data and Results for Common Sugar Beet Applied Herbicides

Herbicide	Solubility in Water (ppm)	Half Life (Days)	K_{oc} (mL/g)	Herbicide Leaching Potential[1,4]	Herbicide Solution Runoff Potential[2]	Herbicide Adsorbed Runoff Potential[3]
Clethodim	5,400	3	10	Low	Intermediate	Low
Clopyralid	1,000	30	2	High	Intermediate	Low
Cycloate	95	30	430	Intermediate	High	Low
Desmedipham	8	30	1,500	Low	Intermediate	Intermediate
EPTC	344	6	200	Low	Intermediate	Low
Ethofumesate	50	30	340	Intermediate	High	Low
Glyphosate,	900,000	47	24,000	Very Low	High	High
Phenmedipham + Desmedipham[5]	4.7	30	2,400	Low	Intermediate	Intermediate
Pyrazon	400	21	120	Intermediate	Intermediate	Low
Quizalofop-p-ethyl	0.31	216	510	High	Intermediate	High
Sethoxydim	4,390	5	100	Low	Intermediate	Low
Trifluralin	0.3	60	8,000	Low	Intermediate	High
Triflusulfuron-methyl	110	6	59	Low	Intermediate	Low

Source: (USDA-NRCS, 2011c)

Note: Based on the following herbicide inputs - Application Method – Surface applied; Application Area – Broadcast (applied to more than half of the field); Application Rate – Standard (a label rate greater than ¼ lb active ingredient per acre).

[1] Pesticide leaching potential indicates the tendency of a pesticide to move in solution with water and leach below the root zone. A low rating indicates a minimal movement.

[2] Pesticide solution runoff potential indicates the tendency of a pesticide to move in surface runoff in the solution phase. A high rating indicates the greatest potential for pesticide loss in solution runoff.

[3] Pesticide adsorbed runoff potential indicates the tendency of a pesticide to move in surface runoff attached to soil particles. A low rating indicates minimal potential for pesticide movement adsorbed to sediment.

[4] WIN-PST ranking range: Very Low, Low, Intermediate, High, and Extra High.

[5] Data are for phenmedipham only as desmedipham is already reported in the table.

Based on a study by Ali (2004), herbicides are used by virtually all sugar beet growers. In 2000 approximately 98 percent of planted acres received one or more herbicide applications (Ali, 2004). Prior to adoption of H7-1 sugar beet, growers regularly used multiple chemical herbicides to control weeds in conventional sugar beet fields (Kniss, 2010b; Wilson, 2010) In the post-widespread H7-1 sugar beet planting period after 2008, glyphosate was the main herbicide used on most sugar beet crops (Stachler et al., 2011) (Table 3-18). Glyphosate has a high K_{oc} value, relative to other herbicides, and adsorbs tightly to soil particles, which gives it a very low potential for leaching into groundwater (see Table 3–50). Compared to other commonly used sugar beet herbicides, glyphosate has the highest K_{oc} value and the lowest potential for leaching into groundwater (see Table 3–50).

(Vereecken, 2005) has recently reviewed the mobility and leaching of glyphosate from soils. Some of the conclusions reached are:

- Adsorption of glyphosate is mainly governed by the mineral phase of the soil matrix with a strong preference for iron hydroxides.

- Soil organic matter seems to play only an indirect role.

- The soil pH determines the electrical charge of glyphosate and therefore its adsorption on the mineral phase. The use of Koc is therefore not appropriate to characterise the sorption of glyphosate.

- Phosphate, introduced by fertilizer, may occupy sorption sites and therefore increase the mobility of glyphosate. However, available laboratory studies indicate that this does not necessarily lead to increased leaching.

- Leaching studies on drained field sites indicate that glyphosate may be transported to deeper soil layers through a combination of high rainfall intensity after application on a wet macroporous soil, despite the fact that the compound is strongly sorptive and rapidly degrading. When glyphosate is applied with irrigation much more glyphosate leaches out than when there is a delay between glyphosate application and the start of irrigation. Factors that appear to be related to preferential transport include presence of soil structures such as biopores and burrows, the rainfall intensity, the date of application in relation to the occurrence of rainfall, and the soil profile wetness.

- Data from glyphosate monitoring in the USA and Europe indicate a low occurrence in groundwater. This is in line with two experimental lysimeter studies on glyphosate which indicate that glyphosate does not occur in the leachate water at concentrations of environmental concern

Glyphosate has a high potential to move in surface water runoff during the solution phase and when attached to soil particles (see Table 3–50), which could lead to glyphosate reaching and contaminating surface waters. Coupe et. al. (2011) estimate that about 1% of the glyphosate applied moves into surface water. Maximum glyphosate concentrations measured in surface water ranged from 1-430 μg/L depending on how much glyphosate was being applied locally and the time between application and rainfall.

Compared to other commonly used sugar beet herbicides, glyphosate has a higher potential than most sugar beet herbicides to move in runoff either in solution or adsorbed to soil (see Table 3–50). But because of glyphosate's physical characteristics, soil and sediments of bodies of water are the main sinks for glyphosate residues from surface water, greatly reducing further transport (Cerdeira and Duke, 2006)(citing Franz et al., 1997 and Goldsborough and Brown, 1993).

Once in surface water, glyphosate dissipates more rapidly than most other herbicides, and various studies have shown that glyphosate appears in surface water less than several alternative herbicides (Cerdeira and Duke, 2006) (citing Carpenter et al., 2002). Glyphosate is not readily broken down by water or sunlight (U.S. EPA 1993a), but micro-organisms (in soil, sediment, or natural water) degrade glyphosate quickly to the major metabolite AMPA, which is further degraded although at a slower rate than the parent glyphosate (U.S. EPA 1993a; U.S. EPA 2006c). In a U.S. Geological Survey (USGS) monitoring study of surface water, groundwater, and soil conducted from 2001–2006, the metabolite AMPA was observed more frequently than the parent compound glyphosate and glyphosate and its metabolite AMPA were found in surface water more frequently than in groundwater (Scribner et al., 2007). About half of glyphosate use at the time was from agriculture (primarily soy beans and corn) and half from home gardening and other use.

F. Human Health and Safety

The areas of human health and safety described in this section are those potentially affected by the alternatives analyzed in chapter IV. These areas include all known aspects of direct and indirect human contact with sugar beet. People directly ingest the products of sugar beet in the form of sugar, food additives, and dietary supplements. In addition, people may inhale sugar beet pollen, usually on or near farms. People consume meat, dairy, and other products derived from livestock that are fed sugar beet pulp and molasses. Additionally, fungicides, insecticides, and herbicides are used on some sugar beet, which in turn can result in exposure to these substances. Within the context of H7-1 sugar beet and GE crops more broadly, people in the United States have been eating and otherwise coming into contact with GE crops since 1996, when herbicide-tolerant soybean and other crops first became commercially available (Fernandez-Cornejo and Schimmelpfennig, 2004).

This section is organized by public health and safety (section III.F.1) and worker health and safety (section III.F.2). Sections III.F.1 and III.F.2 each include two main subsections: (1) sugar beet and related products, and (2) pesticides.

1. Public Health and Safety

Sugar beet is used for food, feed, and various other products to which people are exposed. One component of the affected environment is the direct human consumption of products derived from sugar beet, such as sugar and food additives, as described below. This section also addresses exposure to pesticides used on sugar beet.

a. Sugar Beet and Related Products

Regulatory and other controls on the safety of direct human consumption of sugar beet and related products are provided by the Food and Drug Administration (FDA) and EPA, as described below. This section also describes sugar beet products that people are exposed to, products that are genetically related to sugar beets, the composition of sugar beet, and the potential allergenicity and toxicity of sugar beet components.

(1) Regulatory Oversight

As described in section I.E, regulatory oversight of H7-1 sugar beet is provided by three Federal agencies – APHIS, FDA, and EPA. APHIS' role is described in detail in section I.E, but the roles of FDA and EPA warrant additional discussion in this section due to the focus of these agencies on human health.

FDA is the lead U.S. regulatory agency for oversight of plant-derived food and feed, including those developed from GE crops. FDA has authority to regulate food under the Federal Food, Drug, and Cosmetic Act (FFDCA) and the Public Health Service Act. Under FFDCA, it is the responsibility of food and feed manufacturers to ensure that the products they market are safe and properly labeled. In addition, any food additives, including those introduced into food or feed by way of plant breeding, must receive FDA approval before marketing. The term "food additive" includes substances, the intended use of which results in their becoming components of food. By definition, food additives do not include pesticides or substances that are generally recognized as safe under the conditions of their intended use. In general, when an intended expression product present in food is one that is already present at generally comparable or greater levels in currently consumed foods, there is unlikely to be a safety question that would call into question the presumed GRAS status of the naturally occurring substance. Likewise, minor variations in molecular structure that do not affect safety would not ordinarily affect the GRAS status of the substance and, thus, would not ordinarily require regulation of the substance as a food additive (U.S. FDA, 1992)

To help developers of foods and feeds derived from GE plants comply with their obligation to market safe food in accordance with FDA statutory and regulatory requirements, FDA encourages developers to participate in a voluntary FDA consultation process prior to commercialization. In that process, developers submit data and information to FDA that provide the basis to support a conclusion that a food from a GE crop complies with FDA statutory and regulatory requirements. A consultation for H7-1 sugar beet has been completed (U.S. FDA, 2004), as described below in section III.F.1.a(5). FDA's approach to the regulation of foods derived from crops such as H7-1 sugar beet is described in the FDA policy statement concerning regulation of products derived from new plant varieties, including those varieties that have been genetically engineered, U.S. FDA, 1992).

Under FIFRA, EPA regulates the pesticides applied to GE crops, such as H7-1 sugar beet. Before a pesticide can be used on an herbicide-tolerant crop (or any crop other than those currently approved), the pesticide manufacturer must seek a label change for that pesticide. The label describes how the herbicide can be applied to the herbicide-resistant crop and any restrictions on the use of the herbicide. Growers of the herbicide-resistant crop must follow the EPA label when applying the registered herbicide to the crop. Under FFDCA, EPA sets tolerances for pesticide residues. Tolerances are the legal limit for a pesticide chemical residue in or on a food. Tolerances are set such that there is a reasonable certainty that no harm would result from aggregate exposure to the pesticide chemical residue, including all anticipated dietary exposures and all other exposures for which there is reliable information. Section III.F.1.b provides additional detail about tolerances for sugar beet.

(2) Sugar Beet Products

Direct human ingestion of sugar beet product occurs primarily via white sugar, which is produced through a refinement process that is described further below. Sugar beet accounts for approximately 55 percent of total sugar produced in the United States, or about 4.6 million tons per year (USDA-ERS, 2010b; USDA FSA (Farm Services Agency), 2010). The use of sugar (sucrose) from sugar beet, that is, “obtained by crystallization from sugar beet juice that has been extracted by pressing or diffusion, then clarified and evaporated,” is GRAS, under the conditions prescribed (21 CFR § 184.1854). According to the National Health and Nutrition Examination Survey (NHANES) and using the Foods Analysis and

Residue Evaluation (FARE) software, the average American consumes 16.7 grams of beet sugar daily (Monsanto and KWS SAAT AG, 2010).

During 2010, approximately 40,000 tons of sugar beet are reported to have been used for domestic food consumption via non-sugar food items (USDA FSA (Farm Services Agency), 2010). Human ingestion of sugar beet occurs via a variety of products, including food additives, baker's yeast, and pharmaceuticals. Sugar beet pulp is a key source for these products. It also has been used in recent years as a dietary fiber mainly marketed under the trade names Fibrex and Atlantis (Cho and Dreher, 2001). These products are generally reported to contain one third water-soluble fiber and two-thirds water-insoluble fiber (Cho and Dreher, 2001) and are reported to have shown general health benefits ((Langkilde et al., 1993) citing Hagander et al., 1988, 1989, Israelsson et al., 1988, Lampe et al., 1991, Tredger et al., 1991).

One of the principal non-sugar substances in sugar beet molasses is betaine, which is marketed as a pro-vitamin in the food, animal feed, and pharmaceutical industries (Dutton and Huijbregts, 2006). Betaine has been of interest for its role in osmoregulation (NCBI, 2011). As a drug, betaine hydrochloride has been used as a source of hydrochloric acid in the treatment of hypochlorhydria. Betaine has also been used in the treatment of liver disorders, for hyperkalemia, for homocystinuria, and for gastrointestinal disturbances. Other sugar beet-derived products include citric acid and MSG, which are obtained from fermentation of sugar beet molasses. Citric acid, a common food additive used as a preservative and flavor enhancer, is commercially produced during the fermentation of sugar beet molasses by the mold *Aspergillus niger* (Ronzio, 2003). MSG, a widely used flavor enhancer, is also produced via industrial fermentation of sugar beet molasses (Davidson and Jaine, 2006). Although beet molasses is typically used in combination with cane molasses in these fermentation processes, beet molasses is generally preferred as it has lower ash content, which reduces the waste matter flow (Harland et al., 2006; FSANZ (Food Standards Australia New Zealand), 2010). Sugar beet molasses is also used in the production of baker's yeast and in certain chemicals and pharmaceuticals (CFIA, 2002; SMBSC (Southern Minnesota Beet Sugar Cooperative), 2010a).

Humans consume meat and dairy from livestock that consume feed derived from sugar beet molasses, sugar beet pulp, or sugar beet leaves. Despite its suitability as feedstuff for a variety of animals, sugar beet-derived feed makes up only a small percentage of total animal feed consumed in the United States. Section III.C.1.a provides a description of livestock exposure to sugar beet products.

(3) Other Crops

Given the possibility of gene flow from sugar beet to related crops, the affected environment also includes direct and indirect consumption of Swiss chard, table beet, and fodder beet. These crops are discussed in sections III.B.2, III.B.3, and III.B.4, respectively. Swiss chard, a leafy plant, is grown for food and generally sold in fresh markets. In 2001, organic Swiss chard was grown on a total of 33 acres certified for organic production, with 100 percent of the harvest sold at a fresh market (Walz, 2004). Detailed information on non-organic certified Swiss chard production is unavailable, but one estimate is that around 12,500 acres are planted in the United States (according to (WSCPR (Washington State Commission on Pesticide Registration), 2006) Washington has <250 acres and that this represents <2 percent of U.S. acreage. Table beet are typically grown for their leaves and roots, and are prepared for consumption in a variety of ways. Although the leaves are typically steamed or stir-fried, table beet roots can be steamed, roasted, boiled, pickled, and eaten warm or cold as a condiment or salad. As described in section III.B.3, approximately 8,500 acres of table beet is planted in the United States, 60% of which is grown for canning (Nolte, 2010). For comparison, nationwide data on sugar beet indicate that in 2010 approximately 1.2 million acres of sugar beet were planted(USDA-ERS, 2010b). Fodder beet, as their name suggests, are typically grown for use as livestock feed. Fodder beet (also called mangel) leaves and roots can be consumed by humans, although little information could be found regarding human consumption in the United States.

(4) Composition of Sugar Beet and Products

The nutritional composition of conventional sugar beet, including their pulp and molasses byproducts, has historically made them attractive for human and animal consumption. As noted in section III.B.1.a, sugar beet roots typically contain 75.9 percent water, 2.6 percent non-sugars, 18.0 percent sugar, and 5.5 percent pulp (CFIA, 2002). Sugar beet tops generally contain 16–18 percent dry matter (sugar beet solids, excluding water) and are good sources of protein, vitamin A, and carbohydrates (Harland et al., 2006). Sugar beet are rarely consumed in their raw state and are commonly processed into white sugar, pulp, molasses, and other products.

Sugar beet pulp is rich in digestible fiber and energy, which is primarily derived from the structural carbohydrates of the beet root (Harland et al., 2006). Dietary fiber in roots comes exclusively from its cell walls and does not contain resistant starch or other polysaccharides (Cho and Dreher, 2001). Sugar beet root fiber is not mature and thus not extensively lignified; it contains one-third pectin, one-third hemicellulose, and one-third cellulose (Harland et al., 2006). Sugar beet fiber is highly digestible, with a high hydration capacity and a high proportion of soluble dietary fiber (Cho and Dreher, 2001).

Molasses derived from sugar beet is high in energy, with a protein digestibility of around 77 percent and a dry matter digestibility of around 90 percent (Harland et al., 2006). The main component of sugar beet molasses dry matter is sugar, at approximately 50 percent as sold (Harland et al., 2006). Beet molasses can be well utilized by ruminant livestock, with a nitrogenous composition falling into three main categories: betaine (27 percent), amino acids (33 percent), and uncharacterized (35 percent). Small quantities of reducing sugars, raffinose, and ash are also present (Harland et al., 2006). Sugar beet molasses is high in the nutrients potassium and sodium, but low in vitamins (Harland et al., 2006).

The composition of the hybrid lines containing H7-1 produced through conventional breeding was compared by the petitioner to the composition of the corresponding conventional sugar beet control (Monsanto and KWS SAAT AG, 2004). The composition of food from GE plants is examined to assess whether there have been any unintended changes in the composition of the food that are important to nutrition or safety. These analyses included proximate analysis (crude ash, crude fiber, crude fat, crude protein, and dry matter), carbohydrates, quality parameters, saponins (naturally-occurring "anti-nutrients" that have a bitter taste and can act as a deterrent to foraging), and 18 amino acids. Quality parameters measured in root samples included percent sucrose, invert sugar, sodium, potassium, and alpha-amino nitrogen. All analyses were conducted as a single analysis for the root (brei) and top (leaf) samples collected as three replicate samples from each of five field trials sited. Fifty-five statistical comparisons were made with the control line, of which seven were found to be statistically different ($p < 0.05$). Six of these differences were due to amino acid levels in the sugar beet tops (alanine, histadine, phenylalanine, and tyrosine) and roots (alanine and glutamic acid) and one was due to dry matter mean level in top tissue. Based on the statistical methods, three of these seven would have been expected based on chance. In all seven cases, the ranges for the statistically different components in H7-1 significantly overlapped or fell completely within the range of values observed for the control, the conventional reference varieties, and for available published values from conventional sugar beet varieties.

(5) Allergenicity, Toxicity, and Related Hazards

Substances that are foreign to the human body, such as plant proteins, can elicit allergic or toxic responses ranging from mild irritation to death. These substances are found in many sources. Allergens can be found in or on animal hair, pollen, insects, dust mites, plants, pharmaceuticals, and food. Some allergens are simply storage proteins (reserves of metal ions and amino acids) that are harmless to most people but elicit an immune response in others. Toxins, however, cause an adverse health effect in most people when intake exceeds a toxin-specific threshold level. Toxins often accumulate in plants as defense compounds against pests or pathogens.

Characteristics of the primary structure of many allergenic proteins have been entered into databases that can be searched for matches to substances for which allergenicity are unknown (Metcalfe et al., 1996; Metcalfe et al., 2003). Most plant allergens come primarily from pollen and are classified as environmental (Luoto et al., 2008).

Allergic rhinitis, or hay fever, while relatively mild in terms of effects, causes respiratory and other morbidities in more than 10 percent of the U.S. population (CDC (Center for Disease Control and Prevention), 2009). Anaphylaxis, a much more serious allergic reaction, includes food-induced reactions that have been estimated to cause 150 to 200 deaths annually in the United States (Sampson, 2003). Food allergies as a group are more prevalent in children than adults, affecting approximately 4 percent of U.S. children under 18 years of age (CDC (Center for Disease Control and Prevention), 2009). From 1997 to 2007, the prevalence of reported food allergies in this group increased 18 percent.

It has been reported that two allergenic proteins, Beta v 1 and Beta v 2, have been identified in pollen from conventional sugar beet (Luoto et al., 2008).

Sugar beet contain several substances that could be considered anti-nutrients, including oxalic acid and saponin (Duke, 1983). Saponins are actively eliminated in sugar processing. Saponins may cause feed intake to be reduced due to the bitter taste imparted by these compounds.

The primary product, sugar, is extracted during processes that result in purity levels of >99.9 percent (Potter and Mansell, 1992; Dutton and Huijbregts, 2006). Older studies have found that a small quantity of impurities trapped within the sugar's crystal lattice might have led to allergic responses in some people (Richter et al., 1976; Potter and Mansell, 1992). It is unclear whether these impurities were due to the sugar beet or the refining process, and whether processes today would result in this same level of impurity. More recent studies have reached mixed conclusions regarding the extent and identity of these beet sugar impurities (Potter et al., 1990; Klein et al., 1998; Parpinello et al., 2004; Oguchi et al., 2009).

Most sugar beet being grown in the United States in recent years are the GE variety designated as H7-1 sugar beet. H7-1 sugar beet was designed to be resistant to the herbicide glyphosate by the insertion of a non-native gene through a well-established *Agrobacterium*-mediated process (Monsanto and KWS SAAT AG, 2004). The genes consist of a promoter sequence (35S of figwort mosaic virus), chloroplast targeting sequence (*ctp2*; from *Arabidopsis thaliana*), *cp4 epsps* coding sequence (from *Agrobacterium* sp. strain CP4), and terminator sequence (E9 3'). The intended purpose of the genetic modification is to develop a sugar beet variety that produces the CP4 EPSPS protein. There are variations in the amino acid sequences of EPSPS among different plants and bacteria. The EPSPS from *Agrobacterium* sp. strain CP4 is just one variant of EPSPS. In conventional plants, including sugar beet, endogenous EPSPS (without the modification due to CP4) regulates the synthesis of aromatic amino acids, such as tyrosine. Applied glyphosate binds to EPSPS and causes plant death by inhibiting EPSPS function. The CP4 EPSPS protein, however, is not inhibited in the presence of glyphosate and thus it continues to function in the synthesis of aromatic amino acids. Mammals do not possess EPSPS proteins or make their own aromatic amino acids, but rather obtain these amino acids from the foods they consume.

In 1999, H7-1 sugar beet field trials were conducted at six distinct field locations distributed across Europe in the major sugar beet production areas. Samples of brei (root tissue processed using standard sugar beet industry methods) and top (leaf) tissues were collected and analyzed for levels of the CP4 EPSPS protein. On average across the sites, concentrations of the CP4 EPSPS protein on a fresh weight basis were found to be 181 µg per g (ranging from 145 to 202 µg per g) in root tissue and 161 µg per g (ranging from 112 to 201 µg per g) in leaf tissue (Monsanto and KWS SAAT AG, 2004). The differences in these ranges likely are not meaningful. For example, the range noted above for the root CP4 EPSPS protein spans 31 percent of the average, which is less than the range of crude protein obtained from controls (51 percent) and reference varieties (38 percent) reported by the petitioner (Monsanto and KWS SAAT AG, 2004). Also, APHIS notes that these ranges are similar to the ranges of the CP4 EPSPS protein in other crops expressing this protein (CERA (Center for Environmental Risk Assessment) and ILSI (International Life Sciences Institute) Research Foundation, 2010).

As noted above, sugar beet is farmed mostly for extraction of their sugar (sucrose) content, and most people consume some quantity of beet sugar. Refined sugar is more than 99.9 percent sucrose (Potter and Mansell, 1992; Dutton and Huijbregts, 2006). The crystalline structure of sucrose is identical regardless of plant source (conventional or GE, sugar beet or cane). Other sugars, minerals, and proteins have been detected in refined sugar at trace levels (Lew, 1972; Potter et al., 1990; Potter and Mansell, 1992; Klein et al., 1998; Parpinello et al., 2004). According to one estimate, protein content in refined sugar is reduced by a minimum factor of 1.7×10^5 (ANZFA, 2001). Thus, while human exposure to (i.e., consumption of) protein gene products via both conventional and H7-1 sugar beet is conceivable, the high purity of the processed beet sugar indicates this exposure is negligible, especially compared to direct ingestion of sugar beet fiber and other products. Furthermore, as discussed in section III.F.1.a(1), FDA generally would consider such proteins, present at generally comparable or greater levels in currently consumed foods that are commonly and safely consumed in the diet, to be presumptively GRAS (Brackett, 2005). FDA has long held that "minor variations in molecular structure that do not affect safety would not ordinarily affect the GRAS status of the substances and, thus, would not ordinarily require regulation of the substance as a food additive (57 FR 22984 at 22990, May 29, 1992)."

Recently, assays have been developed to attempt to detect sugar beet genes in beet sugar, for purposes of identifying the source of the sugar and for labeling (Oguchi et al., 2009). While genetic material in refined sugar might be theoretically possible, the extraction and purification steps of the standard sugar production process are very efficient in removal of nucleic acids, and thus refined sugar does not appear to contain functional DNA (Klein et al., 1998; Oguchi et al., 2009). Japanese scientists, while trying to decide whether mandatory GE labeling would be applicable to sugar products imported to Japan, were unable to detect any DNA in processed sugar products using highly sensitive detection methods –PCR amplification designed to detect as few as five copies of the target DNA (Oguchi et al., 2009). Their studies indicated that sugar beet DNA is degraded early in the sugar purification process. Based on these findings, the Japanese government has determined that sugar does not contain sufficient amounts and/or quality of DNA to warrant labeling.

FDA considers transferred genetic material (nucleic acids) to be presumptively GRAS, and therefore, does not anticipate that such material would itself be subject to food additive regulation (57 FR 22984 at 22990, May 29, 1992). Thus, engineered DNA such as *cp4 epsps* would not ordinarily require regulation of the substance as a food additive. Humans have always consumed large amounts of DNA as a normal component of food and there is no evidence that this consumption has had any adverse effect on human health. H7-1 DNA is chemically no different than other DNA (non-recombinant DNA) found in food. The genetic engineering resulted in the insertion of DNA sequences but left the basic chemical structure unchanged.

Nonsugar products, such as fiber and other substances used in food from beet pulp and molasses, undergo much less processing or are the byproducts of sugar refining. These non-sugar products might contain sugar beet DNA and protein. Animals, but rarely are humans exposed to the fiber, pulp, or molasses directly through ingestion (U.S. FDA, 2004). The ingestion of CP4 EPSPS protein by humans , was addressed as part of the FDA consultation (U.S. FDA, 2004), the USDA–APHIS EA (USDA-APHIS, 2011b), and the petitioner Environmental Report ((Monsanto and KWS SAAT AG, 2010), section 3.11.2) described previously. The following observations can be made based on the available data:

- The CP4 EPSPS protein expressed in H7-1 and other glyphosate-tolerant crops is equivalent to CP4 EPSPS protein expressed in *E. coli* and other glyphosate-tolerant (GT) crops based on molecular weight and by recognition by CP4 EPSPS-specific antibodies to CP4 EPSPS proteins in *E. coli*.

- Except for its reduced affinity for glyphosate, the CP4 EPSPS protein is equivalent to the family of EPSPS proteins that naturally occur in crops.

- No treatment-related adverse effects were observed in an acute toxicity test in which mice were gavaged (orally dosed) with up to 572 mg of CP4 EPSPS per kg of body weight, which would be equivalent to a human ingesting about 221 kg of beet root at one time (assuming a 70-kg adult and the 181-µg per g average noted above for CP4 EPSPS protein in root tissue). The study was designed to reflect a 1,000-fold factor of safety on the highest possible human exposure to CP4 EPSPS, based on assumed exposures to soybean, potato, tomato, and corn at the time the study was done (Harrison et al., 1996). (Note that the 572-mg per kg body weight high-end dose for CP4 EPSPS is the measured dose, as determined by ELISA [enzyme-linked-immunosorbent serologic assay], while the 400-mg per kg body weight high-end dose noted in the EA (USDA-APHIS, 2011c) and Environmental Report (Monsanto and KWS SAAT AG, 2010) is the initial target dose. Also, these sources note that the daily CP4 EPSPS content in the maximum mouse exposure was equivalent to the amount in approximately 160 pounds [73 kg] of H7-1 sugar beet, which could not be independently verified and is about 32 percent of the 221 kg calculated above.).

- The CP4 EPSPS protein does not have biologically relevant amino acid sequence similarities to protein toxins known to cause adverse health effects in humans or animals, based on a comparison of the amino acid sequence of CP4 EPSPS to protein sequences in the ALLPEPTIDES database using the FASTA algorithm (Monsanto and KWS SAAT AG, 2010).

- There are no known reports of allergies or significant pathogenicities to *Agrobacterium* sp., the soil bacterium used as the source of the *cp4 epsps* coding sequence for H7-1 sugar beet and other glyphosate-resistant plant lines (Swiss Institute of Bioinformatics, 2011). This bacterium has been known to infect people, but generally only locally (e.g., in tissues surrounding catheters) in immunocompromised patients, as with many other common bacteria (Van Baarlen et al., 2007).

- There is an absence of immunologically relevant amino acid sequence homology between CP4 EPSPS and known allergens, as determined by comparison using the FASTA algorithm of the amino acid sequence of the CP4 EPSPS protein to sequences in the ALLERGEN3 database (Hileman et al., 2002; Monsanto and KWS SAAT AG, 2010), and as confirmed by APHIS using an updated FASTA database (FARRP (Food Allergy Research and Resource Program).

- The CP4 EPSPS protein is rapidly degraded in *in vitro studies* using simulated gastric and intestinal fluids. Two studies were performed to assess the *in vitro* digestibility of CP4 EPSPS protein. In the first study, the CP4 EPSPS protein was exposed to simulated gastric and intestinal fluids (Harrison et al., 1996). The half-life of the CP4 EPSPS protein was reported to be less than 15 seconds in the gastric fluid, greatly minimizing any potential for the protein to be absorbed in the intestine. The half-life was less than 10 minutes in the simulated intestinal fluid. The second study, conducted under different experimental conditions, reported similar results, as noted in the FDA consultation (U.S. FDA, 2004).

Feeding studies have not revealed adverse effects that can be ascribed to the CP4 EPSPS protein. For example, no differences were observed in CP4 EPSPS protein or gene consumption on feed intake, milk composition, and milk production in dairy cattle fed Roundup Ready® Alfalfa compared with feeds composed of conventional varieties of alfalfa that are similar in nutrient composition. (Combs and Hartnell, 2007). EPA's review of the *cp4 epsps* gene and CP4 EPSPS protein as inert ingredients for a plant-incorporated protectant (PIP), pursuant to section 408(d) of FFDCA in a rulemaking unrelated to H7-1 (but informative nonetheless regarding the risk of H7-1 sugar beet), concluded that both the gene and protein present a low probability of risk to human health and thus warranted an exemption from the requirement for a pesticide tolerance in or on all raw agricultural commodities (40 CFR § 180.1174 and (U.S.EPA, 2005). The CFIA approved H7-1 sugar beet for livestock feed in 2005, noting that "this plant novel trait and novel feed does not present altered environmental risk nor does it present livestock feed safety concerns when compared to currently commercialized sugar beet varieties in Canada" (CFIA, 2005). The European Food Safety Authority has also concluded that food and feed from H7-1 sugar beet are as safe as food and feed from conventional sugar beet (EFSA, 2006).

Regarding allergenicity and toxicity more broadly, the current evidence from similar GE crops such as GT soybeans, GT corn, GT cotton, GT alfalfa, and GT wheat (not commercially grown) suggests that the transgenic CP4 EPSPS protein present in H7-1 sugar beet poses negligible risk to humans (NRC, 2004; Peterson and Shama, 2005; Lemaux, 2009). For example, H7-1 sugar beet has been the subject of a completed consultation at FDA. As part of its consultation regarding H7-1 sugar beet, FDA concluded that the Agency had no questions about the developer's determination that H7-1 sugar beet is not materially different in composition, food and feed safety, or other relevant parameters from conventional sugar beet. (U.S. FDA, 2004). Multiple countries that regulate the importation of biotechnology-derived crops and derived products have granted regulatory approval to H7-1 sugar beet for food and/or feed uses, including Japan, Canada, Mexico, EU, South Korea, Australia, New Zealand, Colombia, Russian Federation, Singapore, and the Philippines (FSANZ (Food Standards Australia New Zealand), 2005; Monsanto and AG, 2007; Berg, 2010). These diverse regulatory authorities have all reached the same conclusion – that food and feed derived from H7-1 sugar beet are as safe and nutritious as food and feed derived from conventional sugar beet.

As described in section III.E.3, the use of tractors and other equipment to cultivate the soil and conduct other activities involved with growing sugar beet can result in engine emissions and fugitive soil particulates, some containing adsorbed pesticides and other agricultural chemicals, being carried by the wind to the neighboring public. These substances can cause serious health effects (Bennett et al., 2004; Baker et al., 2005). These emissions and particulates are an expected consequence of farming in general, but they can be reduced or increased due to changes in farming practices. As discussed more under worker health, section III.F.2.a, cultivation and equipment use has dropped substantially from the pre-2005/6 period of conventional sugar beet production to the more recent 2010/11 period of largely H7-1 sugar beet production. Subsequent reductions in health risks thus are possible.

b. Pesticides

The affected environment in terms of public health and sugar beet production includes the pesticides used in growing sugar beet (insecticides, herbicides, and fungicides). Pesticides are composed of active ingredients (a.i., the chemicals of primary toxicological concern) and inert ingredients (adjuvants, surfactants, preservatives, solvents, diluents, thickeners, and stabilizers). The terms a.i. and inert ingredient are defined by FIFRA, the federal law that governs pesticides. An active ingredient is one that prevents, destroys, repels, or mitigates a pest, or is a plant regulator, defoliant, desiccant, or nitrogen stabilizer. By law, the active ingredient must be identified by name on the pesticide product's label together with its percentage by weight. All other ingredients in a pesticide product are called inert ingredients. An inert ingredient means any substance (or group of similar substances) other than an active ingredient that is intentionally included in a pesticide product. Called "inerts" by the law, the name does not mean non-toxic. Inert ingredients play key roles in the effectiveness of pesticides, such as to prevent caking or foaming, extend product shelf-life, or allow herbicides to penetrate plants. The only inert ingredients approved for use in pesticide products applied to food (such as sugar beet) are those that have either tolerances or tolerance exemptions in the Code of Federal Regulations (CFR), 40 CFR part 180 (the majority are found in sections 180.910 – 960).

People can be directly exposed to pesticides in general via inhalation, oral, and dermal routes if they live on or near farms that use them. They can also be exposed to pesticide residues by ingesting the crops that are sprayed directly, or products derived from crops, including animals fed the crops and the products from these animals (e.g., milk). Consumption of adjacent crops affected by spray drift is also a possible route of exposure, as is inhalation and dermal exposure from spray drift to residents near those spraying operations. Aerial broadcast spraying would tend to increase exposure to nearby residents and bystanders compared to ground-level methods. Migration of pesticides to surface water or groundwater used for drinking water also is a potential pathway for exposure.

EPA evaluates pesticides before they can be marketed and used in the United States, to ensure that they will meet Federal safety standards to protect human health and the environment. EPA undertakes this analysis under the authority of FIFRA and FFDCA. Under FIFRA, EPA regulates the sale, distribution, and use of pesticides. Pesticide products must meet EPA requirements for registration ensuring that the products do not pose unreasonable risks to human health and the environment. Products meeting these requirements are granted a license or “registration” that permits their distribution, sale, and use according to specific use directions and requirements identified on the pesticide label.

FFDCA authorizes EPA to set a tolerance, or maximum residue limit, which is the amount of pesticide residue allowed to remain in or on each treated food commodity. The tolerance is the residue level that triggers enforcement actions. Agricultural products containing pesticide residues above the tolerance level are unlawful. In setting the tolerance, EPA must make a safety finding that the pesticide can be used with “reasonable certainty of no harm” from aggregate exposure to the pesticide chemical residue. To make this finding, EPA considers the following (U.S. EPA 2006d; U.S. EPA 2010c):

- The toxicity of the pesticide and its major break-down products;
- The cumulative effects from exposure to different pesticides that produce similar effects in the human body;
- Whether there is increased susceptibility to infants and children or other sensitive subpopulations from exposure to the pesticide;

- Whether the pesticide produces an effect in humans similar to that produced by a naturally occurring estrogen or produces other endocrine-disruption effects;

- How much of the pesticide is applied and how often;

- The aggregate, non-occupational exposure from the pesticide (exposure through diet, including from milk and other livestock products; from pesticide use in and around the home; and from drinking water); and

- How much of the pesticide (i.e., the residue) remains in or on food by the time it is marketed and prepared.

As discussed previously, sugar beet is an intensively managed crop, and are highly sensitive to pest pressure including weeds, diseases, and insect pests. Nationwide in 2000, 99 percent of the farms growing sugar beet used at least one pesticide application (Ali, 2004). The most recent year available from the National Agricultural Statistics Service (NASS) for pesticide use data for sugar beet is 2000 (USDA-NASS, 2008). In that year, 1.56 million acres of sugar beet were planted and approximately 11 million lb of a.i. of pesticides were used (sections III.B.1.c and f). For perspective:

- Fungicides contributed the largest fraction (8.1 million lb. a.i.; 73 percent), insecticides the second largest (1.7 million lb. a.i.; 15 percent), and herbicides the third (1.4 million lb. a.i.; 12 percent).

- Similarly, sulfur, a fungicide, contributed the single largest amount (7.6 million lb. a.i.; 68 percent); terbufos, an insecticide, contributed the second largest (1.2 million lb. a.i.; 10 percent); and desmedipham, an herbicide, contributed the third largest (0.3 million lb. a.i.; 2 percent).

As noted in section III.B.1.c(5), management practices for conventional sugar beet and H7-1 sugar beet would be expected to be similar with regard to insecticide and fungicide use. Herbicide use, however, is known to have changed substantially as a result of the adoption of H7-1 sugar beet. Therefore, the remainder of this section focuses on public health and safety related to herbicides. An overview of the use of herbicides in sugar beet production is provided, and several factors contributing to human health risks from the herbicides are introduced, including those related to exposure (e.g., quantity used) and those related to inherent toxicity. This discussion is then followed by detailed risk profiles of the primary herbicides used. Risk-based summary data have been compiled as part of the analysis of regulatory alternatives in section IV.F.

As noted in section III.B.1.d, both conventional and H7-1 sugar beet production uses several different herbicides. For 2011, herbicide use pattern data were available for several herbicides used on conventional and H7-1 sugar beet in Minnesota and Eastern North Dakota. Assuming only conventional sugar beet was planted, total herbicide use was estimated at approximately 2.35 million lb. a.i. Assuming only H7-1 sugar beet was planted, total herbicide use is estimated at approximately 1.91 million lb. a.i., a reduction in about 22% of total pounds of herbicide applied. Glyphosate use under the recent H7-1 sugar beet scenario is estimated to be about 7 times greater than previous use, while use of other herbicides is estimated to range from 15 fold to 43 fold less for those that are used. Several of the herbicides were not used at all (see Tables 3-17 and 3-18). As described in section III.B.1.d, however, the use pattern for these herbicides is not straightforward, as many growers use “micro-rates” of herbicides in tank mixes to achieve the desired weed suppression. Growers might use up to five of the “micro-rate” applications through the growing season (USDA-APHIS, 2011b). The more frequent the application, the greater is worker exposure to pesticide as well as the stress to the grower to make timely applications.

FFDCA, section 408(b)(2)(A)(i), Tolerances and Risk, allows EPA to establish a tolerance – the legal limit for a pesticide chemical residue in or on a food – if EPA determines that the tolerance is “safe.” Section 408(b)(2)(A)(ii) defines “safe” to mean that “there is a reasonable certainty that no harm will result from aggregate exposure to the pesticide chemical residue, including all anticipated dietary exposures and all other exposures for which there is reliable information.” This includes exposure through drinking water and in residential settings, but does not include occupational exposure. Section 408(b)(2)(C) requires EPA to give special consideration to exposure of infants and children to the pesticide chemical residue in establishing a tolerance and to “ensure that there is a reasonable certainty that no harm will result to infants and children from aggregate exposure to the pesticide chemical residue.”

Tolerances for herbicides used in conventional sugar beet production are listed in Table 3–51. Tolerances exist for sugar beet throughout many stages of the sugar production process, including roots, tops, dried beet pulp, molasses, and refined sugar. Tolerances have not been established, or were not available in the Code of Federal Regulations (CFR) as of the date of publication of this EIS, for the a.i. trifluralin in sugar beet, although tolerances are available for closely related products.

The subsections below provide toxicity profiles relevant to both long-term and short-term (accidental) public exposure for each of the key herbicides used in the production of sugar beet. This information is intended to help characterize the inherent toxicity of these different herbicides based on laboratory tests of animals, not the actual human exposures and health risks resulting from the application of these herbicides on sugar beet or other crops and lands. The primary reports used for these profiles are cited in the headings. A limited literature search was conducted for each to confirm whether any substantial updates exist to EPA's understanding of the risks. Any additional literature is cited in the profile.

The profiles provided below primarily describe EPA's evaluation of each of the pesticide a.i. and present information on toxicity, metabolism, chances for exposure, and outcomes of long-term risk assessments for the general public. A key metric discussed in these profiles is the reference dose (RfD). The RfD is an estimate (with uncertainty spanning perhaps an order of magnitude) of a daily oral exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime (U.S. EPA 2011c). Another key metric is the chronic population adjusted dose (cPAD), which is the chronic oral RfD adjusted by a safety factor as described in the Food Quality Protection Act (FQPA). The cPAD is required by the FQPA, and takes into account exposures to sensitive subpopulations. Another metric is the acute dietary risk. The acute dietary risk is calculated based on quantity of food eaten in one day and maximum residue values in the food. A risk estimate that is less than 100% of the acute Population Adjusted Dose (aPAD) (the dose at which an individual could be exposed on any given day with no adverse health effects) are considered by the agency to not be of concern.

These profiles also address toxicity from short-term accidental exposures, such as from spills or misuse. Thus, these profiles refer to an EPA permanent damage classification system that organizes acute toxicity data on chemicals based on laboratory test results and route of exposure.

Table III-51. Tolerances for Herbicides Used in Conventional Sugar Beet Production

Agricultural Chemical (Herbicide)	Trade Name (typical)	WSSA Mechanism of Action Group No[1]	Tolerances in ppm:[2] (Dried Pulp/Molasses/Refined Sugar/ Roots/Tops)				
			Dried Pulp	Molasses	Refined Sugar	Roots	Tops
Clethodim	Select®	1	–	1.0	–	0.20	1.0
Clopyralid	Stinger®	4	–	10	–	2.0	3.0
Cycloate	Ro-Neet™	8	–	–	–	0.05	0.05
Desmedipham	Betanex®	5	–	–	–	0.1	5.0
EPTC	Eptam®	8	–	0.4	–	–	0.5
Ethofumesate	Nortron®	8	–	0.5	0.2	0.3	4.0
Glyphosate	(Several)	9	25	–	–	10	10
Phenmedipham	Betamix®	5	0.5	0.2	–	0.1	0.1
Pyrazon	Pyramin®	5	–	1.5	–	0.2	3.0
Quizalofop-p-ethyl	Assure® II	1	–	0.2	–	0.1	0.5
Sethoxydim	Poast®	1	–	10	–	–	3.0
Trifluralin	Treflan® HFP	3	No published tolerances for trifluralin in sugar beet[3]				
Triflusulfuron-methyl	Upbeet®	2	–	–	–	0.05	0.05

[1] Source: (USDA-APHIS, 2011b).
[2] Source: CFR, Title 40, Part 180, Subpart C – Pesticide Tolerances.
[3] Tolerances of 0.05 part per million (ppm) do exist, however, for “sugarcane, cane,” “vegetable, leaves of root and tuber,” and “vegetable, root and tuber, except carrot.” For a further discussion of residues of trifluralin in sugar beet, see the public toxicity profile for trifluralin in section III.F.1.b(12).

The categories are defined in Table 3–52, below. Toxicity categories range from I to IV, depending on how toxic a certain chemical is found to be. A chemical that is in toxicity category I for a specific route of exposure is more toxic than a chemical in category II, and so on. The categories for skin and eye irritation have specific definitions based on laboratory studies in animals, ranging from an effect that is short-term, all the way to one that causes permanent damage.

The toxicity categories for each of the chemicals in this analysis are presented in Table 3–53 below. Additional details on the acute (short term) toxicities of these herbicides are provided in section III.F.1.b on worker risks.

Table III-52. EPA Toxicity Categories (U.S. EPA 2007)

Type of Study	Category I	Category II	Category III	Category IV
Acute Oral	Up to and including 50 mg/kg	>50 thru 500 mg/kg	>500 thru 5,000 mg/kg	>5,000 mg/kg
Acute Dermal	Up to and including 200 mg/kg	>200 thru 2,000 mg/kg	>2,000 thru 5,000 mg/kg	>5,000 mg/kg
Acute Inhalation	Up to and including 0.05 mg/liter	>0.05 thru 0.5 mg/liter	>0.5 thru 2 mg/liter	>2 mg/liter
Primary Eye Irritation	Corrosive (irreversible destruction of ocular tissue) or corneal involvement or irritation persisting for more than 21 days	Corneal involvement or other eye irritation clearing in 8–21 days	Corneal involvement or other eye irritation clearing in 7 days or less	Minimal effects clearing in less than 24 hours
Primary Skin Irritation	Corrosive (tissue destruction into the dermis and/or scarring)	Severe irritation at 72 hours (severe erythema or edema)	Moderate irritation at 72 hours (moderate erythema)	Mild or slight irritation at 72 hours (no irritation or slight erythema)

Table III-53. EPA Toxicity Categories for Herbicides Used in Conventional Sugar Beet Production [1]

Active Ingredient	Oral	Dermal	Inhalation	Skin Irritation	Eye Irritation	Skin Sensitization
Clethodim	III	IV	III	I	III	No
Clopyralid	IV	IV	IV	No	I	No
Cycloate	III	IV	IV	III	III	Yes
Desmedipham	IV	III	IV	IV	II	Yes
EPTC	III	III	II	IV	III	Slight/Weak
Ethofumesate	IV	IV	II	IV	IV	No
Glyphosate	IV	IV	Study Waived	IV	III	No
Phenmedipham	III	III	IV	IV	IV	No
Pyrazon	III	IV	IV	IV	IV	No
Quizalofop-p-ethyl	III	IV	IV	IV	IV	No
Sethoxydim	IV	III	III	IV	III	Yes
Trifluralin	IV	III	III	IV	III	Yes
Triflusulfuron-methyl	III	III	II	IV	III	Slight/Weak

[1] The toxicity profiles in the subsections for each herbicide provide the data sources for these categories.

(1) Clethodim

Clethodim is a selective postemergence cyclohexanedione herbicide that is used to control annual and perennial grasses in broadleaf crops including soybeans, peanuts, cotton, flax, sunflowers, alfalfa, sugar beet, and others. Clethodim is of moderate to low acute toxicity by oral (III), dermal (IV), or inhalation (III) exposure. However, clethodim is a severe dermal irritant in EPA toxicity category I. Clethodim is not a skin sensitizer (a compound that causes a worsening allergic response with subsequent exposures), but does cause moderate eye irritation (toxicity category III). EPA reviewed animal studies that evaluated whether clethodim would be likely to cause cancer and concluded that clethodim is "not likely" to be a human carcinogen. (U.S. EPA 2008b)

The primary target organ (the organ in which the critical toxic effect is seen) for clethodim toxicity is the liver, based on studies in rats and dogs. Endpoints of toxicological concern in these chronic oral studies are: liver tissue changes without evidence of cancer, increased liver weight, and decreased body weight. A long-term study was also conducted in mice that were fed clethodim in their diet at high doses. The adverse effects noted included decreases in healthy blood parameters, decreases in liver weights with increased size of liver lobe cells, increased pigment of the bile duct, abnormal cell reproduction, and decreased survival by test subjects. Rats exposed to clethodim on their skin at the highest doses had anogenital discharge, decreases in body weight gains and weight gain relative to food consumption, and increased liver weight. Reproductive studies with clethodim in rats did not show adverse reproductive effects and clethodim did not cause developmental toxicity in rat studies.

In the metabolism and pharmacokinetics study, clethodim was readily absorbed, excreted mainly in the urine, was rapidly and extensively metabolized with the predominant metabolite as clethodim sulphoxide and less than 1% eliminated as the unchanged parent compound. In a skin absorption study in rats, researchers found that about 30 percent of the applied clethodim was absorbed by the body.

The chronic oral RfD for clethodim is 0.01 mg per kg per day and is based on changes in blood chemistry and increased absolute and relative liver weights from a chronic oral study in dogs. The cPAD for clethodim is the same as the chronic oral RfD, 0.01 mg per kg per day. If the exposure estimate from an EPA risk assessment exceeds the cPAD, then the exposure is deemed by the EPA to be of concern for the general population and more sensitive subgroups (U.S.EPA, 2000). EPA conducted a chronic dietary risk assessment for clethodim and found that the risk estimate for food and drinking water was 27 percent of the cPAD for the U.S. population in general, and 73 percent of the cPAD for children 1–2 years of age (the highest exposed population subgroup). There is no appropriate endpoint for assessing acute dietary exposure; therefore, no acute dietary assessments have been performed.

Tolerances for clethodim and its metabolites on sugar beet crops have been established for sugar beet roots, tops, and molasses from the processed beet, as stated in 40 CFR §180.458. The tolerance for roots is 0.2 ppm, and the tolerance for residues on molasses and sugar beet tops is 1.0 ppm (see Table 3–51). EPA has established that adequate analytical methods exist for data collection and the enforcement of tolerances for clethodim.

EPA found that post-application exposure to clethodim is unlikely except following its use in transplanted sod, because application of clethodim as a spot treatment in grass—the likely public use—would result in minimal, if any, contact with clethodim residues. Although the EPA does not believe residential handler exposures are likely to occur, it does recommend that label revisions be made stating that such that products containing clethodim include the statement, "Recommended for Commercial Applicators Only."

(2) Clopyralid

Clopyralid is an herbicide in the pyridine family and is used to control broadleaf weeds in a variety of crops, including Swiss chard, sugar beet, bushberries, cole crops, oats, strawberries, and others. Clopyralid is low in toxicity (EPA toxicity category IV) for oral, dermal, and inhalation exposure, and is not a skin irritant or skin sensitizer. The acid form of clopyralid is a severe eye irritant in EPA toxicity category I. No evidence of carcinogenicity was found in 2-year studies with mice and rats, nor were findings positive for mutagenicity or clastogenicity found in bacterial studies. Clopyralid has been classified by EPA as "not likely to be carcinogenic to humans."(U.S. EPA 2009b)

None of the animal toxicity studies that EPA evaluated indicated that there was a single organ that experienced the critical toxic effect when clopyralid entered the body. Adverse effects in various organs were noted in the test animals. These effects included: changes in blood cells and blood chemistry, lesions on the skin, liver weight increases, and decreased gains in body weight. No pre- or post-natal sensitivity was noted in response to clopyralid exposure in the animals tested, except at doses that caused severe toxicity to the maternal animals.

Clopyralid is absorbed into the body almost completely at both high and low doses, based on studies in rats. The absorbed clopyralid was eliminated by the animals mainly in the urine within 72 hours after exposure, though the majority of animals removed the clopyralid within

6 to 12 hours after they were exposed. In the studies conducted, there was no evidence that clopyralid was modified by the body, and only clopyralid was found in the urine and feces of the experimental animals.

The chronic, or long-term, oral RfD for clopyralid is 0.15 mg per kg per day and is based on tissue changes in the stomach of rats that were fed clopyralid in their diets for 2 years. Rats had evidence of abnormal cell growth in their stomachs and thickening of a specific part of the stomach, the limiting ridge. The limiting ridge is not found in primate or dog stomachs. However, researchers attributed the adverse effects to irritation, an effect which EPA concluded was relevant to humans. Stomach lesions were also found in long-term studies with rats and rabbits exposed to clopyralid.

The chronic cPAD is the chronic oral RfD adjusted by a safety factor as described in the FQPA. The cPAD is required by FQPA, and takes into account potential exposures for sensitive subpopulations. The cPAD for clopyralid is the same as the chronic oral RfD at 0.15 mg per kg per day. If an exposure estimate produced from an EPA risk assessment exceeds the cPAD, then the exposure is deemed to be of concern for the general population and sensitive population subgroups (U.S.EPA, 2000). An acute endpoint was also determined for clopyralid. The aPAD is the same as the acute RfD at 0.75 mg per kg per day (U.S. EPA 2009a). Both the EPA chronic and acute dietary risk assessment assumes that all crops in the model were treated with the herbicide, and that residues on all of the crops were at the tolerance level (the maximum pesticide residue allowed on a crop) for each commodity. Additionally, modeled estimates of clopyralid residues in drinking water were incorporated into the analyses. EPA's chronic dietary risk assessment estimate was at 9 percent of the cPAD for the general U.S. population and 23 percent of the cPAD for children 1-2 years old, the most highly exposed population subgroup, both of which are deemed to be not of concern for this compound. EPA's acute dietary risk assessment estimate was at 5 percent of the aPAD for the general U.S. population, and 9 percent of the aPAD for children 1-2 years old, the most highly exposed population subgroup, both of which are risks that are not of concern for this compound (U.S. EPA 2009a)

Tolerances have been established for clopyralid and its metabolites on sugar beet roots, tops, and molasses from the processed beet, as stated in 40 CFR §180.431. The tolerance for roots is 2.0 ppm, the tolerance for residues on sugar beet tops is 3.0 ppm, and the tolerance for residues in molasses is 10.0 ppm.

EPA conducted a residential exposure estimate in 2002 to address non-occupational risk, and did not update the estimate in the 2009 human health risk assessment because there were no new residential uses of clopyralid. In their assessment, EPA only considered oral and inhalation pathways of exposure to clopyralid for assessing non-occupational risk. Dermal exposures were not considered based on a lack of adverse effects at the highest dose tested in a 21-day dermal toxicity study in rabbits. EPA evaluated acute residential exposure from lawn treatment activities for handlers of the products, and for toddlers that might ingest granules applied to lawns. EPA noted that "…due to the episodic nature of granule ingestion, it is not appropriate to include this source of exposure in aggregate assessments." EPA concluded that acute residential exposures from these aggregated pathways were risks not of concern. In their assessment of long-term aggregate risk from clopyralid, EPA determined that there are no non-dietary exposure scenarios appropriate for assessing long-term exposures. As a result, the long-term aggregate risk from clopyralid is equivalent to the chronic dietary risk, and EPA concluded that the risks were also not of concern.

EPA evaluated the exposure potential from spray drift for residents living near spraying operations using products containing clopyralid. EPA worked with the Spray Drift Task Force (which includes representatives from industry, EPA Regional Offices, State Lead Pesticide Agencies, and other parties) to develop spray drift management practices. As a result, EPA is requiring interim mitigation measures to be placed on product labels and labeling for aerial applications. EPA is also considering further refinements of their policy to reduce off-target drift risks to the general public.

(3) Cycloate

Cycloate is a pre-emergent, broad spectrum herbicide that is used to manage multiple broadleaf weeds, annual grasses, and selective perennial grasses; it is primarily used on spinach, sugar beet, and garden beet. Cycloate is of low acute toxicity by oral (category III), dermal (category III), and inhalation (category IV) exposure. Cycloate is not an eye or skin irritant, or a dermal sensitizer. Based on the available data reviewed by EPA, it was concluded that cycloate is "not likely to be carcinogenic to humans."(U.S. EPA 2004)

Studies in several species indicate that the primary critical effect of cycloate is neurotoxicity of the central and peripheral nervous systems. Acute exposures in rats have shown nerve cell death in areas of the brain that control smell, memory, and stress responses. A chronic toxicity/carcinogenicity study reported wasting of the spinal nerves and changes to the femoral nerve in females dosed with 3.1 mg per kg per day of cycloate. Developmental toxicity studies have shown that cycloate does not cause developmental effects in rats or rabbits. Multi-generation reproductive studies showed decreased body weight in the offspring, decreased body weight gains, and decreased food consumption, as well as changes in the tissues of the nervous system, focusing on the brain and spinal cord.

Metabolism studies in the rat and mouse indicate that the primary route of elimination is through the urine and that N-ethylcyclohexylamine is the primary urinary metabolite. Cycloate and its metabolites do not bioaccumulate; however, oral administration half-lives indicate there are some slow metabolizers/excreters of this chemical. Absorption ranged from 61–68 percent. At 192 hours, tissue concentrations were low, with most remaining residues in the liver and kidneys.

The chronic oral RfD for cycloate is 0.005 mg per kg per day and is based on spinal nerve axonal atrophy and femoral nerve alterations in female rats. The acute RfD equals the aPAD and is 0.066 mg/kg.day for the general U.S. population. The cPAD for cycloate is the same as the chronic oral RfD. EPA conducted a chronic dietary risk assessment for cycloate and found that the risk estimate for food and drinking water was 2.4 percent of the cPAD for the U.S. population in general, and 5.5 percent of the cPAD for children 3–5 years of age (the highest exposed population subgroup) both risks of which are not of concern. The acute (food only) dietary exposure estimates are not of concern (<100% aPAD) for the general U.S. population and all population subgroups. The acute assessment resulted in an exposure estimate for the general U. S. population at 0.000408 mg/kg/day, or <1% of the aPAD at 95% exposure. The most highly exposed subpopulation was children aged 3-5 years, at 0.000755 mg/kg/day, or 1.1% of the aPAD at 95% exposure.

In 2004, EPA reassessed the tolerances for cycloate residues on sugar beet tops and roots. EPA determined that the total toxic residues to be regulated in the target crops, including sugar beet, should consist of cycloate and its metabolites (breakdown products). Based on this determination, EPA then recommended that the tolerance expression and levels should be amended to reflect this determination. As a result, EPA recommended that the current tolerance (expressed as cycloate, per se) of 0.05 ppm for garden beet roots be reassessed at 0.50 ppm, expressed as cycloate and its 3HC and 4HC metabolites; and that the current tolerance (expressed as cycloate, per se) of 0.05 ppm for garden beet tops be reassessed at 1.0 ppm, expressed as cycloate and its 3HC and 4HC metabolites. However, these tolerances have not been officially adopted or codified as of 2010, and the tolerance level of 0.05 ppm remains for cycloate residues on sugar beet roots and tops. The established tolerances for cycloate on sugar beet roots and tops are stated in 40 CFR §180.212.

Products containing cycloate are not registered for residential use, or for use around public buildings, recreational areas, or schools. Since non-occupational and residential exposure are not expected, only dietary exposure sources were considered for aggregate risk assessment. EPA has established that no population or subgroup posed risks of concern for either acute of chronic dietary exposure to cycloate based on food and water exposure, and that no risk concerns for aggregate exposure exist.

(4) Desmedipham

Desmedipham is an herbicide used to manage annual weeds (including sowthistle, coast fiddleneck, common lambsquarters, nettleleaf goosefoot, prostrate pigweed, wild buckwheat, and wild mustard). Desmedipham is used primarily on non-food crops such as Swiss chard and table beet (both grown for seed), and for food crops such as sugar beet. Desmedipham is of low acute toxicity by oral (category IV), dermal toxicity(category III),dermal irriation (category IV), and inhalation (category IV) exposure. It is a dermal sensitizer. It is an eye irritant (toxicity category II) and a mild skin irritant (category III). Desmedipham is classified as Group E for carcinogenicity, based on "evidence of non-carcinogenicity for humans."(U.S. EPA 2005a)

Studies on the subchronic and chronic toxicity of desmedipham in rats and dogs indicate that this substance primarily affects the blood, as evidenced by consistent hematological effects (e.g., anemia and increases in methemoglobin formation). Several studies also reported effects in the spleen and the thyroid (decreases in thyroid hormones and thyroid weight). In a 2-year study in rats, authors reported significant decreases in body weights, dose-related anemia, increased methemoglobin formation (which indicates a decrease in the ability of the blood to carry oxygen); and significant decreases in red blood cell counts and hemoglobin (the blood protein that transports oxygen). Mild changes in the thyroid function of mid- and high-dose females and increased spleen weights in both sexes were also noted.

Several chronic and carcinogenicity studies in mice and rats indicate that desmedipham is not likely carcinogenic. Developmental studies indicate that *in utero* exposure to desmedipham may cause reduced body weight and increased incidence of external and skeletal defects in offspring of animals exposed at high dose levels. A two-generation reproduction study with desmedipham in rats showed no evidence of reproductive toxicity.

When animals were fed a low dose of desmedipham, absorption of the chemical was rapid but incomplete. In the studies, excretion (removal) of desmedipham occurred mainly via the urine. At the low single or repeated dose of 5 mg/kg, excretion was mainly through the urine where nearly

67-84% of the administered dose was collected by 30 hours post-exposure. Ninety-six hours after dosing, levels of desmedipham in the tissues were very small except in the blood and plasma, where measurable amounts were found. The major urinary metabolites identified were ethyl-N-(3-

hydroxyphenyl) carbamate and 4-acetamidophenol, depending on how the metabolites were tracked.

EPA assessed occupational exposure for desmedipham and determined that there is the potential for short- and intermediate-term exposures from handling desmedipham products during the application process to sugar beet. The short- and intermediate- term Margins of Exposure (MOE) for some scenarios were not of concern for pesticide handlers. The addition of personal protective equipment and engineering controls resulted in exposures that were not of concern for all exposure scenarios. Post-application exposures may occur following applications to sugar beet during routine crop-production tasks; however, EPA concluded that health risks to handlers from post-application exposures would not pose a significant risk.

The chronic oral RfD for desmedipham is 0.04 mg/kg and the acute RfD is 0.1 mg/kg. Tolerances for desmedipham have been established for sugar beet roots and tops, as stated in 40 CFR §180.353. In 2005, the registrant of desmedipham products, Bayer CropScience, requested that the tolerance for sugar beet tops be raised from 0.2 ppm to 15 ppm, based on the registrant's submitted data from field trials. EPA required the registrant to submit additional field trial data before the tolerance could be reassessed. The tolerances for desmedipham on sugar beet tops and roots were updated in September of 2008. Additional supporting information on the action was not found. The updated tolerances for sugar beet are 0.1 ppm for roots and 5.0 ppm for tops.

EPA is required to conduct a residential exposure assessment for a.i. if certain toxicological criteria are observed and if there is potential for residential exposure. There are no residential uses of desmedipham, therefore the residential exposure/risk assessment was not conducted by EPA as part of the reregistration process for desmedipham.

(5) EPTC

The summary below is based on EPA's 1999 RED for EPTC.(U.S. EPA 1999) It should be noted that the EPA is currently reevaluating EPTC and therefore some of the information regarding the EPA assessment of EPTC may change.

EPTC (S-ethyl dipropylcarbamothioate) is a pre- and postemergence herbicide that is used to control germinating annual weeds (including sedges, grasses, and broadleaf weeds) in potatoes, peas, dry beans, corn, alfalfa, and snap beans. EPTC is of moderate toxicity (category III) by the dermal and oral routes and slightly irritating to the eyes (category III). EPTC is moderately toxic by inhalation (category II). EPTC is not carcinogenic, based on long-term studies in rats and mice and a lack of carcinogenic effect in other long-term studies. Long-term reproductive and developmental studies with EPTC have also not shown carcinogenic effects.

Studies in several species indicate that deterioration of the heart muscle and nerve cell death are the main adverse effects of chronic, or long-term, EPTC exposure. Toxicity of the heart muscle occurred in subchronic (a duration between short- and long-term) and long-term studies of exposure to EPTC. Rats and dogs fed EPTC showed signs of nervous system toxicity. In these studies, scientists reported dose-related increases in the number of occurrences and severity of nerve cell death and degeneration of the tissue in the brain, skeletal muscle, and various peripheral nerves. EPTC also interferes with cholinesterase (an enzyme that allows for normal nerve function) in the blood and brain, but these effects are reversible. Although EPTC is a primary eye and skin irritant, absorption through the skin is fairly low due to the relatively high evaporation of EPTC from the skin. Long-term studies have shown no evidence of carcinogenicity from exposure to EPTC. Developmental studies in rats and rabbits showed decreased fetal body weights and decreased litter sizes, but these effects were related to the significant maternal toxicity (decreased body weight and increased mortality) caused by EPTC exposure.

Studies of the metabolism of EPTC indicate it is rapidly absorbed and eliminated from the body. Studies have shown that very little EPTC accumulates in the body. Urine is the main route of elimination of EPTC, though lesser amounts are eliminated in feces and by exhalation. There were no observed difference in elimination of EPTC between males and females.

The chronic oral RfD for EPTC is 0.025 mg per kg per day and is based on dose-related increases in heart muscle deterioration in parent rats during a two-generation reproductive study. The cPAD for EPTC is 0.0025 mg per kg per day, and is based on the chronic oral RfD. EPA conducted a chronic dietary exposure assessment and found that the risk estimate based on exposure to residues of EPTC was 9.6 percent of the cPAD for the U.S. population in general, and 17.4 percent of the cPAD for children 1–6 years of age (the highest exposed sub-group). These levels are risks that are not of concern for chronic dietary exposure.

Tolerances for EPTC and its metabolites have been established for sugar beet tops and for molasses from the processed sugar beet, as stated in 40 CFR §180.117. The tolerance of 0.1 ppm for sugar beet roots, tops, and molasses was revoked in 1999 due to the removal of an outdated commodity classification system. The current tolerance for sugar beet tops is 0.5 ppm and the tolerance for residues in sugar beet molasses is 0.4 ppm.

Products containing EPTC are registered for use in residential gardens for vegetables and ornamental plants. In their risk assessment, EPA determined that residential handlers were more likely to transplant seedlings and plant seeds by hand, thus increasing their chances of exposure to EPTC. Additionally, EPA concluded there is potential oral exposure to children from ingestion of EPTC-treated soil. Skin and inhalation exposures for residential handlers can occur during handling, mixing, loading, and application, though these exposures are classified as short term because applications of EPTC typically only occur once per year. The four major residential exposure scenarios are as follows: loading/applying granular products with a push-type spreader, a belly grinder spreader, by hand/spoon, or by applying granular products with a shaker can. Post-application exposure scenarios include EPTC use in parks, recreational areas, and golf courses, in addition to private residential use.

For the four scenarios of residential exposure assessed by EPA, only the belly grinder spreader posed risks of concern for dermal exposure. None of the inhalation exposures evaluated posed risks of concern for residential exposure. As part of their risk assessment, EPA has required manufacturers of products that use the belly grinder spreader to remove that method of application from their labels.

In their assessment of aggregate risks from EPTC, EPA concluded that the acute, short-term (1–7 days), and lifetime aggregate risks from exposure to EPTC from the diet (food and drinking water) and from residential exposures do not pose risks of concern. EPA has concluded with reasonable certainty that no harm would result to the general public from acute or short or long-term dietary exposure to EPTC.

(6) Ethofumesate

Ethofumesate is a selective, pre- and post-emergent terrestrial herbicide that is incorporated into the soil to manage grasses and broad-leaf weeds primarily in sugar and other beet crops, but also in carrots, garlic, onions, shallots, and certain grasses (such as grasses for feed and on golf courses). Ethofumesate is of low acute toxicity (category IV) by oral and dermal exposure, but is of moderate toxicity by inhalation exposure (category II). It is not a dermal (category IV) or eye irritant (category IV), and is not a dermal sensitizer. The U.S. EPA Health Effects Division (HED) RfD Committee in 1993 classified ethoumesate as having "inadequate information to classify as a carcinogen." However after evaluation by the HED Hazard Identification Assessment Review Committee (HIARC) in 2004, it was concluded that ethofumesate should be classified as "not likely to be carcinogenic to humans."(U.S. EPA 2006b)

The target organ of ethofumesate toxicity is the liver. The main effects reported in 90-day feeding studies in rats and dogs included decreases in body weight gain and liver toxicity. Mice are less sensitive to ethofumesate than rats, dogs, or rabbits. Reproductive and developmental toxicity has been reported in rabbits exposed to ethofumesate. Effects noted include abortions, resorptions of litters, and incomplete development of backbones in offspring of mothers that were treated. Maternal weight loss and death was also reported at high doses. However, developmental and reproductive effects have not been reported in rats. Tests to evaluate whether ethofumesate can cause DNA mutations, in living animals and in cell cultures grown in the laboratory, indicate that ethofumesate is not likely to be carcinogenic.

A metabolism study in rats indicated that ethofumesate is eliminated from the body mainly through the urine. In a study, most of the ethofumesate that was given to test animals (rats) was eliminated within 5 days after exposure. Breakdown products of ethofumesate are reported to have similar effects on the body as ethofumesate.

Based on the evidence of reproductive toxicity in animals exposed to ethofumesate, two chronic oral RfD values were developed by EPA. The first chronic oral RfD of 0.3 mg per kg per day was set for women ages 13–49 and is based on a developmental toxicity study in rabbits that found increased resorption of developing fetuses, loss of young after implantation, and incomplete development of the vertebrae bones. The second chronic oral RfD of 1.3 mg per kg per day for ethofumesate is set for the general population, including infants and children, and is based on decreased body weight gain in females in a long-term toxicity and cancer study in rats. The cPAD values for ethofumesate are 0.3 mg per kg per day for women ages 13–49 and 1.3 mg per kg per day for the general public including infants and children and are based on the same studies, respectively, as the RfDs. The estimated chronic dietary exposure from food and drinking water is less than 1 percent of the cPAD for all population subgroups. An acute dietary risk endpoint was identified for the population of females (13-49 years) based on a developmental toxicity study in rabbits. The aPAD value is 0.3 mg/kg/day The acute dietary estimates do not pose risks of concern at 4% of the aPAD at the 95th percentile for the female (age 13-49 years old) subgroup population. No appropriate endpoint was identified for the general population and infants.

Tolerances for ethofumesate and its metabolites have been established for sugar beet roots, tops, refined sugar, and molasses from the processed beet, as stated in 40 CFR §180.345. The tolerance for tops is 4.0 ppm, the tolerance for roots is 0.3 ppm, the tolerance for refined sugar is 0.2 ppm, and the tolerance for residues in molasses is 0.5 ppm.

Residential exposure to ethofumesate is expected to be limited to exposure via food, drinking water, and potential short-term post-application exposure of adults and children from lawn care applications and time spent at golf course (e.g., incidental ingestion and dermal exposure). With the exception of women of child-bearing years, residential post-application MOE for toddlers and adults do not exceed EPA levels of concern for the most common rate of 1.5 lb a.i. per acre and the occasional rate of 3.0 lb per a.i. per acre.

With the exception of women of childbearing years, residential post-application MOEs for toddlers and adults to ethofumesate on treated turf, regardless of the pathway of exposure, do not exceed the Agency's levels of concern. For women of childbearing age, MOE values of 73 (application rate of 1.5 lb a.i. per acre) and 37 (application rate of 3.0 lb a.i. per acre) were estimated based on a developmental study in rabbits and a conservative assumption that dermal absorption will be 100 percent, and screening-level assumptions regarding exposure from the Agency's SOPs including high contact activities on turf immediately posttreatment. Additionally, the endpoint used for females 13+ years of age comes from a developmental study in rabbits that has a steep dose-response curve resulting from a NOAEL (30 mg/kg/day) that is 10X lower than the LOAEL (300 mg/kg/day); thus, a dose spacing issue may likely exists. EPA therefore, considers this a highly conservative estimate of post-application risk for the population females 13-49 years of age exposed to ethofumesate on turf. These MOE Values pose risks of concern for this exposure pathway. The MOE values also incorporated screening-level assumptions regarding exposure that included high contact activities (aerobics) on turf immediately post-treatment. No additional mitigation or data needs for exposure to ethofumesate for women of childbearing age were discussed by EPA.

(7) Glyphosate

Glyphosate is a systemic, non-selective herbicide that is used to control weeds in many crops including soybeans, corn, cotton, sugar beet, and canola. Glyphosate is of low acute toxicity (category IV) by oral and dermal exposure. The requirement for an acute inhalation study was waived by EPA in their assessment of glyphosate (U.S. EPA 2006d). Glyphosate caused moderate eye irritation that cleared within 7 days or fewer (category III). Glyphosate is a mild/slight skin irritant (category IV) and is not a dermal sensitizer. EPA reviewed animal studies that evaluated whether glyphosate would be likely to cause cancer and concluded that glyphosate is in Group E, "no evidence of human carcinogenicity (U.S. EPA 2006d)."

Glyphosate has shown adverse reproductive effects in two-generation developmental toxicity studies in rabbits and rats (U.S. EPA 2006d). Rabbits exposed to glyphosate showed mortality, diarrhea, and nasal discharge at 350 mg per kg per day in a developmental toxicity study. A developmental study in rats showed incomplete development of the sternebrae (a structure similar to the sternum or breastbone in humans) and decreased body weights in the offspring of mothers exposed at 3,500 mg per kg per day. At the same dose, the mothers were found to have mortality, decreases in the total number of viable offspring, decreases in implantation of fetuses in the uterus, decreased body weight gain, diarrhea, inactivity, and red matting on the head, forelimbs, nose, and mouth. On the basis of developmental studies in rats and rabbits and reproductive findings in rats, glyphosate exhibited no evidence of increased qualitative and quantitative susceptibility.

A chronic oral RfD of 1.75 mg per kg per day has been established by EPA based on the developmental study in rabbits that found death in maternal animals, along with diarrhea and abnormal nasal discharge (U.S. EPA 2006d). The cPAD for glyphosate is the same as the RfD, at 1.75 mg per kg per day (U.S. EPA 2006d). The EPA level of concern was 100 for short-, intermediate- and long-term incidental oral exposure, meaning that exposures equal to or greater than 175 mg per kg per day pose risks of concern. The risk estimate for short-, intermediate- and long-term dietary exposure to glyphosate does not pose risks of concern for the U.S. population in general, as well as population subgroups. The chronic exposure estimates for the U.S. population and infants <1 year old (the most highly exposed population subgroup) are 2% and 7% of the cPAD, respectively. There is no aRfD based on the absence of an appropriate toxicological endpoint attributable to a single exposure (dose), including maternal toxicity in developmental toxicity studies.

In lactating goats and laying hens that were fed a mixture of glyphosate and AMPA, a breakdown product, showed that the main route of elimination of glyphosate was through the urine and feces (U.S. EPA 2006d). Residues of glyphosate and AMPA were found in the eggs, milk, and in livestock meat in those studies. In similar studies with rats, 30–36 percent of the glyphosate that animals were exposed to was absorbed into the body. More than 97 percent of the glyphosate that the animals were given was eliminated unchanged from the feces and urine (U.S. EPA 2006d). Small amounts of the breakdown product AMPA were also detected in the feces and urine. Less than one percent of the glyphosate that the animals were exposed to was found in the animals' bones at the conclusion of the study (U.S. EPA 2006d).

On February 20, 1998, EPA issued a notice announcing the filing of two pesticide petitions by Monsanto/KWS SAAT AG in the *Federal Register*. No public comments were received in response to the notice of filing. The data EPA evaluated led to the increase in the tolerance levels for glyphosate because the agency was reasonably certain that no harm would result from residues of glyphosate below these levels. Therefore, on April 14, 1999, EPA issued a final rule that increased the tolerance levels for glyphosate in or on sugar beet dried pulp, sugar beet roots, and sugar beet tops. The tolerance for sugar beet pulp is now 25 ppm and for sugar beet roots and tops it is 10 ppm. Thus, while in EPA's reregistration eligibility decision (RED) for glyphosate in 1993, a tolerance of 0.2 ppm on sugar beet was assessed and found to be acceptable (U.S. EPA 1993a), in 1998, the tolerance for glyphosate on sugar beet was increased to 10 ppm for roots and tops, and to 25 ppm for dried pulp, which represents a 50- to 125-fold increase in allowable residues of glyphosate on sugar beet (EPA, 1998).

The qualitative nature of glyphosate residue in plants and animals appears to be adequately understood, and studies with a variety of plants indicate that uptake of glyphosate from soil is limited. The material that is taken up is readily translocated throughout the plant. In animals, whether ingested or absorbed, most glyphosate is essentially not metabolized and is rapidly eliminated in urine and feces. Enforcement methods are available to detect residues of glyphosate in or on plants. EPA conducted a dietary risk assessment for glyphosate based on a worst-case risk scenario, that is, assuming that 100 percent of all possible commodities or acreage was treated, and assuming that tolerance-level residues remained in or on all treated commodities. Based on the assessment, EPA concluded that the chronic dietary risk posed by glyphosate food uses is minimal (U.S. EPA 1993a). An appropriate endpoint attributable to a single dose was not identified in the glyphosate toxiclogical database; therefore, an acute anlaysis is unnecessary.

APHIS Biotechnology Regulatory Services (BRS) has also reviewed the data supplied to EPA and agrees with EPA's assessment regarding the reasonable certainty that no harm would result from residues of glyphosate below the tolerances. APHIS is not aware of any new peer-reviewed data that have demonstrated a need for reassessment of EPA's original decision to increase glyphosate tolerances for sugar beet.

(8) Phenmedipham

Phenmedipham is a selective herbicide used to manage broadleaf weeds. It is primarily used in sugar beet, table beet, and spinach, as well as Swiss chard grown for seed. Phenmedipham is of low acute toxicity by oral (category IV) and dermal (category III) exposure. The acute toxicity category for inhalation exposure has not been established, as EPA waived the original study for inhalation exposure in 1988. Phenmedipham is a non-irritant to eyes and skin (category IV) and is not a dermal sensitizer. EPA has classified phenmedipham as "not likely to be carcinogenic to humans," based on studies in rats and mice (U.S. EPA 2005g).

The target of phenmedipham toxicity is the red blood cells. Hemolytic anemia (a decrease in red blood cells due to the abnormal breakdown of the cells) is the main adverse effect. A long-term dietary study with phenmedipham showed that hemolytic anemia occurred in both sexes of rats. In the same study, males showed abnormal cell multiplication in the kidneys and deposits of calcium in the kidneys, a condition which decreases the kidneys' ability to function efficiently. Females showed decreases in body weight, body weight gain, and food efficiency (how well the animals use the food they ate to grow and mature). A pair of two-generation studies (one in rats and one in rabbits) indicated that there is no evidence of developmental toxicity from exposure to phenmedipham.

A skin absorption study in the rat showed that 10 percent of the applied phenmedipham was absorbed into the system. No additional information was found in the sources consulted on the distribution, metabolism, or excretion of phenmedipham.

The chronic oral RfD for phenmedipham is 0.24 mg per kg per day and is based on a combined chronic toxicity/cancer study in male and female rats that showed hemolytic anemia in both sexes, as well as changes in body weights and food efficiencies for females and kidney toxicity for males. The cPAD for phenmedipham is the same as the chronic oral RfD, at 0.24 mg per kg per day. EPA conducted a chronic dietary exposure assessment and found that the risk estimate for food and drinking water contribution was less than 1 percent of the cPAD for the general U.S. population and all population subgroups. There are no studies that identify an acute hazard based on toxic effects observed for phenmedipham that would likely result from a single oral exposure. Therefore,an acute analysis is unnecessary.

Tolerances were initially established for residues of phenmedipham on sugar beet roots and tops at 0.1 ppm for both commodities. In their reassessment of the tolerances, EPA concluded that phenmedipham residues from sugar beet dried pulp and molasses do not pose any risks of concern. However, EPA also concluded that phenmedipham concentrates in sugar beet pulp and molasses at 3X and 1.3X the rate, respectively, than in unprocessed sugar beet roots. Therefore, the final tolerance for phenmedipham in dried pulp is 0.5 ppm, for molasses is 0.2 ppm, and for both roots and tops is 0.1 ppm, as stated in 40 CFR §180.278.

To assess the risks to the public from exposure to phenmedipham, EPA conducted an assessment for aggregate exposure through food and drinking water. Residential exposures to phenmedipham were not considered, as there are no home-use products registered that contain phenmedipham. Based on their assessment of food and drinking water, EPA concluded that risks from exposure to residues below the tolerance levels for phenmedipham are within acceptable levels and thereby meet the FQPA safety standards.

According to the EPA dietary risk assessment, there are no dietary exposures of concern for phenmedipham. EPA considers their assessment to be protective of the general U.S. population, as well sensitive subpopulations, including infants and children.

(9) Pyrazon)

Pyrazon is used as a preplant, preemergence, and early postemergence herbicide. Pyrazon acts by preventing photosynthesis from happening normally in green plants. It is used primarily in sugar beet and table beet production, but is also registered for commercial use in ornamentals plants. Technical grade pyrazon (usually greater than 90 percent concentration) is of low acute toxicity (category III/IV) by oral, dermal, and inhalation exposure (U.S. EPA 2005c). It is not a dermal sensitizer, nor is it a skin or eye irritant (toxicity category IV for both pathways) (U.S. EPA 2005c). Pyrazon is classified by EPA as “not likely to be a carcinogen in humans (U.S. EPA 2005c).”

Studies in animals indicate that the most common effects of pyrazon exposure are reduced body weight and food consumption (U.S. EPA 2005c). High doses of pyrazon may also result in motor skill effects; however, these neurotoxic effects have been attributed to weight loss and poor condition of the rats, which may have been caused by malnutrition (U.S. EPA 2005c). High doses of pyrazon in dogs caused the development of small cavities in parts of the kidney (U.S. EPA 2005c). Skin exposure to pyrazon does not result in systemic effects (effects throughout the body from a localized exposure) (U.S. EPA 2005c). Developmental and reproductive studies in the rat and rabbit showed no effects in parents or offspring (U.S. EPA 2005c). There was no evidence of carcinogenicity in rodent studies; thus, pyrazon is classified as “not likely to be carcinogenic in humans (U.S. EPA 2005c).”

In rats, pyrazon is absorbed in the digestive tract and eliminated mainly though urine, with some removal occurring through the bile to the stomach and thereby the feces (U.S. EPA 2005c). Most of the substance is eliminated from the body within 24 hours for low doses and within 48 hours for high doses. Sex differences in elimination of pyrazon have been noted; female rats removed pyrazon at a lower rate than males in a 14-day study (U.S. EPA 2005c). Only 3.3 percent of the pyrazon taken into the body reportedly remains in the tissues after administration (U.S. EPA 2005c). Metabolites, or breakdown products, from pyrazon have been found in the urine and feces of test animals (U.S. EPA 2005c).

The chronic oral RfD for pyrazon is 0.18 mg per kg per day and is based on decreased body weight and weight gain in females in a chronic rat toxicity study (U.S. EPA 2005c). The cPAD for pyrazon is the same value as the chronic oral RfD, 0.18 mg per kg per day (U.S. EPA 2005c). In a chronic dietary risk exposure assessment conducted by EPA, it was determined that estimated exposures to pyrazon residues from dietary sources account for less than 0.1 percent of the cPAD for all population subgroups (U.S. EPA 2005c). Nearly all (>99%) of the estimated dietary exposure is from drinking water (U.S. EPA 2005c). Exposures to residues of pyrazon from food and drinking water were estimated using two dietary exposure models, Lifeline and DEEM-FCID. The estimated chronic aggregate risk for infants, the population subgroup with the highest estimated exposure, ranges from 21% to 25% of the cPAD using the Lifeline and DEEM-FCID dietary models, respectively (U.S. EPA 2005c). An endpoint of concern attributable to a single dose was not identified for pyrazon; therefore, an acute RfD was not established and an acute dietary risk assessment was not conducted (U.S. EPA 2005c).

EPA has established tolerances for pyrazon and its metabolites on or in sugar beet roots and tops, as stated in 40 CFR §180.316. Prior to 2008, no tolerance existed for sugar beet molasses, and the tolerances for roots and tops were 0.1 ppm and 1.0 ppm, respectively. EPA concluded in their tolerance reassessment in 2005 that the current tolerances were not appropriate due to data deficiencies. EPA planned to revise the tolerances for pyrazon, and did so in 2008. The tolerance for roots is 0.2 ppm, for tops is 3.0 ppm, and for molasses it is 1.5 ppm (U.S.EPA, 2008).

No residential exposures to pyrazon were expected by EPA when they conducted their aggregate risk assessment for pyrazon. EPA evaluated exposures to food and drinking water, and focused on chronic exposure due to the lack of an identified acute toxicity endpoint. In EPA's estimate, more than 99 percent of the exposure to pyrazon residues for the public comes from drinking water. EPA concluded that the aggregate risk from exposure to pyrazon for the U.S. population, including sensitive subgroups, does not pose risks of concern (greater than 100 percent of the cPAD). EPA estimated the aggregate risk for infants, the highest exposed population group, to be between 21 percent and 25 percent of the cPAD.

(10) Quizalofop-p-ethyl

Quizalofop-p-ethyl is a selective preplant and preemergence herbicide used to manage annual and perennial grasses in canola, cotton, dry beans, peas, lentils, mint, soybean, and sugar beet. Quizalofop-p-ethyl is of low acute toxicity by oral (category III), dermal (category IV), and inhalation (category IV) routes. It is not an irritant of the eye or skin (category IV), and is not a skin sensitizer. EPA Cancer Peer Review Committee classified quizalofop-p-ethyl as Category D, "not classifiable as to human carcinogenicity."(U.S. EPA 2006e)

The liver is considered the target organ of quizalofop-p-ethyl. Several animal studies have shown increased liver weights and adverse tissue changes, including enlargement of the central part of the lobe of the liver of treated animals. Quizalofop-p-ethyl is not a skin or eye irritant and it shows low dermal toxicity and no systemic toxicity when applied to the skin. Rats and rabbits exposed to quizalofop-p-ethyl in utero and after birth have shown some signs of developmental toxicity. Observed developmental effects included an increase in the number of rats born with an extra rib, although this abnormality disappeared by the time the young rats were 8 weeks old, suggesting that the effect may not have been biologically significant. Reproductive effects of quizalofop-p-ethyl in rats include a decreased percentage of pups born alive and decreased body weights. Finally, the exposed mothers in both reproductive and developmental studies experienced decreased body weights during the study.

A metabolism study in rats showed that following oral administration, quizalofop-p-ethyl is absorbed from the digestive tract and eliminated in the urine and feces. Elimination is rapid and the major metabolite is an acid byproduct of quizalofop-p-ethyl, which is then metabolized further. No additional information were available on the fate of quizalofop-p-ethyl in the body, from the references consulted.

The chronic oral RfD is based on a long-term toxicity and carcinogenicity study in rats that were fed quizalofop-p-ethyl for 104 weeks. Males at the second-highest dose tested had mild anemia. Males and females at the highest dose tested had significant enlargement of the central part of the liver. These observed adverse effects were used as the basis of the chronic oral RfD of 0.009 mg per kg per day. The cPAD for quizalofop-p-ethyl is the same as the RfD at 0.009 mg per kg per day. In a chronic dietary risk exposure assessment conducted by EPA, it was determined that the highest chronic dietary risk from exposure to quizalofop ethyl is to

1-2 years old children (29% cPAD), which is not a risk of concern (100% of the cPAD). An acute dietary risk assessment was not conducted as there are no doses/endpoints selected for acute dietary risk assessment since there were no effects observed in oral toxicity studies that could attributable to a single dose exposure. There are no residential use products that contain quizalofop-p-ethyl, so EPA did not prepare a residential risk assessment. EPA has concluded that, based on their aggregate risk assessment, none of the evaluated exposures for quizalofop-p-ethyl pose risks of concern.

EPA has established tolerances for quizalofop-p-ethyl and its metabolites on or in sugar beet roots and tops, and in sugar beet molasses, as stated in 40 CFR §180.441. The tolerance for roots is 0.1 ppm, for tops is 0.5 ppm, and for molasses it is 0.2 ppm.

(11) Sethoxydim

Sethoxydim is a selective, postemergence herbicide in the cyclohexenone class of compounds and is used in the management of annual and perennial grasses in broadleaf crops. It is used in a variety of agricultural crops, such as fruits, vegetables, tree nuts, herbs, ornamental and flowering plants. Sethoxydim is also used in recreational areas and other non-agricultural outdoor areas. It is of low acute toxicity (category III) by oral, dermal, and inhalation exposure (U.S. EPA 2005h). It is not a skin or eye irritant (category IV) (U.S. EPA 2005h). Dermal sensitization for sethoxydim has not been classified since the supporting study was waived based on lack of sensitization in guinea pigs (U.S. EPA 2005h). Sethoxydim is classified as "not a likely human carcinogen" based on a lack of evidence of carcinogenicity in mice and rats (U.S. EPA 2005h).

The target organ of sethoxydim is the liver (U.S. EPA 2005h). A chronic toxicity study found significant increases in absolute and liver weight in dogs, as well as adverse chemical changes and tissue injury in the liver (U.S. EPA 2005h). Liver effects from exposure to sethoxydim have also been noted in oral studies in mice and inhalation studies in rats (U.S. EPA 2005h). Other effects in adult animals given high doses of sethoxydim include irregular walking behavior, decreased activity, and anogenital staining, although all of these effects except the staining were short-lived (U.S. EPA 2005h). There is evidence of developmental toxicity in rats and rabbits; the offspring of treated animals experienced skeletal anomalies and reductions in body weight (U.S. EPA 2005h). However, a two-generation reproductive study in rats did not show reproductive effects (U.S. EPA 2005h). Skin exposure did not result in local or systemic toxicity (U.S. EPA 2005h). Carcinogenicity studies in rats and mice found no increased tumor rates and sethoxydim is classified as "not a likely human carcinogen (U.S. EPA 2005h)." Endocrine disruption has not been observed following exposure to sethoxydim (U.S. EPA 2005h).

A metabolism study in rats indicated that sethoxydim is eliminated rapidly and has low accumulation in tissue (U.S. EPA 2005h). Excretion occurs mainly in the urine (78 percent), but also occurs through feces (20.1 percent) (U.S. EPA 2005h). Sex differences in metabolism were not reported for sethoxydim (U.S. EPA 2005h).

A combined chronic toxicity and carcinogenicity study in mice was used to derive the chronic oral RfD of 0.14 mg per kg per day for sethoxydim (U.S. EPA 2005h). Because the FQPA safety factor is 1X for sethoxydim, the cPAD is also 0.14 mg per kg per day. The endpoint for the RfD selection was the early onset of liver effects including abnormally increased liver cell size and fatty degeneration in the liver (U.S. EPA 2005h). The partially refined chronic dietary exposure (food only) estimates did not pose risks of concern (<100% cPAD) for the general U.S. population (2.7% of the cPAD) and all other population subgroups. The most highly exposed population subgroup was all infants (<1 year old), at 7.5% of the cPAD (U.S. EPA 2005h).

A rat developmental study was used to select the dose and endpoint for establishing the acute RfD of 1.8 mg/kg/day (U.S. EPA 2005h). The acute

Population-Adjusted-Dose (aPAD) is also equal to 1.8 mg/kg/day (U.S. EPA 2005h). From the acute analysis, the exposure at the 99.9th percentile (99.9th percentile used because the assessment incorporated estimates of percent crop-treated, field trial data and some experimental processing data) was 5.3% of the aPAD for the general U.S. population and 9.2% of the aPAD for children 1-2 years old and also children 3-5 years old (the two most highly exposed population subgroups) (U.S. EPA 2005h).

EPA has established tolerances for sethoxydim residues in sugar beet at 10 ppm for sugar beet molasses and 3.0 ppm for sugar beet tops, as stated in 40 CFR §180.412. EPA has established that there are adequate analytical methods for enforcement of tolerances for sethoxydim.

Sethoxydim is registered for residential use on ornamentals and flowering plants, recreational areas, as well as around buildings and other structures (U.S. EPA 2005d). There is the potential for short term dermal and inhalation exposure to sethoxydim pre- and post-application during mixing, loading, and applying of liquid products (U.S. EPA 2005d). There is also the potential for incidental oral exposure by children (U.S. EPA 2005d). While product labeling use instructions suggest only spot-treatment, which is not considered by HED to result in consequential exposures, there is no recommendation against broadcast lawn use of products containing sethoxydim (U.S. EPA 2005h). To account for this, EPA considered the potential use of backpack sprayers or low pressure handwand applicators. Incidental ingestion exposure is considered to be unlikely based on the infrequent use and application specified on product labeling(U.S. EPA 2005d). EPA did not identify a dermal endpoint of concern.; therefore, only exposure from inhalation (adult handlers) and incidental ingestion (children, postapplication) were assessed (U.S. EPA 2005d). An MOE of 100 or greater poses a risk of concern for all residential population groups. Estimated MOE values for adults range from 1.4E+6 to 1.6E+6., while MOEs estimated for children range from 26,000 (hand-to-mouth) to 7.6E+6 (soil ingestion). The resulting MOEs are above the target MOE of 100 and, therefore, are not of concern to EPA (U.S. EPA 2005d).

(12) Trifluralin

Trifluralin is a preemergence herbicide used to manage annual grasses and broadleaf weeds. It is used on a wide range of food and feed crops including: asparagus, cabbage varieties, chicory, kale, kohlrabi, lentils, hops, corn, wheat, melon varieties, onion varieties, barley, and sugar beet. Trifluralin is used in non food crops such as non-bearing fruit trees, and is used in a variety of non-agricultural settings. Trifluralin is of low acute toxicity by oral (category IV), dermal (category III), and inhalation (category III) exposure. It is a slight eye irritant (category III), but not a dermal irritant (category IV). Trifluralin is a dermal sensitizer. The OPP Carcinogenicity Peer Review Committee has classified trifluralin as Group C, "possible human carcinogen."(U.S. EPA 1996c)Data indicate that trifluralin toxicity is species and sex dependent. Subchronic studies in rats have shown kidney and urinary system effects such as increased formation of protein droplets in the kidney and increased amounts of protein in the urine. Significant increases in bladder tumors in female rats and tumor formation in the kidney in males support the evidence for the bladder and urinary system as targets of toxicity in rats. Other studies have shown that the liver is also affected by trifluralin; one oral subchronic study in rats showed reductions in liver weight and a 1-year oral study in beagle dogs resulted in increased liver weight. A 31-day toxicity study in the rat indicated that dermal exposure can also cause increased liver weight. Despite the incidence of cancerous tumors in rats, two studies in mice suggest that trifluralin is not carcinogenic. EPA has based their determination on data from rat studies, and therefore trifluralin is considered a "possible human carcinogen" (Category C). In developmental studies, trifluralin exposure has been associated with reduced fetal body weight and increased runts in the litters of both rabbits and rats. In reproductive studies, trafluralin has caused reduced litter sizes at high doses.

Studies in rats indicated that after oral dosing, trifluralin is not readily absorbed from the digestive tract. Essentially all of the trifluralin that is absorbed is completely broken down and eliminated within 3 days of exposure. Fecal excretion is the main route of elimination (80 percent); while the remaining 20 percent is eliminated through the urine. There are between 30 and 40 different metabolites that have been detected in urine following exposure to trifluralin.

The chronic oral RfD for exposure to trifluralin is 0.024 mg per kg per day as determined from a one-year feeding study in dogs. EPA conducted a dietary assessment using the Dietary Risk Evaluation System (DRES), and found that even if all population subgroups were exposed to maximum residue concentrations, the total exposure values would still be well below the RfD. Thus, the chronic, non-carcinogenic dietary risk from exposure to trifluralin has been determined to be of minimal concern. EPA has also identified the potential for residential exposure to trifluralin through handling practices; however, data from the occupational exposure assessment indicate that the level of risk would be insignificant.

Tolerances for trifluralin have been established for a wide variety of agricultural commodities, but not specifically for sugar beet. However, EPA considers the processing studies submitted for sugar beet to be adequate to not require food/feed additive tolerances for residues of trifluralin for sugar beet. EPA has also established that available enforcement methods are adequate for the determination of trifluralin residues.

(13) Triflusulfuron-methyl

Triflusulfuron-methyl is an herbicide that is used almost exclusively in sugar beet (though it also has some usage in chicory and table beet) to manage a variety of grass and broadleaf weeds. Triflusulfuron-methyl is of low acute toxicity by oral (category IV), dermal (category III), and inhalation (category IV) exposure. Triflusulfuron-methyl is a slight dermal (category IV) and eye (category III) irritant. It is not a dermal sensitizer. Triflusulfuron-methyl has been classified as a Category C, "possible human carcinogen."(U.S. EPA 2002a)

According to subchronic and chronic studies, the liver and testes appear to be the two organs most affected by exposure to triflusulfuron-methyl. Most studies also noted significant decreases in body weight and some evidence of adverse changes in the blood, including decreased red blood cell count. Liver toxicity was evidenced by increases in liver weights and microscopic changes in the liver, as well as an increased incidence of liver tumors in male mice. Testicular toxicity occurred in both subchronic studies with decreased testes weight and microscopic abnormalities including increased abnormal cell growth in the cells which secrete testosterone. Tumors in these cells (adenomas) have also been observed in male rats. Rat and rabbit studies indicate that there is no evidence that this chemical is developmentally or reproductively toxic. In dermal studies, no effects were seen, even at the highest doses.

In one metabolism study in rats where triflusulfuron-methyl was labeled with radioactivity, researchers showed that the liver had a large amount of radioactive triflusulfuron-methyl 5 days after exposure. Additional radioactivity was detected in the ovaries and skin of high-dose animals, indicating that triflusulfuron-methyl was moved there by the body. Elimination occurred mainly through the urine in low-dose animals, while elimination occurred mainly through the feces in high-dose animals.

The RfD for triflusulfuron-methyl is 0.024 mg per kg per day and is based on increased incidences of interstitial hyperplasia in the testes, decreased body weight gain, and alterations in hematology (mostly in males). In a chronic dietary risk exposure assessment conducted by EPA, it was determined that estimated exposures from triflusulfuron-methyl represent less than 1 percent of the cPAD for the general U.S. population and all population subgroups. The chronic RfD is considered by EPA to be adequately protective of these effects and indicates no concern for cancer risk. Therefore, a quantitative assessment of cancer risk using a cancer potency factor is not required.

Tolerances for triflusulfuron-methyl residues have been established at 0.05 ppm for sugar beet roots and tops as stated in 40 CFR §180.492. EPA considers the tolerance enforcement method available to be adequate for this commodity.

There are no current or pending uses for triflusulfuron-methyl that would result in residential exposure, though EPA notes that spray drift is always a potential source of exposure to residents near spraying operations. The agency has been working with the Spray Drift Task Force, EPA Regional Offices, and State Lead Agencies for pesticide regulation to develop spray drift management practices. Interim mitigation requirements for product labeling are currently in effect.

2. Worker Health and Safety

Workers are exposed to sugar beet and related products, including pesticides, during seed and crop production and processing. Workers also operate specialized equipment, which carry safety risks. Therefore, worker health and safety in terms of sugar beet and product production and pesticide use is described below.

a. Sugar Beet and Related Products

Sugar beet pollen, which is allergenic in some people, can be an occupational hazard (Ursing, 1968). It is reported that Luoto et al. (2008) identified two allergenic proteins, Beta v 1 and Beta v 2, in sugar beet pollen.

Regarding workers in sugar refineries, no data could be found indicating that such workers are experiencing adverse reactions as a result of sugar beet root processing. Another category of workers besides those on the farm and in sugar refineries are those processing, supplements, extracts, and other products. These workers likely would be exposed primarily during transport and initial processing. Exposures to equipment hazards and to extracting solvents are some of the risks these workers face.

The Occupational Safety and Health Administration (OSHA) was created by Congress with the Occupational Safety and Health Act of 1970 (OSH Act) to ensure safe and healthful working conditions by setting and enforcing standards to provide training, outreach, education, and assistance. Under the OSH Act, employers are responsible for providing a safe workplace devoid of serious health hazards and in accordance with all OSH Act safety and health standards. Compared to other private-sector occupations, however, agricultural workers and their families encounter a disproportionate number of injuries and diseases associated with physical, chemical, and biologic hazards (NIOSH, 2006). The Bureau of Labor Statistics (BLS) reports that there were 399 fatal occupational injuries in U.S. crop production, including support activities for crop production, in

2005 (BLS, 2011) and another 23,300 workers were temporarily or permanently disabled as the result of injuries related to crop production and support activities.

In sugar beet farming, an average rate of about 0.7 fatalities occurred each year (or a fatality every 1.4 years) between 1992–2006, as seen in Table 3–54. This estimate assumes that for years in which both sugar beet and sugarcane are reported (1992–2002), the sugar beet contribution was one-half the total, based on the approximately one-half market share of sugar beet sugar (section III.B). This estimate also does not differentiate fatalities for conventional versus H7-1 sugar beet farming, although APHIS expects that it primarily reflects conventional sugar beet farming because H7-1 sugar beet was not deregulated until March 2005 and was not widely grown until 2008 and beyond.

Data on injuries specific to sugar beet farming could not be readily found in the literature. Therefore, APHIS developed an estimate based on injuries from total crop production scaled to sugar beet production using acreage, assuming sugar beet farming hazards are similar to those of overall crop production and that equipment use contributes the bulk of the fatal and nonfatal injuries. This latter assumption is supported by BLS (2010b) data, which for 2005 indicate that over 90 percent of fatal farm injuries are equipment-related (i.e., excluding assaults and violent acts and fires and explosions). Thus, using 2005 acreage data from USDA NASS (2011c), 1.3 M acres of sugar beet in the United States divided by 318 M acres of all crops in the United States, or 0.041 sugar beet acre per total crop acres, times 23,300 total crop production injuries, equals approximately 95 annual injuries attributable to conventional sugar beet farming.

Table III-54. Reported Sugar Beet[1] Farming Fatalities, 1992-2006

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Reported Fatalities	3	8	0	0	5	0	0	0	0	0	0	0	0	0	3

Source: (BLS, 2010b).
[1] Sugar beet and sugarcane data are reported together between 1992–2002.

These injuries and fatalities could be caused in a variety of ways. For example, tractors are the leading cause of death and serious injury in agriculture (NIOSH, 2004) and thus likely would be major contributors in sugar beet farming also. Tractor accidents typically fall under the categories overturn, runover, collision, and entanglement. Overturns (also called rollovers) are responsible for over half of all tractor-related fatalities, and usually result in massive traumatic injuries to tractor operators. The impact of these accidents can be lessened by the use of seatbelts and ROPS-equipped (rollover protective structure) vehicles. Runovers occur when an operator or bystander is crushed under the tractor or attached equipment. An operator may be injured in a runover accident by falling from a moving tractor, or while standing on the ground and starting the vehicle. Bystanders may become victims of runover accidents when they are unseen by the operator or by slipping and falling under moving equipment wheels. Thus, the greater the number of farm workers in the field hand weeding, the greater the likelihood of runovers. Extra riders on moving tractors are also at risk for falling off the vehicle and being crushed. Children under 15 account for the majority of these latter victims. Runover injuries can be prevented by use of ROPS and seatbelts, and by prohibiting extra riders. Collisions occur when a tractor is operated on a public roadway and strikes, or is struck, by a motor vehicle or train. Entanglement occurs when an operator becomes entangled in the tractor's power take-off driveline. Use of proper machine shields and guards can prevent these injuries. The impacts of these accidents can be lessened by the protective measures already mentioned, and by community-wide safety efforts targeting motorists and tractor operators.

As discussed in detail in section III.B.1.c.(2) of this EIS, the adoption of H7-1 sugar beet has resulted in a large reduction in equipment use. Section III.B.1.c(2) shows that between 2000 and 2010, rotary hoe and harrow usage in Minnesota and North Dakota, where the majority of sugar beet are grown, decreased from 62 percent of the acreage to 2.8 percent, a 95-percent reduction. During that same time period, use of electrical discharge systems (EDSs), weed pullers, mowing, and swathing decreased from 1.9 percent of the acreage to 0.4 percent, a 79 percent reduction. Between 2004 and 2009, hand weeding decreased from 28 percent of the acreage to 4 percent, an 86 percent reduction. Data on fuel used for cultivation and herbicide spraying (Hirnyck, 2007)indicate that tractor and related equipment use is 30 percent lower under H7-1 sugar beet crop production practices compared to conventional beet. Data in section III.B.1.c(2) also note that on average, farmers growing H7-1 sugar beet row crop cultivated their fields once as compared to 1.5 cultivations reported by conventional sugar beet growers. This would indicate a 33 percent reduction.

Decreases in farm equipment and machinery usage such as that described above have been linked to decreases in injuries and fatalities in the agricultural sector (Shutske, 2001)Therefore, APHIS used the reduction in equipment use under H7-1 sugar beet adoption to develop an estimate of a proportional reduction in injuries and fatalities. Using the most conservative of these estimates above for a reduction in equipment use, a 30% reduction in fuel use, by sugar beet crop agricultural workers can be reasonably expected to cause an approximately 30 percent decrease in sugar beet farming related injuries and deaths. Using the estimated fatality rate of approximately 0.7 per year for conventional sugar beet, APHIS would expect H7-1 sugar beet crop production to result in a fatality rate of approximately 0.5 per year. Similarly, using the estimated 95 nonfatal injuries for conventional sugar beet, APHIS would expect H7-1 sugar beet crop production to result in a nonfatal injury rate of approximately 66 per year, a decrease of about 29 non-fatal injuries per year.

As with agricultural workers in general, occupational-related injuries and illnesses are disproportionally high in beet sugar manufacturing plants compared to other industries (BLS, 2010a). In 2005, the beet sugar manufacturing industry had the highest incidence rate among private industry of total nonfatal occupational injury and illness cases, at 18.3 per 100 full time workers compared to 4.6 per 100 for all industries. In 2007, the rate for beet sugar workers was 11.7 per 100 full time workers compared to 4.4 per 100 for all industries. In 2009, the rate for beet sugar manufacturing was 10.0 per 100 full time workers compared to 3.6 per 100 for all private industry. While the rates for sugar beet workers dropped after adoption of H7-1 sugar beet, rates also dropped for all industries. The most common risks for accidents in sugar manufacturing facilities are trips and falls caused by slippery floors, incorrect use of packaging and transport equipment, contact with sharp edges on processing equipment, and explosions, as discussed above (International Finance Corporation, 2007). Other safety issues include hearing damage due to high noise levels and burns from steam lines and hot water.

Reductions in the use of tractors and other equipment to cultivate the soil and conduct other activities also results in reductions in engine emissions and fugitive soil particulates. Particulates have inherent toxicity, and they can also carry adsorbed pesticides and other agricultural hazardous chemicals. Worker exposure to engine emissions and particulates can cause serious health effects (Bennett et al., 2004; Baker et al., 2005). While such risks are an expected consequence of farming in general, they can be reduced (or increased) following changes in farming practices such as ready access to protective equipment, proximity to care facilities in the event of injury, improvements in equipment and working requirements. As discussed above, cultivation and equipment use has dropped substantially from the pre-2005/6 period of conventional sugar beet production to the more recent 2010/11 period of largely H7-1 sugar beet production. Subsequent reductions in worker health risks thus are possible.

Combustible dust is another worker hazard associated with sugar beet. In 2009, OSHA submitted an advance notice of proposed rulemaking requesting public input for the development of a proposed standard for combustible dust (74 FR 54334, Oct. 21, 2009), citing six recorded combustible dust incidents in the sugar beet industry since 1980. In 2008, a massive accumulation of combustible sugar dust at the Imperial Sugar refinery in Port Wentworth, Georgia fueled a massive explosion and fire that caused 14 deaths and 38 injuries, 14 of which were serious and life threatening (U.S. Chemical Safety Board, 2010). Although the Port Wentworth refinery processed cane sugar, sugar beet refineries also produce combustible sugar dust and are at risk for similar accidents.

b. Pesticides

Farm workers can be exposed to pesticides when:

- preparing the pesticides for use, such as by mixing a concentrate with water or loading the pesticide into application equipment
- applying the pesticides
- entering an area where pesticides have been applied
- inhaling soil particulates with adsorbed pesticides

Direct intake of or contact with pesticides by workers can be through the skin (dermal), by inhalation (to the lungs), orally (through the mouth), or into the eyes. Various indirect pathways exist, such as hand to mouth or eye contact and tracking pesticides from shoes and clothing into vehicles and homes. The intake amount can be affected by myriad factors, including form of the herbicide (liquid, powder, granulated), application method (backpack, boom, aerial), frequency and duration of application, use of protective equipment, and weather.

Virtually all sugar beet growers use herbicides; for example, in 2000 approximately 98 percent of planted acres received one or more herbicide applications (Ali, 2004). Hundreds of commercial herbicides are available, but only a fraction is labeled for use with sugar beet. As discussed in section III.B.1.d, all herbicides used on sugar beet, other than glyphosate, decreased during the transition from conventional sugar beet use to H7-1 sugar beet use between 2005 and 2010, while glyphosate use on sugar beet increased. Based on the last registration review, glyphosate has relatively low human health toxicity, as described in section III.F.1.b. Glyphosate is currently being evaluated by EPA for reregistration review and this level could possibly change (EPA, 2009). Based on EPA current understanding, with regard to subchronic and chronic toxicity at higher doses to which farm workers might be exposed, one of the more consistent effects of exposure of laboratory animals to glyphosate is reduced body weight gain compared to controls. Body weight loss has at times been noted in some chronic studies at excessively high doses ≥20,000 ppm in diet, though not in multiple subchronic studies (WHO, 2005). Nevertheless, other general and non-specific signs of toxicity from subchronic and chronic exposure to glyphosate include changes in liver weight, blood chemistry (which might suggest mild liver toxicity), and liver pathology (USDA-FS, 2003). PPE and other safeguards should be used.

Glyphosate is not considered a carcinogen, as described in section III.F.1.b. EPA considered in its human health risk assessments the potential exposure to applicators and bystanders resulting from increased glyphosate use. Based on the toxicity of glyphosate and its registered uses, including use on GT crops, EPA concluded that occupational exposures (short-term dermal and inhalation) to glyphosate are not of concern because no short-term dermal or inhalation toxicity endpoints have been identified for glyphosate (71 *FR* 76180, 2006). Additional evidence to support the EPA conclusion can be found in the Farm Family Exposure Study, a biomonitoring study of pesticide applicators (Acquavella et al., 2004). This biomonitoring study determined that the maximum estimated systemic dose for farmer-applicators as the result of routine labeled applications of registered glyphosate-based agricultural herbicides to crops, including GT crops, was 0.004 mg per kg. This level is approximately 500 times lower than the RfD established for glyphosate of 1.75 mg per kg per day. Furthermore, as discussed in the previous section, the use of manual labor has declined substantially as growers adopted H7-1 sugar beet in recent years. APHIS would expect that these reductions have resulted in fewer workers being exposed to these herbicides.

The chronic (long term) toxicities of the key herbicides used for both conventional and H7-1 herbicides are described in section III.F.1.b. The acute toxicities for these herbicides used on sugar beet were summarized in the EA for sugar beet (USDA-APHIS, 2011b) and have been updated below in Table 3–55. Many of these herbicides do have a human health risk and are labeled accordingly as to the measures needed to minimize the risk during handling and application on sugar beet.

Table 3–56, also updated from the EA, lists the herbicides used in conventional sugar beet production and their label contents (e.g., pre-harvest intervals (PHI), maximum use amounts, measures needed to mitigate exposure risks to humans). Information presented in the table was gathered from selected federal pesticide labels for the given EPA Registration Numbers. The selection of products is representative of products commonly applied to sugar beet. Some information on pesticide labels may vary from State to State, but signal words, precautionary statements, and exposure mitigation statements are required to remain consistent. Application rates may also vary slightly from product to product containing the same a.i., but total rates may not exceed the maximum rates determined by EPA.

Maximum application rates for single applications, as well as the maximum rate per season, are presented in Table 3–56. The maximum application rates were derived from application amounts listed on the labels for sugar beet, which are typically in units of pints per acre. These values were converted to units of gallons, then to the number of pounds per gallon, based on the label for the product. When amounts were listed in pounds active equivalents (a.e.) per gallon, APHIS converted the amount to pounds a.i., based on equivalent information from the label. The impacts of these herbicides in terms of relative risks are analyzed for the regulatory alternatives in section IV.F.

The “signal words” on the labels for pesticide products can be either Caution, Warning, or Danger. Products bearing a Caution signal word are lowest in toxicity, those with Warning are of moderate toxicity, and those with Danger are highest in relative toxicity. Of the products listed in these tables, nine bear a Caution, three bear a Warning, and one (quizalofop-p-ethyl) bears a Danger. Signal words are based on acute toxicity testing of the concentrated product by oral, inhalation, dermal, skin sensitization, and eye exposures (discussed briefly below). The test results showing the highest toxicity are used to assign the signal word for the product (NPIC, 2008).

Table III-55. Herbicide Acute Toxicity (Oral and Dermal) for Use on Sugar Beet

Active Ingredient	Trade Name (typical)	WSSA Mode of Action Group No.	Acute Toxicity Oral (mg/kg) LD_{50}	Acute Toxicity Dermal LD_{50} (mg/kg)	Source
Clethodim	Select®	1	1,630 (male rats) 1,360 (female rats)	>5,000 (rabbit)[1]	(U.S. EPA 2008b)
Clopyralid	Stinger®	4	>5,000 (male and female rat)	>5,000 (male and female rat)	(U.S. EPA 2009a)
Cycloate	Ro-Neet™	8	3,250 (male rat) 4,175 (female rat)	>5,000 (rabbit)	(U.S. EPA 2004)
Desmedipham	Betanex®	5	>5,000 (rat)	>4,000 (rat)	(U.S. EPA 1996b)
EPTC	Eptam®	8	1,294 – 1,976 (rat)	>2,000 (rabbit)	(U.S. EPA 1999)
Ethofumesate	Nortron®	8	>6,400 (rat)	>20,050 (rat/rabbit)	(U.S. EPA 2006b)
Glyphosate	Roundup® (WeatherMax, Ultra, Original)	9	>4,320 (rat)	>2,000 (rabbit)	(U.S. EPA 1993c)
Phenmedipham	Betamix®	5	>8,000 (rats)	>4,000 (rabbit, non-irritant)	(U.S. EPA 2005g)
Pyrazon	Pyramin®	5	2,140 (female rats) >3,930 (male rats)	>2000 (rat)	(U.S. EPA 2005c)
Quizalofop-p-ethyl	Assure® II	1	1,670 (male rats) 1,480 (female rats)	>5000 (rat)	(U.S. EPA 2006e)
Sethoxydim	Poast®	1	3,125 (male rats) 2,676 (female rats)	>5,000 (rats; non-irritant)	(U.S. EPA 2005d)
Trifluralin	Treflan® HFP	3	>5,000 (rat)	>2,000 (rats; non-irritant)	(U.S. EPA 2005d)
Triflusulfuron-methyl	Upbeet®	2	>5,000 (M & F rats)	>2,000 (M & F rats)	(U.S. EPA 2002a)

[1] The cited EPA reference lists the LD_{50} at ">5.0 mg/kg" and Toxicity Category IV. This value is amisprint, and should be >5.0 g/kg. Toxicity category IV is >5,000 mg/kg as defined. This change in numbers is also supported by the entry for clethodim in the Herbicide Handbook (WSSA, 2008), which lists >5000 mg/kg for this endpoint.

Of the products in Table 3–56, those with Warning and Danger signal words may cause moderate to severe eye injury. Label warnings for all products on the list advise users to avoid contact with eyes, skin, or clothing, and to wear personal protective equipment when applying. Signal words may vary between products with the same a.i. Signal words are an indicator of the relative toxicity of the formulated product, which includes the a.i. and any other ingredients in the product. For this reason, some products may have signal words that reflect a higher toxicity value than is assigned to the a.i. alone.

The remainder of this section provides toxicity profiles relevant to worker exposure. Examples of accidental worker poisonings are described. APHIS would expect that some reductions in such poisonings have occurred in recent years due to fewer workers in the field and to the use of a less toxic herbicide profile.

(1) Clethodim

Details of the toxicity classifications and risk assessments for clethodim have been presented in section III.F.2.b(1). The EPA assessed occupational exposure for clethodim for multiple crops using the highest labeled application rate of 0.25 lb. a.i. per acre on the highest acreage treated. The short- and intermediate-term MOE on the day of treatment did not pose risks of concern for pesticide handlers (U.S. EPA 2008b). EPA also concluded that there was adequate information to address post-application exposures to clethodim, that no post-application exposures are of concern, and no new post-application assessments are required.

(2) Clopyralid

At the time that the clopyralid human health risk assessment for uses on Swiss chard, the bushberry subgroup, and strawberry was in development (U.S. EPA 2009a), EPA noted that an updated occupational risk assessment was in development. Based on a previous assessment conducted in 2002 (EPA, 2002), EPA expected that occupational risks would not pose risks of concern. The 2002 risk assessment assumed that “baseline” personal protective equipment (PPE) would be used by applicators. As clopyralid is a solid, workers that manufacture clopyralid may be exposed either by inhalation or dermal exposure. Given that clopyralid is applied in a liquid solution, the most likely route of exposure for applicators is by dermal exposure. No additional case reports or studies were found that addressed occupational exposure to clopyralid.

Table III-56. Label Contents for Herbicides Used in Conventional Sugar Beet Production

Active Ingredient	Example Product Name, EPA Registration #	Label Signal Word	Sugar Beet PHI[2] (days)	Max lb a.i./acre - Single Application[3]	Max lb a.i./acre - Season[3]	Label Precautionary Statements /Special Directions[4]	Applicator and Handler PPE[5] Required to Mitigate Risks
Clethodim	Clethodim® 2E, 42750-72	Caution	40	0.25	0.5	Causes moderate eye irritation. Harmful if swallowed. Avoid contact with eyes, skin or clothing. Environmental hazard statements for surface water, runoff, drift, and disposal of equipment washwater or rinsate. "The use of this product may pose a hazard to the federally designated endangered species of Solano Grass and Wild Rice." Warnings for repeated use leading to selection of resistant weed biotypes. Crop injury warnings. Physical hazard: Combustible.	Long-sleeved shirt, long pants, shoes plus socks, chemical-resistant gloves, protective eyewear. Do not reuse heavily contaminated clothing.
Clopyralid	Stinger® , 62719-73	Caution	45	0.33	0.33	Causes moderate eye irritation. Harmful if absorbed through skin. Avoid contact with eyes, skin, or clothing. Warning for use near surface water, disposal of equipment washwaters, contamination of water used for irrigation or domestic purposes, and leaching to groundwater under certain conditions. Crop injury warnings for (1) use of treated plant material or manure from animals grazed in treated areas, as mulch or compost; and (2) spreading of treated soil. Up to 18-month rotation restrictions to many crops due to risk of injury; field bioassay recommended. Physical hazard: combustible	Long-sleeved shirt, long pants, chemical-resistant gloves made of waterproof material, shoes plus socks, protective eyewear.

Active Ingredient	Example Product Name, EPA Registration #	Label Signal Word	Sugar Beet PHI[2] (days)	Max lb a.i./acre - Single Application[3]	Max lb a.i./acre - Season[3]	Label Precautionary Statements /Special Directions[4]	Applicator and Handler PPE[5] Required to Mitigate Risks
Cycloate	Ro-Neet™ 6-E , 73637-5	Caution	Not Specified – Applied preplant, at planting, immediately post-planting, or in fall before ground freezes.	4.0	4.0	Harmful if swallowed. Causes moderate eye irritation. Avoid contact with eyes, skin, or clothing. Environmental hazard statement for use near surface water, disposal of equipment washwaters, and drift. Soil incorporation or soil injection required. Crop injury concerns dependent on soil type.	Long-sleeved shirt, long pants, chemical-resistant gloves and apron, shoes plus socks, engineering controls required for dermal penetration and inhalation protection. In California: For mixers, loaders, applicators and other handlers 93-gallon limit for handling in any 21-day period.
Desmedipham	Betanex®, 264–620	Warning	75	1.275	1.95	Harmful if swallowed or absorbed through the skin. Causes substantial eye injury. Avoid contact with eyes or clothing. Prolonged or frequently repeated skin contact may cause allergic reactions in some individuals. Avoid contamination of food and feedstuffs. This product contains the toxic inert ingredient isophorone. This product is toxic to fish. Environmental hazard statements for surface water, runoff, drift, and disposal of equipment washwaters. Physical hazard: Do not store near heat or open flame. Sugar beet injury possible under many situations.	Long-sleeved shirt, long pants, chemical-resistant gloves, shoes plus socks, protective eyewear.

Active Ingredient	Example Product Name, EPA Registration #	Label Signal Word	Sugar Beet PHI[2] (days)	Max lb a.i./acre - Single Application[3]	Max lb a.i./acre - Season[3]	Label Precautionary Statements /Special Directions[4]	Applicator and Handler PPE[5] Required to Mitigate Risks
Desmedipham / phenmedipham (product contains equal concentrations, by weight, of both active ingredients)	Betamix®, 264-621	Warning	75	1.22	1.95	Causes moderate eye irritation. Harmful if swallowed or absorbed through skin. Do not get in eyes or on clothing. Avoid contact with skin. This product contains the toxic inert ingredient isophorone. This pesticide is toxic to fish and aquatic organisms. Warning against application to surface water, drift, runoff, and disposal of equipment washwaters. May be hazardous to fish and aquatic organisms. Physical hazard: Do not use or store near heat or open flame. Sugar beet injury possible under many situations; evening applications recommended. Rotation restriction of 120 days for cereals.	Long-sleeved shirt, long pants, chemical-resistant gloves, shoes plus socks, protective eyewear. Do not reuse heavily contaminated clothing.
EPTC	Eptam®, 10163–281	Caution	49	4.5	Not specified	Harmful if inhaled or absorbed through skin. Avoid contact with skin, eyes, or clothing. Avoid breathing dust. Toxic to mammals. Environmental hazard statement for use near surface water and disposal of equipment washwaters. Soil incorporation or soil injection required. Rotation restrictions of 6 to 12 months for crops other than sugar beet or ryegrass. Do not graze livestock on treated crops.	Long-sleeved shirt, long pants, shoes plus socks. For exposure to the concentrate: chemical-resistant footwear, gloves and apron; protective eyewear. Additional PPE requirements for chemigation systems, dry bulk fertilizer impregnation and application, backpack or hand-held application. In CA limit

Active Ingredient	Example Product Name, EPA Registration #	Label Signal Word	Sugar Beet PHI[2] (days)	Max lb a.i./acre - Single Appli-cation[3]	Max lb a.i./acre - Season[3]	Label Precautionary Statements /Special Directions[4]	Applicator and Handler PPE[5] Required to Mitigate Risks
							mixing/loading to a maxmimum of 1000 pounds per handler per 21 day period, not to exceed 100 pounds per handler per day
Ethofumesate	Nortron®, 264–613	Caution	90	3.75	4	Harmful if absorbed through skin. Avoid contact with skin, eyes, or clothing. Wash thoroughly with soap and water before eating, drinking, chewing gum, or using tobacco. This pesticide is toxic to fish. Environmental hazard statement for use near surface water. drift, runoff, and disposal of equipment washwaters. Rotation restrictions of 6 to 12 months for crops other than sugar beet, table beet, onions, shallots, carrots or ryegrass. Do not graze livestock on treated crops.	Long-sleeved shirt, long pants, shoes and socks, chemical resistant gloves, protective eyewear if system operates under pressure, chemical-resistant footwear and apron for use in emergenices.
Glyphosate	Roundup® Weather Max, 524-537	Caution	14 (conve n-tional sugar beet); 30 (H7-1 sugar beet)	4.51 (pre-emergence) ; 3.0 (assumed pre-emergence on H7-1, to maximize post-emergence use); 1.375 (emergence to 8-leaf	7.29 (conventi o-nal and H7-1 sugar beet)	Causes moderate eye irritation, harmful if inhaled, avoid contact with eyes, skin, or clothing, avoid breathing vapor or spray mist. Environmental hazard statement: Do not apply directly to water. do not contaminate water when cleaning equipment or disposing of equipment washwater.Physical or chemical hazard statement: Do not mix, store, or apply product in galvanized or unlined steel containers or spray tanks. Product may be combustible, and could flash or explode, avoid proximity to heat and flame.	Long-sleeved shirt, long pants, chemical-resistant gloves, shoes plus socks. Keep and wash PPE separately from other laundry.

Active Ingredient	Example Product Name, EPA Registration #	Label Signal Word	Sugar Beet PHI[2] (days)	Max lb a.i./acre - Single Application[3]	Max lb a.i./acre - Season[3]	Label Precautionary Statements /Special Directions[4]	Applicator and Handler PPE[5] Required to Mitigate Risks
				stage); 0.95 (8-leaf stage to canopy closure)			
Phenmedipham (no products were found that contain only phenmedipham for use on sugar beet; the Spin-Aide label is presented here for reference)	Spin-Aide, 264-616 – a product for use only on red beet.	Warning	75	EPA RED lists max for sugar beet at 0.375–0.633.	1.0	Causes substantial, but temporary, eye injury. Harmful if swallowed or absorbed through skin. Do not get in eyes or on clothing. Avoid contact with skin. This product contains the toxic inert ingredient isophorone. This pesticide is toxic to fish and aquatic organisms. Do not apply directly to water; do not contaminate water when cleaning equipment or disposing of equipment washwater Drift and runoff may be hazardous to fish and aquatic organisms. Physical hazard: Combustible. Sugar beet injury possible under many situations; evening applications recommended. Rotation restriction of 120 days for cereals.	Long-sleeved shirt, long pants, chemical-resistant gloves, shoes plus socks, protective eyewear. Do not reuse heavily contaminated clothing
Pyrazon	Pyramin® DF, 7969-81	Caution	0	7.3	7.3	Harmful if swallowed, inhaled or absorbed through skin. Avoid breathing dusts or spray mists. Causes moderate eye irritation. Avoid contact with skin, eyes or clothing. Do not contaminate water used for irrigation or domestic purposes. Drift and runoff may be hazardous to aquatic organisms in water adjacent to treated areas. Warning for leaching to groundwater under certain conditions. Significant crop injury warning statements,	Long-sleeved shirt, long pants, chemical-resistant gloves, shoes plus socks. Do not reuse clothing heavily contaminated with this product's concentrate.

Active Ingredient	Example Product Name, EPA Registration #	Label Signal Word	Sugar Beet PHI[2] (days)	Max lb a.i./acre - Single Appli-cation[3]	Max lb a.i./acre - Season[3]	Label Precautionary Statements /Special Directions[4]	Applicator and Handler PPE[5] Required to Mitigate Risks
						depending on soil moisture level, soil type (organic matter content, loam, sandy, etc.), and temperature at time of application, application method, and tank mix products. Plant back restrictions of 1 year for certain crops.	
Quizalofop-p-ethyl	Assure® II , 352-541	Danger	45 days, (60 days for feeding of tops)	0.0825	0.17	Causes irreversible eye damage. Harmful if swallowed, inhaled, or absorbed through the skin. Avoid contact with eyes, skin, or clothing. Avoid breathing vapor or spray mist. This product contains petroleum-based distillates. This pesticide is toxic to fish and invertebrates. Environmental hazard statements for use near surface water, drift, runoff, and disposal of equipment washwaters. Rotation restriction of 120 days for crops not labeled. Need spray adjuvant added. Special precautions for spray tank clean out. Physical hazard: Combustible.	Long-sleeved shirt, long pants, chemical-resistant gloves, shoes plus sock, protective eyewear. Do not reuse clothing heavily contaminated with this product's concentrate.
Sethoxydim	Poast®, 7969-58	Warning	60	0.47	0.94	Causes substantial, but temporary, eye injury. Causes skin irritation. Harmful if absorbed through skin or swallowed. Do not get in eyes, on skin, or on clothing. This product is toxic to aquatic organisms. Do not apply directly to water; do not contaminate water when disposing of equipment washwater. Adjuvant addition required. Crop injury warnings. Multiple confirmed resistant weed biotypes. Physical hazard: Combustible.	Coveralls over short-sleeved shirt and short pants, chemical-resistant gloves, chemical-resistant footwear plus socks, protective eyewear, chemical-resistant headgear for overhead exposure, chemical-resistant apron for cleaning,

Active Ingredient	Example Product Name, EPA Registration #	Label Signal Word	Sugar Beet PHI[2] (days)	Max lb a.i./acre - Single Appli-cation[3]	Max lb a.i./acre - Season[3]	Label Precautionary Statements /Special Directions[4]	Applicator and Handler PPE[5] Required to Mitigate Risks
							mixing, loading. Do not reuse clothing heavily contaminated with this product's concentrate.
Trifluralin	Treflan® HFP, 62719-250	Caution	NA; one applica-tion between first true leaf and 6-inch stage	0.75	0.75	Causes moderate eye irritation, harmful if swallowed, prolonged or frequently repeated skin contact may cause allergic reaction in some individuals. Avoid contact with eyes, skin, or clothing. Contains petroleum distillates. This pesticide is extremely toxic to freshwater marine and estuarine fish and aquatic invertebrates including shrimp and oyster. Do not apply directly to water; do not contaminate water when disposing of equipment washwater. Environmental hazard statement for aerial drift. Soil incorporation required within 24 hrs of application. Crop injury warnings. Crop rotation restrictions ranging from 5 to 21 months.	Long-sleeved shirt, long pants, shoes plus socks, chemical-resistant gloves, protective eyewear. Do not reuse clothing heavily contaminated with this product's concentrate.

Active Ingredient	Example Product Name, EPA Registration #	Label Signal Word	Sugar Beet PHI[2] (days)	Max lb a.i./acre - Single Application[3]	Max lb a.i./acre - Season[3]	Label Precautionary Statements /Special Directions[4]	Applicator and Handler PPE[5] Required to Mitigate Risks
Triflusulfuron-methyl	UpBeet®, 352-569	Caution	60	0.032	0.078	Avoid contact with skin, eyes and clothing. In case of contact with eyes, immediately flush with plenty of water. Get medical attention if irritation persists. Resistant weed biotypes; multiple MOA resistance. Need spray adjuvant added. Special precautions for spray tank clean out. Requires tank mix with another herbicide for broad spectrum weed control. . Do not apply directly to water; do not contaminate water when disposing of equipment washwater.	Long-sleeved shirt, long pants, chemical-resistant gloves, shoes plus socks.

NA indicates not applicable.
[1] Signal words for pesticide products listed in this table are from the product label represented by the EPA Registration Number.
[2] PHI – Post Harvest Interval
[3] Maximum application rates per single application per season were obtained from the labels. See the text for details on how these values were derived.
[4] All the labels for herbicides in the table have a form of the following statement: "Do not apply directly to water, to areas where surface water is present or to intertidal areas below the mean high water mark. Do not contaminate water when [cleaning equipment or] disposing of equipment washwaters (or rinsate)." The text in bracket is excluded only for trifluralin and triflusulfuron. The text in parentheses is included for clethodim, cycloate, EPTC, pyrazon, and quizalofop-p-ethyl.
[5] PPE – Personal Protective Equipment.

(3) Cycloate

EPA determined that there is a potential for short- and intermediate-term exposures in for workers handling products containing cycloate during application activities including mixing, loading, and applying the products (U.S. EPA 2004). Because cycloate is incorporated into the soil within a short time after application, EPA expected any post-application exposures to be minimal. EPA has completed their occupational risk assessment for cycloate, and used the Pesticide Handler Exposure Database (PHED) to evaluate the exposures for pesticide handlers.

EPA established a MOE for inhalation and dermal exposure for five individual activities that workers might engage in while using products containing cycloate. When the risk estimate for an activity does not exceed the MOE, then that exposure is of concern to EPA. For cycloate application in sugar beet, activities whose risks were of concern included: closed mixing and loading for chemigation (fumigation application of a pesticide) – dermal and inhalation exposure; closed mixing and loading for ground boom application – inhalation exposure; closed mixing and loading for impregnation into dry bulk fertilizers – inhalation exposure; applying impregnated dry bulk fertilizers from an enclosed cab – inhalation exposure.

As the results of the EPA risk assessment indicate, risk from inhalation exposures remain a concern for some scenarios, even with maximum PPE and/or engineering controls. EPA has proposed some mitigation measures, including the voluntary cancellation of the chemigation application of cycloate, the requirement for engineering controls (including closed cabs and closed mixing/loading systems), and prohibiting the practice of on-farm impregnation of cycloate onto dry bulk fertilizer. EPA has also decided to require additional product use data to better characterize exposure from dry bulk fertilizer applications.

A review of human health incident data sources found two incidents that were due to workers not wearing label-specified PPE. A third incident was due to a worker being too close to a tractor while it was involved in spraying the soil.

(4) Desmedipham

After evaluating the occupational risks from exposure to desmedipham in 1996 (U.S. EPA 1996b), EPA determined that changes needed to be made in regulations governing occupational use of desmedipham. EPA was concerned about the MOE for dermal exposure risk for people who mix and load desmedipham products. EPA required that chemical-resistant gloves be worn by all mixers and loaders of wettable powder formulations of demedipham. An additional requirement was that a dust/mist respirator would be worn by mixers and loaders of wettable powders that were used for groundboom applications. Finally, EPA required engineering controls to mitigate risk, including water-soluble packaging or decreased application rates for applicators making or preparing for aerial applications of desmedipham.

(5) EPTC

In 1999, EPA evaluated occupational handler scenarios for workers that use products containing EPTC (U.S. EPA 1999). *It should be noted that the EPA is currently reevaluating EPTC and therefore some of the information regarding the EPA assessment of EPTC may change.* EPA determined that the intermediate-term endpoints from exposure to EPTC resulted in risks that were of concern to the agency. The risks for handlers that EPA was concerned about were based on dermal and inhalation exposure. To mitigate those exposures, EPA recommended that additional PPE, including double layer clothing and respirators, must be worn by mixers, loaders, and applicators. EPA also required that engineering controls such as enclosed cockpits are required during application of products containing EPTC. Of the 19 cases submitted to the California incident database (1982–1995) 17 involved use of EPTC alone and were judged to be responsible for the health effects.

(6) Ethofumesate

EPA conducted an occupational exposure assessment for ethofumesate and found that none of the potential occupational risks resulting from application of ethofumesate posed risks of concern (U.S. EPA 2006b). The agency based their conclusions on data from the PHED version 1.1. The re-entry interval (REI) established as a requirement of the worker protection standard (WPS) for ethofumesate is 12 hours, and EPA concluded that the interval is appropriate to protect workers from post-application exposure.

(7) Glyphosate

In their human health risk assessment for glyphosate, EPA noted that commercial handlers, applicators and growers that use glyphosate are expected to have short-term inhalation and dermal exposures to glyphosate (U.S. EPA 2006d). EPA did not conduct a short-term or a long-term handler or occupational exposure assessment because no short-term dermal or inhalation endpoints were selected by HIARC. Thus, EPA concluded that the assessment was not required. Labels for glyphosate products require applicators to wear PPE that consists of long-sleeved shirts, shoes with socks, long pants, and chemical-resistant gloves.

(8) Phenmedipham

In 2005, EPA assessed the occupational risks associated with application of phenmedipham for mixers, loaders, applicators, and flaggers (for aerial spray applications). All of the MOE estimates that EPA compiled were for combined dermal and inhalation exposure to phenmedipham. EPA found that if baseline PPE (the minimum required) was used by workers, the all of the handler exposure scenarios for pre- and post-application risks have MOEs greater than 100, which does not pose risks of concern (U.S. EPA 2005g).

(9) Pyrazon

EPA conducted an occupational exposure assessment for pyrazon and found that none of the potential occupational risks resulting from application of pyrazon posed risks of concern (U.S. EPA 2005c). The agency based their conclusions on data from the PHED version 1.1 and considered short- and intermediate-term inhalation exposures. EPA did not assess dermal exposure, since a dermal endpoint of concern has not been identified for pyrazon. The REI established as a requirement of the worker protection standard WPS for pyrazon is 12 hours, and EPA concluded that the interval is appropriate to protect workers from post-application exposure.

(10) Quizalofop-p-ethyl

EPA assessed the occupational risks from exposure to quizalofop-p-ethyl as part of their *Human Health Risk Assessment for New Uses on Barley, Flax, Sunflower and Wheat* (U.S. EPA 2006e). EPA did not calculate any quantitative risks for quizalofop-p-ethyl and concluded that no short-term dermal and inhalation toxicity endpoints were identified for estimating the occupational exposures to handlers and post-application workers. EPA Health Effects Division (HED) reported they had no concerns for occupational exposures associated with the proposed uses of quizalofop-p-ethyl based on the fact that the acute toxicity categories are IV for both dermal and inhalation routes of exposures (U.S. EPA 2006e). Under the WPS, a 12-hour REI is established.

In 2007, EPA conducted a review of incident reports for quizalofop-p-ethyl based on data from three sources: Poison Control Center data from the National Poison Center System (NPCS), the Office of Pesticide Programs (OPP) Incident Data System (IDS), and the National Institute of Occupational Safety and Health (NIOSH) Sentinel Event Notification System for Occupational Risks (SENSOR) (U.S. EPA 2007c). There were no reported cases in the SENSOR database. The NPCS data cover 1993 to 2005, and included ten total exposures to quizalofop-p-ethyl. Reported symptoms from the reports included headache, eye irritation, and throat irritation. There were eight reported cases from 1999 to 2007 in the IDS database. Symptoms reported in those cases included sinus and other headaches, nausea, leg cramps, rashes, diarrhea, fever and hypothermia.

No information was available on the resolution of any of the eight cases from the IDS database.

(11) Sethoxydim

EPA assessed the potential for occupational exposure to sethoxydim in 2005 (U.S. EPA 2005h). The exposures EPA evaluated included the handling of sethoxydim during mixing, loading, and application processes. The potential for postapplication occupational exposure was also evaluated, due to workers entering into areas previously treated with sethoxydim. EPA concluded that short-term and intermediate-term exposures (1 to 6 months) may occur, but that long-term exposures were not expected. EPA only assessed the risks from inhalation exposures, as no dermal toxicity endpoints for sethoxydim were identified. The risk for inhalation exposures was based on values observed in a 28-day rat inhalation study. The most common symptoms reported in incident reports included rash, eye and throat irritation, gastrointestinal symptoms, headache, and dizziness. Two of the more serious cases reported eye problems including visual defect and nonreactive pupils.

(12) Trifluralin

In the occupational exposure assessment for trifluralin, EPA identified the potential for exposure for mixers, loaders, applicators, or other handlers during normal use practices (U.S. EPA 1996c). EPA also found that their occupational cancer risk assessment for all uses shows that the level of risk does not exceed 10^{-5} for occupational handlers of products containing trifluralin or for post-application exposures. The REI for products containing trifluralin is 12 hours, and the minimum PPE required for early entry include coveralls, shoes, socks, and chemical-resistant gloves.

(13) Triflusulfuron-methyl

Due to a lack of chemical-specific data for assessing human exposures to triflusulfuron-methyl, used data from the PHED version 1.1 to complete their risk assessment (U.S. EPA 2002a). EPA concluded that the available data support an REI of 4 hours, but that the shorter REI would only be established following a request from the registrant and the submission of toxicity information on the product. In their risk assessment, EPA found that none of the MOEs for occupational exposure posed risks of concern for both application and postapplication activities.

IV. Environmental Consequences

A. Methodologies and Assumptions Used in Analysis

This chapter evaluates the potential effects of the selection of Alternatives 1 through 3, as presented in chapter II of this environmental impact statement (EIS).

This chapter considers the potential environmental consequences of implementing each alternative on the following: production and management of beet crops (including sugar beet, Swiss chard, table beet, and fodder beet, and gene flow); biological resources (including animals, micro-organisms, and plants); socioeconomics (including various sugar, sugar beet, and vegetable beet markets); physical environment (including land use, soil, air quality and climate change, and surface water and groundwater quality); and human health (including public and worker health and safety).

1. Methodologies

This EIS analyzes the potential environmental impacts of various alternative options for determining the regulated status of H7-1 sugar beet. Models and assessments used for the analysis range from those discussed in the studies in the published literature that inform this EIS to those that the Animal and Plant Health Inspection Service (APHIS) developed or refined for the EIS. An example of the former is the GENESYS-BEET model, which is a computation model developed to examine numerous components of the cultivated beet and weed beet lifecycles (see section III.B.5). An example of the latter is the relative risk calculation APHIS used to relate the risks of herbicides to glyphosate.

In order to assess the potential for unintended gene flow between H7-1 sugar beet and vegetable beet seed production in the United States, APHIS determined the distribution of vegetable seed production in the Swiss chard and table beet sections (see sections III.B.2, III.B.3, IV.B.2, and IV.B.3). Because public data were not available for much of Swiss chard and table beet seed production, APHIS used publications from the Washington State Extension Office (du Toit et al., 2007; McMoran et al., 2010), and contacted regional extension agents and commercial seed producers of both vegetable beet crops (Falconer, 2011; Mcmoran, 2011a). Using these data, the estimated acreage and distribution of each crop type was mapped at the State level to preserve confidential business information. Additionally, using planting data supplied to APHIS in 2011 as a permitting requirement, APHIS determined the county level distribution of H7-1 sugar beet seed production for 2011. Using these county level maps, APHIS determined the counties in which sugar beet and vegetable beet seed production occurs.

In the gene flow section, section III.B.5, estimates of pollen cloud dissipation rates and competition at sink fields were assessed to determine the potential for unintended gene flow at the different isolation distances used in each of the alternatives. APHIS used published pollen dispersal distances from gene flow studies that were summarized in (Darmency et al., 2009). Using the best fit models for pollen dispersal and gene flow under conditions of no pollen competition (male-sterile receptor plants), APHIS determined the rate of pollen dilution up to 3,280 feet. APHIS also used published estimates of pollen production and ovule production for *Beta vulgaris* to determine the relative size of pollen clouds that have not dispersed (OECD). APHIS did not extrapolate beyond the distances where empirical data are available; thus rates of gene flow are summarized at 3,280 feet, and did not attempt to determine gene flow potential at the 3- or 4-mile isolation distances utilized by the different alternatives. Previously published computational models that have estimated gene flow at 6 miles (Westgate, 2010) were used as a benchmark beyond the recommended isolation distances. Additionally, APHIS determined the approximate lifecycles, bolting period, and flowering period of sugar beet seed production, sugar beet root production, and wild beet through published data on production methods and through interviews with sugar beet experts (Beet Sugar Development Foundation et al., 2011). Flowering times and published data (Lewellen et al., 2003)were used to evaluate the potential for gene flow to occur between sugar beet and wild beet in California under Alternative 2.

Herbicide usage in sugar beet is an important aspect in assessing the environmental impacts of deregulation of H7-1 sugar beet. To assess regional differences in herbicide use APHIS used published herbicide data from 2000 from the U.S. Department of Agriculture–National Agricultural Statistics Service (USDA-NASS, 2008). To assess herbicide use across the alternatives, APHIS used 2011 survey data from Minnesota and Eastern North Dakota which reports the percent of acres of the total planted (693,740) on which herbicide is sprayed. The seasonal glyphosate rate was determined by Stachler and colleagues through the survey. For other herbicides, either a single use rate or seasonal rate was estimated by Stachler and Agriculture Managers at Minn-Dak, Southern Minnesota Sugar Beet Cooperative, and American Crystal Sugar(Bernhardson et al., 2012). The sugar beet cooperatives also determined that the sugar beet crop in Minnesota and North Dakota was 10.5% conventional and 89.5% H7-1. Total pounds of each herbicide used were calculated for the actual use (Table 3-17) and then normalized assuming 100% of the beet crop was either conventional (Alternative 1) or H7-1 (Alternative 2 or 3) in Table 3-17. (Stachler et al., 2012a).

In the herbicide resistance section IV.C.3, APHIS examined what weeds could have the greatest potential to be problematic in sugar beet and in rotation crops under each of the alternatives. APHIS evaluated sugar beet weeds, and examined the distribution of glyphosate-resistant weed species in the states that produce sugar beet (Heap, 2011; Sprague and Everman, 2011; Stachler et al., 2011); and states that are immediately adjacent to sugar beet states. APHIS then expanded the analysis of these glyphosate-resistant weeds by examining the distribution of each species that has been noted as having biotypes that are resistant to conventional herbicides as well as the distribution of sensitive biotypes (USDA-NRCS, 2010). Finally, APHIS examined the distribution of all remaining glyphosate-resistant species that have occurred worldwide (Heap, 2011), noting if they have been identified as sensitive biotypes in any sugar beet producing states. Using a tiered system to qualitatively classify the different weed species, APHIS identified weeds with the greatest potential to shift into H7-1 sugar beet or other glyphosate-resistant crops in rotation with H7-1.

The biological resources analysis for animal and non-target plants includes an assessment of the composition and nutritional quality of H7-1 sugar beet. This analysis also includes a qualitative and quantitative assessment of the potential effects of sugar beet herbicides on animals and non-target plants. For glyphosate, the assessment incorporates information from the Tier 1 ecological risk assessment conducted by APHIS for the *Final Environmental Impact Statement for Glyphosate-Tolerant Alfalfa Events J101 and J163: Request for Nonregulated Status* (USDA-APHIS, 2010a). Appendix N of the alfalfa Final EIS analyzes the potential effects of glyphosate on plants and animals. For all of the herbicides used on conventional sugar beet, APHIS reviewed and presented available toxicity data for mammals, birds, fish, aquatic invertebrates, terrestrial invertebrates and both monocot and dicot plants and other relevant information published by EPA's Office of Pesticide Programs (EPA OPP), as well as other sources. Where appropriate, APHIS presented estimated environmental concentrations that might reach non-target plants and animals during and soon after herbicide application according to labels.

In analyzing the potential socioeconomic impacts of the alternatives, APHIS first identified potential issues raised by the existing literature, including the Final EA for partial deregulation of H7-1 sugar beet (USDA-APHIS, 2011b). APHIS then prepared relevant baseline information to enable assessing the issues raised. The baseline describes the supply and demand of the various markets along the sugar beet production chain, from seed to sugar, including foreign markets and niche markets such as the organic and non-genetically modified organisms (GMO) segments. The baseline also describes the U.S. vegetable beet market. Finally, APHIS assessed the existing evidence regarding potential impacts of each alternative on the various markets described. This was done mostly qualitatively and based on the existing literature, including recent expert studies and surveys.

The analysis of impacts on the physical environment draws on the analyses APHIS developed for production management, biological resources, and socioeconomic impacts. APHIS supplemented these analyses with data from the existing literature to identify relevant variables such as acreage planted, tillage practices, and the use of glyphosate- and non-glyphosate-herbicides. APHIS estimated the trends in and changes to the identified variables to assess the potential effects of the alternatives on land use, soil, air quality and climate change, and surface water and groundwater quality.

The human health and safety assessments in sections III.F and IV.F use both screening-level approaches to assess toxicity and compare exposure estimates with human health toxicity benchmarks. Specifically, the toxicity assessment of the CP4 EPSPS (5-enolpyruvylshikimate-3-phosphate synthase) protein, used a standard approach in toxicology assessment of applying an excess dose to a test animal and observing the effects. In this case, the dose of CP4 EPSPS was designed to reflect a 1,000-fold factor of safety on the highest possible human exposure to CP4 EPSPS, assuming multiple sources in the diet. The dose was equivalent to a human ingesting about 221 kilograms of beet root at one time. The CP4 EPSPS protein also is assessed for biologically relevant amino acid sequence similarities to protein toxins known to cause adverse health effects in humans or animals. This assessment is based on a comparison of the amino acid sequence of CP4 EPSPS to protein sequences in the ALLPEPTIDES database using the FASTA algorithm. A similar assessment is also made for allergens, using the FASTA algorithm in the ALLERGEN3 database.

Also, the U.S. Environmental Protection Agency (EPA) reference doses (RfD) for herbicides, including glyphosate – an herbicide which would be predominantly used in sugar beet root production under Alternatives 2 and 3 – generally include a 100-fold safety factor above the no-observed-adverse-effect level (NOAEL) from an animal study. EPA's aggregate dietary risk assessments use several models, including the Dietary Exposure Evaluation Model software with the Food Commodity Intake Database (DEEM-FCID™) and the Generic Expected Environmental Concentration (GENEEC) and Screening Concentration In Groundwater (SCI-GROW) models, along with conservative modeling assumptions such as the use of tolerance level residues, 100 percent crop treated, a water dilution model that does not take into account degradation in the water body and partitioning into the water column sediment phases, and maximum pesticide application rates (71 *FR* 76180, 2006). The human health and safety assessments also use a variety of methodologies for assessing and comparing overall risk from herbicides. These methodologies include the following:

- APHIS relative risk score (RRS), a metric developed by APHIS to provide an estimate of the risk of various herbicides, relative to a given herbicide (in this case glyphosate);

- The exposure adjusted toxicity category from the Windows Pesticide Screening Tool (WIN-PST), developed by the USDA Natural Resources Conservation Service (NRCS) as a risk screening tool for pesticides; and

- Environmental Impact Quotient (EIQ), a tool developed to integrate information on different types of environmental and human health impacts of individual pesticides into a single indicator value of impact.

2. Inherent Assumptions

APHIS expects that Alternative 1 (No Action) will result in conditions similar to those used for the cultivation of conventional sugar beet. Data from years prior to 2005, before H7-1 beet was adopted, and more contemporary data collected on conventional sugar beet, were used to predict what conditions would eventually return for the affected environment should Alternative 1 be selected.

APHIS expects that Alternative 2 (Full Deregulation) will result in conditions similar to 2009-2010 after H7-1 sugar beet deregulation and it's widespread adoption. When available, data from those years or data collected on H7-1 sugar beet were used to predict what conditions would occur should Alternative 2 be selected.

APHIS expects that Alternative 3 (Partial Deregulation) will result in similar "on the ground" foot prints of H7-1 sugar beet plantings as Alternative 2 (with the exception of California and western Washington), and that the plantings that would occur under Alternative 3 would be more similar to the conditions seen under deregulation than prior to deregulation. That is, the acreage of H7-1 sugar beet would be closer to 100 percent than to zero percent. It is difficult to predict what impacts the restrictions and conditions contained in Alternative 3 would have on grower choices and behaviors.

APHIS geographically restricted its analysis of the impacts of the root crop to areas that have traditionally grown sugar beet for the purpose of producing sugar. As a result, impacts for producing the root crop were only analyzed in Eastern Washington and not Western Washington which has no sugar beet processing plants within 100 miles.

Other assumptions are stated where applicable throughout the individual resource sections of this EIS.

Data gaps or uncertainties are also discussed in the analysis of potential impacts. Where a lack of data precludes a complete evaluation, APHIS acknowledges the inability to estimate the potential environmental impacts with precision.

B. Production and Management of Beet Crops

This section discusses the potential impacts of the environmental release of H7-1 sugar beet for the three alternatives analyzed in this EIS. Just like section III.B, it is divided into five main sections: sugar beet (IV.B.1), Swiss chard (IV.B.2), table beet (IV.B.3), fodder beet (IV.B.4), and gene flow in these *Beta* species (IV.B.5).

1. Sugar Beet

As described in section III.B.1, sugar beet production in the United States includes production of both seed and roots. Potential impacts of the environmental release of H7-1 sugar beet on both seed and root production are described separately below.

While chapter III describes all uses of sugar beet, it is important to note that none of these uses have caused there to be changes in sugar beet seed or root production with the adoption of H7-1 sugar beet. In some cases, H7-1 sugar beet is not allowed to be used in all applications (e.g., as mandated by the Monsanto Technology Use Guide (TUG), H7-1 sugar beet may not be used for wildlife habitat plots). However, as described in section III.B.1.b(11) and below, seed companies already have in place protocols to separate H7-1 from conventional seed and to reduce the possibility of accidental mixing of seed (Lehner, 2010; Loberg, 2010a), so this requirement has not resulted in any additional changes in seed production practices. In terms of other uses, there have been no changes in sugar beet seed or root production for the use of sugar beet in beet pulp, molasses, food additives, chemical manufacturing, deicing, feed for animals, the use of waste lime from sugar processing plants, and the production of sucrose from sugar beet.

The discussion that follows also does not address all aspects of sugar beet seed and root production, but rather focuses on only those aspects that differ from the No Action Alternative as a result of the two additional alternatives that are analyzed in this EIS. In terms of seed production, the majority of the practices used to produce sugar beet seed have not changed with the adoption of H7-1 sugar beet and therefore are not discussed below. For example, the companies that produce and market sugar beet seed, the requirement of seed variety approval by seed cooperatives, the lifecycle of seed production, the development of monogerm varieties, the methods of hybrid seed production including cytoplasmic male sterility, the planting of hybrid parents in the field, the use of pinning maps in areas where sexually compatible *Beta* species are grown, land preparation, the use of both the direct seeding and stecklings methods, fertilization, crop rotation, and disease management have all remained the same. Additionally, APHIS does not anticipate any changes in these production practices as a result of any of the three alternatives. Therefore, these sugar beet seed production practices are not discussed in detail below. For more information on these seed production practices, see the corresponding sections in III.B.1.b(1) through III.B.1.b(19).

The aspects of sugar beet seed production that have changed with the adoption of H7-1sugar beet and are predicted to vary among the three alternatives include: the counties in which sugar beet seed is produced, the isolation distances used between sugar beet seed production and other fertile *Beta* species, the guidelines used for sugar beet seed production by Betaseed and West Coast Beet Seed, herbicides used during seed production, the post-production processes used after seed has been harvested, and testing for LLP in seeds. These issues, and the associated changes that are expected to occur with each of the three alternatives, are discussed in detail below.

In terms of root production, some practices used to produce sugar beet roots also have not changed with the adoption of H7-1 sugar beet. These practices include root production location, the acreage of crops planted in each region, planting, bolting and harvesting dates, fertilization and pH adjustment, and pest management practices including disease and insect management. Additionally, APHIS does not anticipate any changes in these production practices among the three alternatives. Therefore, these sugar beet root production practices are not discussed in detail below. For more information on these root production practices, see the corresponding sections in III.B.1.c(1) through III.B.1.c(5).

The aspects of sugar beet root production that have changed with the adoption of H7-1 sugar beet and are predicted to be affected by the three alternatives include: the types of seed selected in each area, tillage and weed management, management of bolters, fertilizer application methods, and requirements related to transportation of sugar beet roots to processing facilities. These issues, and the associated changes that are expected to vary among the three alternatives, are discussed in detail below.

a. Seed Crop

The potential impacts of each of the alternatives on seed crop production practices are discussed in turn below.

(1) Alternative 1 – No Action

Under Alternative 1, APHIS would deny the petition seeking a determination of nonregulated status of H7-1 sugar beet. Under Alternative 1, it is possible, but unlikely, that previously deregulated herbicide-resistance traits in sugar beet (event T120-7 and line GTSB77) could be bred into current sugar beet varieties and released for commercial production. However, both Monsanto/KWS SAAT AG and Bayer, the owners of these traits, have stated to APHIS that they have no intention to do so (see section II.B). For more information on regulatory approvals of event T120-7 and line GTSB77, see section III.B.1.a(4). APHIS assumes that under Alternative 1, no herbicide-tolerant sugar beet will be available to growers.

Under Alternative 1, an adequate amount of conventional sugar beet seeds to sell to farmers might not be available until 2014 at the earliest (Miller, 2010). Conventional sugar beet seed that has been held in reserve by seed producers is at least 3 years old making it low quality and potentially unmarketable (Miller, 2010). Whether seed supply would be limited is unclear, as opinions on the topic differ (Miller, 2010; Pates, 2010).

Under Alternative 1, a lag in production of conventional sugar beet seeds would occur. Given that 8–12 years is required to develop a new sugar beet variety, and many sugar beet breeding lines currently contain the H7-1 transgene, several years would be needed to develop conventional varieties with the same trait combinations that currently exist in H7-1 lines (Miller, 2010). For more information on sugar beet seed breeding, see sections III.B1.b(1) though III.B1.b(14). Conventional seed varieties available to farmers in the short term (~1–10 years) would likely not contain the most desirable trait combinations for each region due to the breeding lag. APHIS believes that the lag would not continue in the long term as seed companies would continue to develop new, non H7-1 varieties with the trait combinations desired by farmers.

Additionally, as stated in section III.B.1.b(4), sugar beet farmers can only grow varieties that are approved by sugar beet seed committees after a 3-year trial period. Given the strong grower demand for H7-1 sugar beet, which comprised 95 percent of sugar beet grown in 2009-2010, most beet sugar processors have few to no conventional sugar beet varieties on the approved list. It is possible that an emergency exception would be made to allow growers to use conventional seed varieties that are not on the list but were listed in previous years (American Crystal Sugar Company, 2010). As California cannot grow H7-1 varieties under the current partial deregulation, they are not expected to have a shortage of conventional sugar beet seeds under Alternative 1.

As described in chapter III, for the most part, weed management in seed fields after the adoption of H7-1 sugar beet has not changed. The practices used in 2005 are similar to those used in 2010. The only difference is that H7-1 breeder and foundation seeds may have glyphosate applications for postemergence weed control as long as both parents carry the H7-1 gene (Loberg, 2010b). In general, glyphosate is not used in commercial seed production because at least one of the parents does not carry the resistance gene and could be damaged by glyphosate application. For more information on hybrid crosses in the field, see section III.B.1.b(9). Under Alternative 1, no H7-1 parents would be present in commercial seed fields; therefore, glyphosate could not be used for postemergence weed control.

In 2006, the West Coast Beet Seed (WCBS) Company implemented the Protocol for Genetically Modified (GM) Seed Production (Loberg, 2010a). Betaseed implemented similar protocols. Under Alternative 1, WCBS and Betaseed would no longer need to follow these protocols as H7-1 seed would no longer be produced. Seed companies might revert to pre-2005 practices to ensure that high-quality conventional hybrid seed was produced. For more information on WCBS and Betaseed guidelines, see section III.B.1.b(11).

As described previously in section III.B.1.b(19), sugar beet seed companies have always tested sugar beet seeds for genetic purity. Depending on the specific tests done, this type of testing can detect whether varieties have the intended mix of genetic traits and can also detect if the H7-1 trait is present in conventional lines (Anfinrud, 2010). Under Alternative 1, testing conventional seed for the low level presence of H7-1 would be expected to cease. Seed companies would continue to test for traits introduced by unintended crosses.

In summary, Alternative 1 would not change the basic principles behind sugar beet seed breeding, production practices, or variety development as described above. However, Alternative 1 may result in a short-term shortfall in availability of conventional seed to sell to farmers; the elimination of glyphosate use for postemergence weed control (Loberg, 2010b)(only used now for H7-1 breeder and foundation seeds where both parents carry the H7-1 gene); seed companies reverting back to pre-2005 practices to ensure high-quality conventional hybrid seed; and the elimination of testing for the low level presence of the H7-1 trait. Alternative 1 also would reduce the H7-1 gene flow potential to other *B. vulgaris* crops (Swiss chard and table beet). For more information on gene flow impacts, see section IV.B.5.a.

(2) Alternative 2 – Full Deregulation

Under Alternative 2, a determination of nonregulated status of H7-1 sugar beet would mean that H7-1 sugar beet would no longer be subject to the regulations at 7 CFR part 340.

APHIS does not track all sugar beet seed production acreage. For this EIS, APHIS assumes that seed acreage for domestic use would be in the same ratio (H7-1:conventional) as domestic root acreage. Therefore, if 95 percent of the root crop acreage is H7-1, then 95 percent of the seed acreage for domestic use would be H7-1. The proportion of H7-1 to conventional of the export seed crop is not known, because while USDA tracks overall exports, it does not track the type of varieties exported. Both H7-1 and conventional varieties are exported. However, it should be noted that only Canada has approved H7-1 sugar beet seeds for root production, so H7-1 sugar beet seeds would likely not be exported to any country other than Canada. For more on H7-1 international approvals, see section III.B.1.a(5).

An adequate amount of H7-1 and conventional sugar beet seeds is expected to be available to farmers under Alternative 2.

Under Alternative 2, it is possible, but unlikely, that previously deregulated glufosinate tolerant sugar beet, event T120-7 would be bred into current H7-1 sugar beet varieties to create stacked dual herbicide-resistant varieties. Both Monsanto and Bayer, the owners of these traits, have stated to APHIS that they have no intention to do so (see section II.B). Furthermore, glufosinate-tolerant sugar beet T120-7 is lacking many of the international approvals that H7-1 has, so stacking the two traits would reduce the marketability of processed food produced from GE sugar beet. For more information on regulatory approvals of event T120-7, see section III.B.1.a(4).

Monsanto's Technology Stewardship Agreement (MTSA) is based on the ability to license the H7-1 sugar beet technology to each grower under existing patents to produce one crop. There are a number of applicable patents, including patents on the H7-1 event, the use of technologies, and the germplasm or variety. The existence of patents is the underpinning of the contractual relationship between Monsanto or KWS SAAT AG and the grower. That contractual relationship is one basis for enforcement of stewardship requirements outlined in the TUG. Growers who fail to follow the TUG may be ineligible to purchase Monsanto seed in the future or in extreme cases legal action can be taken by Monsanto. The TUG is separate from the MTSA, and describes the broad range of stewardship activities that Monsanto recommends for the proper use of its biotech seed products. The TUG would be published and provided to growers to guide proper product stewardship whether or not an MTSA is in place.

Independent of grower obligations under the MTSA, the Sugar Beet Grower Cooperatives also impose certain stewardship requirements through grower contracts. Under Alternative 2, because the Grower Cooperatives would maintain control, APHIS concludes that patent expiration would have no impact on sugar beet root production.

Furthermore, because all sugar beet seed is produced as hybrids, seed saving is not practical and available varieties would remain under industry control after patents expire for the following reasons. First, producing hybrid seed is a complex undertaking requiring specialized skills and resources including proprietary parental lines. Second, growers are obligated to plant only varieties that are entered into variety trials which would exclude a grower from producing his own varieties. Third, growers of the root crop are located in regions where it is difficult to grow a seed crop. As stated in section III.B.1.b(1),commercial sugar beet seed is mainly produced in Oregon and Washington where the climate is not too cold or too hot to meet the growing needs of a biennial crop. Sugar beet root production areas, with the exception of the Imperial Valley, are not conducive to seed production as the cold winters would kill sugar beet plants before seed stalks could form in the spring. The Imperial Valley is an undesirable seed production region due to the high spring and summer temperatures that impair pollen and seed development (see section III.B.1.5). As a result, varieties can be effectively removed after patent expiration and replaced with new varieties that are similarly patent protected. It is reasonable to expect that these replacement varieties, which may contain the H7-1 trait stacked with other new biotech traits, will also require stewardship agreements. Therefore, the agency does not anticipate any changes in stewardship requirements for growers after the H7-1 trait patent expires.

After patent expiration, vegetable beet breeders would not be prohibited from breeding the H7-1 trait into any compatible *Beta* species. However, as stated in sections III.B.2 and III.B.3, virtually all of the Swiss chard and some of the table beet seed produced in the United States are for GM-sensitive markets which are unlikely to want this trait in vegetable beet. Growers of table beet for canning might prefer varieties that are glyphosate-resistant so it seems possible that this trait might oneday be used in other beet crops depending on the canning industy's perception of consumer sensitivity to GM.

In 2011, H7-1 sugar beet seed was produced in Oregon, Washington, Idaho and a small amount in Colorado. Fig. 3–1 shows counties in 2011 in which H7-1 sugar beet seed was planted (shaded) and proposed for planting but not planted (hatched). See section III.B.1.b(1) for more on seed production areas. As discussed above and in section III.B.1.b(1), climate constraints hinder sugar beet seed from being produced in other U.S. geographic locations outside of the Northwest. While seed production could move into northern California and western Washington under Alternative 2, APHIS believes areas of seed production would stay about the same as they are now for the following reasons:

- Sugar beet seed production has historically been confined to Oregon. The most recent expansion of sugar beet seed production has been into Eastern Washington, an area without Swiss chard and table beet seed production and not into areas such as western WA and northern.CA where vegetable beet seeds are produced. APHIS is not aware of any reason why sugar beet seed production would follow vegetable seed production into western WA and CA.

- There is a high level of economic motivation to keep pinning schemes and isolation distances in place. Seed producers want to produce seed with high purity and miminal LLP . For more information on LLP, see section III.B.1.b(19).

- Sugar beet seed is unlikely to be grown in western Washington State since this region is already utilized by seed producers for Swiss chard and table beet. Pinning priority for field placement involves seniority and incoming farmers would be less likely to find regions within western Washington that are sufficiently isolated.

- Postemergence weed control would likely continue similar to 2010 practices where H7-1 sugar beet parental lines can be treated with glyphosate. H7-1 breeder and foundation seed may have glyphosate applications for postemergence weed control. Application of glyphosate to all rows in a commercial seed production field is not possible as only one of the parents carries the H7-1 trait in a given cross and the other parent would be killed by the glyphosate. For more information on hybrid crosses in the field, see section III.B.1b(9).

As mentioned under Alternative 1, WCBS and Betaseed would likely continue to follow their strict guidelines to further minimize the potential for gene flow for H7-1 seed production. This includes guidelines from tracking the seed from the field to the final delivery at the processing facility in order to minimize the possibility of accidental mixing with other seeds (Lehner, 2010; Loberg, 2010a). In Willamette Valley, both Betaseed and WCBS follow the Willamette Valley Specialty Seed Association (WVSSA) guidelines for isolation distances of at least 3 miles between H7-1 sugar beet seeds and other sexually compatible *Beta* species. Betaseed has a mandatory more stringent requirement of 4 miles between H7-1 sugar beet seed and other compatible *Beta* species (Lehner, 2010). Examples of additional procedures include grower training, careful monitoring of seed production, prohibiting seed growers from growing other *Beta* species, cleaning equipment before and after harvesting a sugar beet seed crop, and monitoring for and eliminating volunteers after harvest (Lehner, 2010; Loberg, 2010a). The protocols are also updated as required. For example, as described by (2010a) regarding the WCBS protocol: "the protocol needs to be continually reviewed. During the review and handling of the crop, new areas of concern may become evident. When this occurs, the concern must be addressed and solutions implemented" (Loberg, 2010a). Under Alternative 2, these company protocols would remain in place and presumably be updated as needed. For more information on WCBS and Betaseed guidelines, see section III.B.1.b(11).

Under Alternative 2, in both the short and long term, sugar beet seed producers are expected to continue to test all types of sugar beet seed for varietal purity (Anfinrud, 2010). This includes specifically testing conventional sugar beet seed for the presence of the H7-1 trait. For more information on LLP, see section III.B.1.b(19).

In summary, with the exception of a few aspects, Alternative 2 would not change the basic principles behind sugar beet seed breeding, production practices, or variety development, as described above. Alternative 2 does not have any mandatory isolation distances for H7-1 sugar beet seed production, but it is expected that seed companies will continue to participate in regional pinning and isolation distance schemes to ensure that varietal purity is maintained. H7-1 sugar beet seed production could move to other areas where *Beta* species other than sugar beet have traditionally been grown (for example Skagit and Snohomish Counties in Washington State), although APHIS believes this is unlikely due to the increased possibility of gene flow to and from other sexually compatible *Beta* species into sugar beet fields as described above. Alternative 2 would result in higher potential levels of H7-1 gene flow to other *B. vulgaris* crops (Swiss chard and table beet) than Alternative 1 as more acres of H7-1 seed would be produced. For more information on gene flow impacts, see section IV.B.5(a).

(3) Alternative 3 – Partial Deregulation

Under Alternative 3, APHIS would authorize the environmental release of H7-1 seed for seed production under APHIS permits and movement of H7-1 sugar beet seed and stecklings under APHIS permits and notifications in accordance with 7 CFR part 340. APHIS would partially deregulate the H7-1 root crop indefinitely (with conditions, see section II.D).

The geographic distribution of H7-1 sugar beet seed fields would be evaluated and either denied or permitted by APHIS. The isolation distances for H7-1 sugar beet seed fields (as discussed in section II.D) would be determined and enforced by APHIS. These distances are 4 miles from H7-1 to table beet and Swiss chard seed production.

The conditions set forth in Alternative 3 were implemented on a temporary basis in February 2011. It is currently unknown whether these conditions will deter production of H7-1 sugar beet seed since sugar beet seed production and seed grower reporting has not yet been completed. Additionally, the percentage of H7-1 sugar beet seed being produced as compared to conventional sugar beet seed under the conditions proposed for Alternative 3 is not currently known. While APHIS can determine the acreage of H7-1 sugar beet seed production due to the mandatory reporting requirements contained in this alternative, APHIS has no regulatory ability to require companies to report nonregulated seed production acres.

- The location of future H7-1 seed production would likely be similar to 2011 seed production (see Fig. 3–1).

- An adequate amount of H7-1 and conventional sugar beet seeds are expected to be available to farmers under Alternative 3.

- Under Alternative 3, patent expiration would have no impact on how H7-1 sugar beet seed fields would be handled.

Similar to Alternative 2, postemergence weed control would likely continue similar to 2010 practices where H7-1 sugar beet parental lines can be treated with glyphosate for postemergence weed control. For more information on hybrid crosses in the field, see section III.B.1.b(9).

Alternative 3 has 18 mandatory permit conditions for seed production. These include conditions to limit gene flow through isolation distances, informing APHIS when H7-1 fields are planted and whether they produce H7-1 pollen, conditions to reduce the possibility of accidental co-mixing of H7-1 sugar beet seed with non H7-1 seed through recordkeeping and tracking of all seed from production through packaging, and required seed company training and management plans. For more detail on the mandatory conditions, see section II.D.

Alternative 3 would result in increased recordkeeping requirements and increased reporting requirements for seed producers. For example, seed producers would need to send a planting report mentioned above and would be subject to inspections to ensure compliance with mandatory conditions. Many of the permit requirements are similar or identical to practices already in place by Betaseed and WCBS (see section III.B.1.b(11), making it difficult to determine how much of a change in practice would be required. This alternative would not change the basic principles behind sugar beet seed breeding or production practices.

Alternative 3 would also limit the ability of seed producers to produce or sell H7-1 sugar beet seed to farmers in the above mentioned counties in Washington State and California. Given that H7-1 sugar beet seed was not produced in any of the restricted counties in 2011, it is unlikely that this alternative would impact sugar beet seed production in those states. The counties in which sugar beet seed cannot be produced are those in which sugar beet seed traditionally has not been produced. Alternative 3 is also unlikely to affect sales of sugar beet seed in Washington given that the State has very little sugar beet root production (one tenth of 1 percent of the U.S. production) and that production has not historically occurred in the counties in which H7-1 sugar beet are not allowed (Stankiewicz Gabel, 2010).

In 2011, no H7-1 sugar beet seed was produced in California. Therefore, it is unlikely that this alternative would impact sugar beet seed production in the State. Alternative 3 is likely to affect sales of sugar beet seeds in California. While no H7-1 sugar beet seed has been sold in California to date, California would, absent any prohibition, likely adopt H7-1 sugar beet to help manage the wild beet problem in Imperial Valley. Alternative 3, however, would prohibit sales of H7-1 sugar beet in California so that farmers would not have the choice to grow this crop even if they wanted. Sales of conventional sugar beet seed would likely continue.

Under Alternative 3, sugar beet seed production in Oregon would likely be similar to that of Alternative 2 with the exception that Alternative 3 has mandatory isolation distances of 4 miles between H7-1 seed production fields and and table beet and Swiss chard seed production fields. WVSSA guidelines require a 3 mile isolation distance between unlike hybrid seed production as well as between GE and any other *Beta* species, but under Alternative 3, the isolation distance between H7-1 and another hybrid such as table beet would be increased to 4 miles. Under both Alternatives, the isolation distance between hybrid sugar beet and open pollinated Swiss chard or table beet would be 4 miles. Isolation distances between H7-1 plants and conventional or organic sugar beet seed production would also be 4 miles, which is greater than the 3 miles recommended by the WVSSA. APHIS makes an exception when the same party is producing the H7-1 and non H7-1 sugar beet varieties. For more information on WVSSA guidelines and pinning rules, see section III.B.1.b(10).

As standard practices for evaluating seed purity and testing for LLP do not change as a condition of Alternative 3, testing practices for LLP under Alternative 3 are expected to be the same as those under Alternative 2.

In summary, the major differences between Alternatives 2 and 3 are that Alternative 3 has a mandatory isolation distance of 4 miles between H7-1 sugar beet fields and table beet and Swiss chard seed production fields, whereas Alternative 2 does not have any mandatory isolation distances (although producers do use isolation distances of 3–4 miles under Alternative 2 as described above). Additionally, Alternative 3 has mandatory seed production practices to reduce potential gene flow from H7-1 sugar beet seed production to other, sexually compatible species as well as to reduce LLP of H7-1 in conventional sugar beet seed lots. Alternative 3 would not allow the production of H7-1 in western Washington and California. Both these states produce vegetable beet seed so the measure would create isolation distances that vastly exceed distances considered to be effective to minimize gene flow. Alternative 3 would likely result in similar, to slightly reduced, potential levels of H7-1 gene flow to other sexually compatible *B. vulgaris* crops (Swiss chard and table beet) as compared to Alternative 2 based on the mandatory measures and potentially higher compliance. For more information on gene flow impacts, see section IV.B.5(a).

b. Root Crop

The potential impacts of each of the alternatives on root crop production practices are discussed in turn below.

(1) Alternative 1 – No Action

As mentioned in section IV.B.1.a(1), in the short term APHIS expects the combined seed and root acreage for H7-1 sugar beet will return to pre-2005 levels, which was fewer than 1,000 acres (APHIS proprietary data). This area would comprise fewer than 0.09 percent of total sugar beet acres. The field locations would be controlled by APHIS. Possible small-scale seed planting under permit would not be geographically restricted except as permitted by climate and as approved by APHIS. Unlike commercially grown sugar beet roots, small-scale research plot locations may not be limited by transportation distance to a refinery. Therefore, research plots would not be limited to a 60-100 mile radius from a factory.

The use of the H7-1 sugar beet varieties comprised 95 percent of U.S. sugar beet production in 2010 (USDA-NASS, 2010d). Under Alternative 1, commercial root crop production of H7-1 would be stopped. For the Great Lakes, Midwest, Great Plains, and Northwest root growing regions, production practices that had been implemented after the adoption of H7-1 sugar beet would likely return to similar practices used in 2005 (pre-H7-1 sugar beet adoption).

As described above in section IV.B.1.a(1), it is possible that, under Alternative 1, there might not be an adequate amount of conventional sugar beet seeds to sell to farmers in the Great Lakes, Midwest, Great Plains, and Northwest regions until 2014 at the earliest (Miller, 2010). Whether seed supply would be limited is unclear, as opinions on the topic differ (Miller, 2010; Pates, 2010). This lag would not affect sugar beet root growers in the Imperial Valley since H7-1 sugar beet have not been grown in that region to date.

Conventional seed varieties available to farmers in the short term (~1–10 years) would likely not contain the most desirable trait combinations for each region due to the breeding lag. It is assumed that the lag will not continue in the long term as seed companies will continue to develop new, conventional varieties with the trait combinations desired by farmers.

As discussed more fully in section IV.B.1.c, Alternative 1 would change measures for controlling weeds in root fields in a variety of ways. In the Great Lakes, Midwest, Northwest, and Great Plains, such measures would likely return to practices used before H7-1 sugar beet was widely adopted. This would mean more rotary hoeing, hand-hoeing, and mechanical cultivation in each of these regions along with a decrease in stale seed bed in the Great Lakes and a decrease in strip till for seed bed preparation in the Great Plains. It would mean a return to the use of conventional herbicides and more passes through the field to apply herbicides and perform mechanical cultivation. Alternative 1 would not impact measures for controlling weeds in root fields in the Imperial Valley region, since H7-1 sugar beet have not been adopted in California.

As described in III.B.1.c(2), adoption of H7-1 sugar beet has resulted in an increase in strip and other forms of conservation tillage in some of the sugar beet root producing regions. According to (2011),

> "extensive early season preplant tillage associated with conventional sugar beet production has resulted in wind and water erosion in many sugar beet growing regions. During the 2002 growing season in Idaho and the 2007 growing season in Nebraska and Wyoming, 25 to 35% of the sugar beet acreage was replanted due to wind erosion and lack of soil moisture. Approval of H7-1 sugar beet has allowed sugar beet growers to change their tillage practices over the past two years. Growers have reduced preplant tillage and moved to cropping systems that incorporate no-tillage, strip-tillage, and planting into small grain cover crops. The movement away from preplant tillage which contributes to soil erosion and loss of soil moisture has allowed sugar beet growers to meet specific conservation requirements in NRCS programs. Growers who participate in NRCS programs are required to develop a conservation plan for their farms that must be approved by NRCS. Growers have designed their plans around the utilization of H7-1 sugar beet and subsequent use of glyphosate for weed control which has allowed for a reduction in tillage. If sugar beet growers are required to revert to conventional sugar beet herbicides, preplant tillage will be needed for herbicide (Nortron or RoNeet) incorporation and growers risk failing to meet the NRCS requirements in their

conservation plan. Without an approved conservation plan, growers risk losing conservation compliance and eligibility for commodity, conservation, and disaster payments (2008 Farm Act)."

Thus Alternative 1 is expected to make it more difficult for growers to participate in NRCS programs.

Rreduced tillage methods can also affect the method of application and amount of fertilizer applied. For example, for band application of fertilizer on sugar beet, which is more commonly used with strip tillage than conventional tillage, the University of Minnesota recommends a one-third rate reduction for potassium and phosphorus (Overstreet, 2011). Additionally, banding fertilizer with strip-tillage may provide enhanced plant availability of phosphorus in phosphorus-fixing soil environments, which are common in the Midwest region (Overstreet et al., 2011). Under Alternative 1, fertilizer application methods and amounts are expected to return to those of 2005. According to (2011b), fungus diseases, such as *Rhizoctonia* and *Aphanomyces* root rot, are expected to be more of a problem under Alternative 1 for three reasons. First, increased tillage is expected to lead to more *Rhizoctonia* root rot (as a result of throwing infected soil into crowns of plants).   Second, the breeding of resistant varieties is diminished under Alternative 1 because the opportunity to use genetic engineering approaches will be diminished if Alternative 1 is selected. Third, timely application of fungicides will be hindered because, unlike with glyphosate, many fungicides cannot be tank mixed with non-glyphosate herbicides. Instead the herbicides must be applied three or more days prior to or after non-glyphosate herbicide application thereby complicating management and increasing costs.

According to (2011) growers will have a much more difficult time controlling weeds under Alternative 1. As he describes below, they will spend more time and get less effective weed control because the nonglyphosate herbicides injure the crop, are less effective, and are more complicated to apply:

> "Growers relied on treating sugar beet early and often with conventional herbicides, these principles also proved to be effective when growers began using glyphosate. Early weed control experiments with glyphosate demonstrated that treating small weeds was more effective than treating 10-inch weeds, and, that applying two applications of glyphosate at two week intervals improved common lambsquarters and pigweed control over that achieved with a single glyphosate application or two applications extended over a four week interval (Wilson Jr et al., 2002). Growers have demonstrated that the concept of treating

small weeds and treating often until sugar beet develop a canopy prevents weeds from shading the crop. In addition, weeds that may have been injured with a single application of glyphosate can usually be killed when a second treatment follows in two weeks. Postemergence applications of glyphosate have not injured the sugar beet plant, which has resulted in faster canopy development while conventional herbicides caused injury that stunted the crop and increased the time from emergence until row closure. Therefore, most sugar beet growers have found they can achieve excellent weed control with two timely applications of glyphosate."

"In contrast, the micro-rate herbicide "cocktail" of conventional herbicides associated with weed control techniques for conventional sugarbeet required grower perseverance and patience, and presents many downsides in weed control compared to glyphosate-resistant sugarbeet. The cocktail used by most growers consists of a combination of Betamix, UpBeet, Stinger and methylated seed oil adjuvant. For the cocktail to work effectively, herbicides had to be applied sequentially with the first application beginning as soon as weeds began to emerge and were one inch or less. Weeds injured, but not killed by the first treatment, needed to be treated in five to seven days or they would recover and become a weed escape. In addition, a second flush of weeds would emerge and require the initial herbicide treatment to be applied again. This process could continue for four to six weeks and require three to four herbicide applications. If there was sufficient wind or rain to delay treatments, weed control suffered."

"Most growers utilized specialized band sprayers to apply a seven to ten inch band of spray over the crop row; sprayers could cover 12 to 24 rows and travel at speeds of four to five mph. In comparison, glyphosate is applied as a broadcast spray with sprayers that cover 40 to 60 feet and can travel at five to 10 mph."

"The effects of the conventional cocktail to sugarbeet was influenced by air, temperature and sunlight. If growers applied the cocktail in the early morning and midday temperatures rose to above 80º to 90º F, severe crop injury could occur. To avoid injury, growers started spraying in the late afternoon when air temperatures began to decline. Therefore, a grower farming several hundred acres of

> sugarbeet would spend most of their afternoons and evenings during May and June spraying sugarbeet. With glyphosate, the time spent spraying sugarbeet declined dramatically. In addition, glyphosate can be applied in the morning when temperatures are cooler, winds generally calm, and weeds are more susceptible to herbicide uptake, without concerns of later day weather. Growers using the conventional weed control had to take special precautions for the variability of weather and spend more time and resources in application of these less environmentally-friendly herbicides. Growers would find it difficult and expensive to return to this outdated technology."

As described in III.B.1.c(2), sugar beet can bolt (produce a flowering stalk) in their first year of production under certain environmental conditions typically at a rate of about 0.01 percent or 4 plants per acre (OECD; Darmency et al., 2009). Under Alternative 1, bolting sugar beet plants would not produce H7-1 pollen.

In summary, Alternative 1 would stop the commercial root crop production of H7-1, changing the production practices, i.e non-glyphosate herbicide use and tillage would increase and glyphosate use on sugar beet would decrease, that had been implemented after the adoption of H7-1 sugar beet in the Great Lakes, Midwest, Great Plains, and Northwest growing regions. In addition, there might be a short-term shortfall in availability of conventional seed to sell to farmers except in Imperial Valley.

(2) Alternative 2 – Full Deregulation

Under Alternative 2, APHIS assumes that in the short term, H7-1 sugar beet would be adopted at approximately 2010 levels (95 percent of the root crop acres would be H7-1 sugar beet). In the long term, APHIS expects that H7-1 sugar beet will eventually be developed for California and other areas of the United States such that adoption would approach 100 percent.

Alternative 2 would impact weed control measures in root crops, as discussed in section IV.B.1.c. In the short term, weed control would be similar to what was observed in 2010, which is different than what occurred in 2005 (pre-H7-1 sugar beet). In the long term, as glyphosate-resistant weeds migrate into sugar beet fields or develop resistance, weed species with glyphosate-resistant biotypes would be expected to become the weeds of concern in sugar beet. This would likely increase the use of conventional herbicides, mechanical cultivation, and hand-hoeing to control glyphosate-resistant weeds.

There also would likely be a continued trend to increase strip tillage in root fields in theNorthwest and Great Plains and to reduce cultivations in the other regions. Assuming H7-1 sugar beet are adopted in the Imperial Valley, there would also be shifts from the other herbicides, hand-hoeing, and between row cultivation methods to glyphosate applications to control weeds in that region. With the adoption of H7-1 sugar beet, two to three less cultivations would be needed (2011). The increase in strip tillage in the Great Plainsis expected to increase the use of band application of fertilizer in this region, which as mentioned above, reduces the application rate of potassium and phosphorous to one third the amount used when broadcast (Overstreet, 2011).

Bolting H7-1 sugar beet could be a potential source of gene flow as they could produce H7-1 pollen if the flowering occurred relatively early and the flowers were not killed by cold weather. Farmers typically remove bolters as bolting depletes the root of sugars and the woody roots that result from bolters can damage harvesting and processing equipment (Ellstrand, 2003). Additionally under the Monsanto TUG, farmers are required to remove bolters in H7-1 sugar beet fields (Monsanto, 2011a). APHIS expects that farmers would continue the practice of removing bolters for the reasons described above.

In summary, under Alternative 2, there would likely be a continued increase in conservation tillage in root fields in the Northwest, and Great Plains with a concomitant increase in band applications of fertilizer which reduces the rate of potassium and phosphorous applied. Furthermore, a reduction in cultivation in other regions can also be expected including the Imperial Valley. Along with a decrease in tillage and cultivation glyphosate use is expected to increase and non-glyphosate herbicide use to decrease. If glyphosate-resistant weeds become more prevalent, weed control measures in root fields would likely require more use of conventional herbicides, mechanical cultivation, and hand-hoeing.

(3) Alternative 3 – Partial Deregulation

Under Alternative 3, APHIS expects that the percentage of H7-1 sugar beet grown would be close to 2010 levels (95 percent) or slightly lower if some farmers or cooperatives find the mandatory conditions for production of H7-1 sugar beet to be burdensome. An adequate amount of H7-1 and conventional sugar beet seed is expected to be available to farmers under Alternative 3.

In terms of production locations, Alternative 3 would limit the ability of farmers to grow H7-1 sugar beet roots in western Washington State and the entire State of California. Alternative 3 is not likely to affect root production in Washington given that the production has not historically occurred in the counties in which H7-1 sugar beet are not allowed under Alternative 3 (Stankiewicz Gabel, 2010). In the Imperial Valley, H7-1 sugar beet have not been adopted so Alternative 3 would not cause any changes in root production among sugar beet farmers in the Imperial Valley. Alternative 3 would eliminate the choice of California growers to produce H7-1 varieties for California should they become available. In the absence of such a prohibition, it is likely that H7-1 would be widely adopted in the Imperial Valley as glyphosate would offer a simple and effective method to control weeds including wild beet populations, which are very difficult to control by existing methods.

Under Alternative 3, production methods would not change in terms of the adoption of glyphosate as an herbicide, the increased use of strip tillage, and a reduction in hand labor due to the use of H7-1 sugar beet root crop. Nevertheless, due to the requirement for compliance agreements and other mandatory requirements, the additional regulatory requirements under Alternative 3 may discourage some growers from planting H7-1. However, over time with Alternative 3, other growers should make up the difference so the number of acres should remain the same.

Alternative 3 would impact weed control in root crops in the same manner as described in Alternative 2, except for the Imperial Valley region.

As root production practices are expected to be similar in the Great Lakes, the Midwest, the Great Plains, and the Northwest, Alternative 3 is expected to have the same changes in fertilizer application and amounts as described in Alternative 2.

Alternative 3 requires farmers to monitor for bolting crops every 3–4 weeks starting on April 1st in addition to maintaining records as to the presence of bolters for audit purposes. All bolters must be destroyed before flowering.

Under Alternative 3, sharing the equipment used for planting, cultivating, and harvesting H7-1 sugar beet would not be allowed for the production of Swiss chard and table beet in the same growing year. However, to APHIS' knowledge, this equipment is currently not shared as per BMP. In addition, harvesting and transport of H7-1 sugar beet roots could occur only in a manner that minimizes loss of beet. This practice is not different from current practices for moving sugar beet to the processing facilities as the goal of growers is to maximize yield and minimize loss. Detailed records of transport are also necessary for audit purposes.

In summary, Alternative 3 could result in a near-term decrease in the number of H7-1 sugar beet acres planted if the mandatory conditions for production of H7-1 sugar beet discourage some growers from planting sugar beet (this decrease is not expected to continue over the long term). It would alter weed control measures just like Alternative 2, except in the Imperial Valley, where H7-1 sugar beet would not be planted under

Alternative 3. Additionally, Alternative 3 would require monitoring for bolters every 3–4 weeks,would impose mandatory restrictions on the equipment and practices used for handling H7-1 sugar beet, and would require third-party inspections and audits.

c. Weeds in Sugar Beet Seed and Root Crops

This section discusses the potential impacts of the action alternatives on weed management practices within sugar beet agriculture. Weed resistance to herbicides is discussed in section IV.C.3.a.

The production practices that influence weed control and the weed population include: herbicide use, seed bed preparation (such as tillage), crop rotation, hand weeding, in-crop mechanical cultivation, cover crops, irrigation, and fertilization. Neighboring fields and environments and the seed bank from previous growing seasons also influence weed prevalence. Herbicide usage is discussed in section IV.B.1.e. Control of sugar beet volunteers in agricultural settings is discussed in section IV.B.1.d. Although irrigation and fertilization influence weed dynamics, neither of these practices are specifically in place as weed control strategies for sugar beet, except for in the Imperial Valley where pre-irrigation and flat flood irrigation are used as a weed control prior to planting sugar beet (Meister, 2004b). The impact that the alternatives may have on these production practices is discussed in section IV.B.1.a (seeds) and IV.B.1.b (roots). The impact of crop rotation on the development of herbicide resistance in weeds is discussed in section IV.C.3.a.

The discussion below focuses on how rotations, seed bed preparation (such as tillage), hand weeding, in-crop cultivation, and cover crops as weed control approaches could be impacted by the alternatives. This discussion provides background information that informs several other impact assessments later in chapter IV.

(1) Alternative 1 – No Action

In general, glyphosate is not used in commercial seed production because at least one of the parents does not carry the resistance gene. For seed production, H7-1 sugar beet breeder and foundation seeds may have glyphosate applications for postemergence weed control as long as both parents carry the H7-1 trait (Loberg, 2010b). In this respect, Alternative 1, which would restrict the use of H7-1 to breed sugar beet, would change use of glyphosate during seed production under conditions mentioned above. For more information on hybrid seed production, see section III.B.1.b(9). Weed control measures such as seed bed preparation, crop rotation, hand weeding, and in-crop cultivation would be similar under all three alternatives because glyphosate is not used in these aspects of seed production. Cover crops are also not used in seed production.

For root production, since the adoption of H7-1 sugar beet, glyphosate has become the predominant herbicide used to control weeds and all the herbicides that were previously applied have diminished in use. In addition, while conventional tillage was extensively used for sugar beet root production prior to H7-1, reduced tillage and strip tillage have now become more prevalent and cultivations overall are less prevalent. As explained in more detail below, Alternative 1 would alter weed control practices by altering herbicide use and tillage practices.

Under Alternative 1, commercial root crop production of H7-1 would be stopped. For the Great Lakes, Midwest, Great Plains, and Northwest root growing regions, weed control measures would likely return to similar practices used in 2005 (pre-H7-1 sugar beet adoption). In these regions, APHIS does not believe that farmers have changed rotation patterns to control weeds as a result of the adoption of H7-1. Therefore, Alternative 1 would not impact rotation selection from a weed control perspective at least in the short term. Possible long-term impacts of rotations with other Roundup Ready® crops on the development of herbicide-resistant weeds are discussed in section IV.C.3.a.

In the Imperial Valley, H7-1 sugar beet have not been adopted so Alternative 1 would not cause any changes in weed control for sugar beet farmers in the Imperial Valley. It would, however, stop the future adoption of H7-1 sugar beet and prevent growers from using glyphosate to control wild beet in sugar beet production fields.

In the Great Lakes region, the adoption of H7-1 sugar beet has resulted in less in-crop mechanical cultivation, less hand-hoeing, and increased stale seed bed tillage. Stale seed bed is where fields are tilled in the fall to encourage weed seed germination and then weeds are subsequently eliminated before planting in the spring by either cultivation or herbicide treatment. With the adoption of H7-1 sugar beet, growers have been favoring the use of herbicide in lieu of a spring cultivation. In 2010, about 25 percent of fields in the Great Lakes were stale seed bed tilled as compared to less than 5 percent in 2006–2007 (Lilleboe, 2011). Alternative 1 would likely result in an increase in cultivation withstale seed bed and/or an increase in hand-hoeing and in-crop mechanical cultivation compared to current practice.

In the Midwest, the adoption of H7-1 sugar beet resulted in notable changes in postemergence weed control, but very little change in weed control measures used during seed bed preparation. For example, for both H7-1 and conventional sugar beet, the vast majority of farmers continue to use conventional tillage, which results in a 100-percent disturbance of the soil (USDA-NRCS, 2008). Only a few thousand acres of sugar beet are currently strip tilled (tilled in rows where the seeds are planted). Research conducted in the area indicates that the low rate of adoption of strip-tillage is largely due to the lack of equipment that is adapted for the local soils and cropping systems (Overstreet et al., 2011). It is likely that the practice will be adopted more widely as more appropriate equipment is developed and sold. The greatest area of change with H7-1 sugar beet has been seen with postemergence weed control. As stated in section III.B.1, adoption of H7-1 sugar beet has resulted in a dramatic decrease in the use of rotary hoeing, hand-hoeing, and mechanical cultivation.

Alternative 1 would likely result in no changes to seed bed preparation in the Midwest. Postemergence weed control, however, would likely return to pre 2005 levels of rotary hoeing, hand-hoeing, and mechanical cultivation. Growers that sold their cultivation equipment would have to reacquire such equipment (Stachler, 2011). Herbicide use is the major weed control approach in both conventional and H7-1 sugar beet production and is discussed in section IV.B.1.e.

In the Northwest and Great Plains, adoption of H7-1 sugar beet has had the largest impact on weeds as this region has the most difficulty to control weed populations in sugar beet fields that were not effectively controlled with other herbicides (Hofer, 2010). Adoption of H7-1 sugar beet resulted in increased strip till during seed bed preparation, a reduction in in-crop mechanical cultivation, and a reduction in hand-hoeing (Lilleboe, 2008; Kniss, 2010a). Alternative 1 would likely result in a return to in-crop mechanical cultivation, hand-hoeing, and a reverse in the trend of increasing strip till for seed bed preparation.

Use of cover crops provides many benefits to soil quality as discussed in section III.B.1.d(2). APHIS was not able to find data on whether cover cropping practices have changed with the adoption of H7-1 sugar beet. Popular cover crops are grasses, which are easily controlled by herbicides specific for grasses. Adequate herbicides for killing grass cover crops exist for conventional sugar beet. However, grass cover crops in H7-1 sugar beet could be killed with glyphosate, which would also control broadleaf weeds that occur in the cover crop. There is anecdotal evidence that past problems with wind and water erosion can be minimized by planting H7-1 sugarbeet into the previous year’s crop residue or cover crops of wheat and barley for crop and soil protection (Wilson, 2010). In Michigan, oil seed radish is being evaluated as a cover crop to help break up compacted soil (Cavigelli et al., 2010). Oilseed radish has also been noted for its ability to suppress nematodes when used as a cover crop for sugar beet and anecdotedly lead to increased yield (Lilleboe, 2006). Cover cropping techniques could be used with any of the three alternatives if growers become convinced there is a cost benefit (Lilleboe, 2006).

Crops that are grown in rotation with sugar beet occasionally appear in sugar beet fields as volunteers. In conventional sugar beet fields, these volunteers are managed with all the other weeds through herbicide mixtures, mechanical cultivation, and hand-hoeing. If rotated to glyphosate-resistant crops, these same techniques would be used to control glyphosate-resistant crop volunteers. Under Alternative 1, all volunteers in sugar beet, including Roundup Ready® corn and Roundup Ready® soybean would be controlled through herbicides, mechanical cultivation, or hand-hoeing.

In summary, Alternative 1 would not impact measures for controlling weeds in root fields in the Imperial Valley. However, weed control measures in root fields in other regions would likely return to similar practices used before H7-1 sugar beet was widely adopted. In general, this would mean more rotary hoeing, hand-hoeing, and mechanical cultivation in all of the other regions and a decrease in strip till for seed bed preparation in the Great Plains and Northwest. It is unclear if Alternative 1 would change current root production cover cropping practices. Rotation crop volunteers would be controlled through herbicides (glyphosate or non-glyphosate, depending on whether the volunteers are glyphosate-resistant), mechanical cultivation, or hand-hoeing.

(2) Alternative 2 – Full Deregulation

Alternative 2 would not impact weed control in seed production because as described, glyphosate is seldom used for weed control on seed crops. .

Alternative 2 would impact weed control in root crops. In the short term, weed control would be similar to what was observed in 2010, which is different than what occurred in 2005 (pre-H7-1 sugar beet). As shown in Table 3–9, several formerly problematic weeds (foxtail, barnyardgrass, wild oat, wild buckwheat, wild mustard, cocklebur, knotweed, nightshades, and mallow) are now controlled within H7-1 sugar beet fields by the application of glyphosate. The three top weed concerns in the Midwest (pigweed, lambsquarters, and kochia) have always been weeds of concern, but are reported as problems by fewer farmers since 2008 when H7-1 sugar beet was widely adopted (Stachler et al., 2011). Under Alternative 2, APHIS expects that the weed control practices reported in 2010 would continue in the short term. In the long term, if glyphosate-resistant weeds migrate into sugar beet fields or new biotypes are selected, weed species with glyphosate-resistant biotypes would be expected to become the weeds of concern in sugar beet crops. For discussion of the likelihood and impact of herbicide-resistant weeds, see section IV.C.3.a. For discussion of measures to mitigate evolution of herbicide-resistant weeds and methods for controlling herbicide-resistant weeds, see section III.C.3.a(3).

In the Great Lakes root production region, the adoption of H7-1 sugar beet resulted in reduced cultivation. Under Alternative 2, APHIS expects that this trend of reduced cultivation would continue. Hand hoeing and other weed control practices would likely continue at 2010 rates, which are reduced compared to the practices before the introduction of H7-1 sugar beet. In the long term, there may be an increase in tillage, hand-hoeing, or use of additional herbicides to control glyphosate-resistant weeds.

As discussed above under Alternative 1, in the Midwest, conservation tillage has not changed much with the adoption of H7-1 sugar beet although there has been a slight increase in reduced tillage (Lilleboe, 2010). Nevertheless, multi-year studies have been done to investigate the effects of strip till and reduced tillage practices with H7-1 sugar beet on sugar beet yield and sugar content (Overstreet et al., 2011). The data generally indicate that strip tillage, if managed carefully, and conservation tillage have similar yields and sugar content as compared to conventional tillage. As research demonstrates the benefits, in the long term, more farmers can be expected to adopt strip tillage as they become more familiar with and invest in new equipment needed for the practice. In the Midwest, there has been a clear decline in rotary hoe, hand-hoeing, or mechanical cultivation since the adoption of H7-1 sugar beet. As mentioned under Alternative 1, in the Northwest and Great Plains, adoption of H7-1 sugar beet resulted in increased strip till during seed bed preparation, a reduction in in-crop mechanical cultivation, and a reduction in hand-hoeing (Lilleboe, 2008; Kniss, 2010a). Because H7-1 sugar beet would continue to be grown under Alternative 2, APHIS expects that in the short term, Alternative 2 would likely result in no hand-hoeing and reduced mechanical cultivation similar to 2010 levels. In the long term, if glyphosate-resistant weeds become a problem, then APHIS expects that additional mechanical cultivation and herbicides will be used.

In the Imperial Valley, H7-1 sugar beet have not been adopted. Under Alternative 2, APHIS expects that H7-1 sugar beet varieties would be adopted by sugar beet farmers. APHIS expects that Imperial Valley sugar beet farmers would experience the same gains in ease of weed control as farmers in other regions of the United States and would modify their current weed control practices accordingly. California has wild beet that are weeds in sugar beet fields and are tolerant to the herbicides traditionally used on weeds that occur in sugar beet. Herbicide tolerance in wild beet is not due to evolved herbicide resistance or weed shifts (discussed in section IV.C.3.a); they are tolerant because of their close evolutionary relationship to sugar beet – what does not kill sugar beet does not kill wild beet. Adoption of H7-1 sugar beet would allow Imperial Valley sugar beet farmers to control wild beet with glyphosate. Currently, wild beet is controlled with hand-hoeing and mechanical cultivation. Control of wild beet through chemical methods would decrease time and labor costs for farmers. The likelihood that the wild beet will acquire glyphosate resistance is discussed in section IV.B.5.b. In California aerial broadcast of herbicides is more common than in other regions because of the benefit of adding herbicides shortly after irrigation to optimize the impact on weeds. Aerial broadcast is used because when the ground is wet it is not possible to use heavy farm equipment which could damage the crop and the soil. Growers expect that the adoption of H7-1 sugar beet would reduce aerial application of herbicides in favor of ground broadcast because the timing of glyphosate application is less critical and farmers could wait for the ground to dry before herbicide application (Beet Sugar Development Foundation et al., 2011). Tillage, row width, and irrigation are not expected to change with the adoption of H7-1 sugar beet (Beet Sugar Development Foundation et al., 2011).

Under Alternative 2, farmers who adopt H7-1 sugar beet can easily kill cover crops with glyphosate, so the usage of cover crops and planting into crop residue could become more common (Wilson, 2010). However, cover crops are not used in California and would not be used with the adoption of H7-1 sugar beet (Beet Sugar Development Foundation et al., 2011).

In H7-1 sugar beet fields, Roundup Ready® volunteers need to be managed with conventional herbicides, mechanical cultivation, or hand-hoeing. Under Alternative 2, Roundup Ready® volunteers in sugar beet, including Roundup Ready® corn and Roundup Ready® soybean, would be controlled through conventional herbicides (such as clethodim and clopyralid, respectively), mechanical cultivation, or hand-hoeing. Volunteers that are not glyphosate-resistant would be controlled by glyphosate. The Midwest region is most likely to have a Roundup Ready® crop in rotation with sugar beet as common rotation crops in this region are corn and soybean ((SMBSC (Southern Minnesota Beet Sugar Cooperative), 2010b), Table 3-6). APHIS is not aware of any growers changing rotation patterns with respect to Roundup Ready® crops as a result of H7-1 sugar beet adoption. It is possible that farmers may decide to rotate to a different herbicide-resistant variety instead of glyphosate.

In summary, Alternative 2 would not impact weed control measures in seed production but would impact weed control in root production. In all regions there would be an increased use of glyphosate and reduced use of non-glyphosate herbicides compared to what is used on conventional sugar beet crops. In the Midwest there might be an increased use of strip tillage as is occurring in the Northwest and Great Plains. Assuming H7-1 sugar beet are adopted in the Imperial Valley, there would also be decreased use of other herbicides and increased use of glyphosate, while hand-hoeing and mechanical cultivation would decrease. Also under Alternative 2, the use of cover crops and planting into crop residue is expected to become more common (except in California) and the expected increase in Roundup Ready® volunteers would likely increase the use of conventional herbicides, mechanical cultivation, and hand-hoeing to control such volunteers.

(3) Alternative 3 – Partial Deregulation

Like Alternative 2, Alternative 3 would not impact weed control in seed beds. Alternative 3 would impact weed control in root crops in the same manner and for the same reasons as described in Alternative 2, except for the Imperial Valley region. It would differ from Alternative 2 in that H7-1 would not be adopted in the Imperial Valley and the future expected increased use of glyphosate would not happen.

In summary, Alternative 3 would impact weed control measures in the same way as described for Alternative 2, except in the Imperial Valley. Under Alternative 3, H7-1 sugar beet would not be permitted in California or western Washington, so weed control measures in those locations would remain as they are today.

d. Control for Volunteer H7-1 Sugar Beet Varieties

As discussed in section III.B.1.e, volunteers are plants from a previous crop that are found in subsequent crops. Volunteers are often considered a type of weed, not because they have any inherent weedy characteristics, but simply because the volunteer plants are growing where they are not wanted and might interfere, or compete with, the crop. In most cases, volunteers grow from seed left in the field after harvest of a seed crop (e.g., corn, soybean). This section discusses H7-1 sugar beet as volunteers. Volunteers that occur in H7-1 sugar beet crops are discussed in section IV.B.1.c above. Sugar beet that escape agricultural fields are not considered volunteers, but rather feral or wild (see section IV.C.3.c).

(1) Alternative 1 – No Action

Because sugar beet seed plants are prone to shattering during seed harvest, control of volunteers in seed production fields has been an essential component of production practices developed to maximize seed purity. WCBS has detailed requirements in its protocol for post-harvest field management, such as equipment cleaning, field inspections, measures to sprout and remove shattered seed, and crop rotation (see section III.B.1.e). In 2006, WCBS Company implemented the Protocol for Genetically Modified (GM) Seed Production (Loberg, 2010a). Fields that have been used to produce H7-1 seed crops can be expected to have a seed bank of H7-1 sugar beet seeds that will require several years to deplete. Therefore,under Alternative 1, methods that do not utilize glyphosate would need to be continued until the seed bank is depleted (estimated to be about three to five years based on industry volunteer monitoring protocols (Loberg, 2010a). In the long term, seed companies could revert to practices used prior to the adoption of H7-1 sugar beet.

Other *Beta* crops such as Swiss chard and table beet are not grown in the same fields as sugar beet seed, so sugar beet volunteers from a previous crop would not occur in Swiss chard or table beet fields. For a discussion of the likelihood of sugar beet volunteers in remote Swiss chard and table beet fields through geographic distribution of seed, see section IV.B.5.a. For a discussion of the likelihood of the H7-1 trait showing up in Swiss chard and table beet fields through gene flow resulting in off-types, see section IV.B.5.a.

Volunteers are much less of an issue in sugar beet root production fields than in seed production fields since the root crop is harvested before seed is produced. As discussed in section III.B.1.c, there are cases where a root crop “bolts” in the first year and produces a flowering stalk. With the exception of California, it is not expected that bolters from the root crop would grow long enough to produce seed because the growing season is too short. Furthermore, bolting sugar beet are tall and can easily be spotted and rogued from the field. Sugar beet root farmers are incentivized to remove bolters as roots that bolt become woody, have decreased sugar content, and can interfere with the harvest equipment. Imperial Valley is the only production area where sugar beet may go to seed if the sugar beet bolters are not removed. These seeds could disperse in the crop field and be a source of volunteers.

Vegetative root structures called groundkeepers may also be left in the field after harvest, and can grow in the next season if weather permits. In most parts of the United States where sugar beet is grown, beet roots would not be expected to survive the winter, so groundkeepers would be of little concern (Panella, 2003). In the Imperial Valley of California, ground keepers are unable to survive the summer and are also of little concern (2011).

Sugar beet volunteers do not compete well with crops used in rotation with sugar beet (CFIA, 2002), and are generally not a problem. If volunteer sugar beet were to grow in the following crop, it could be controlled by broadleaf herbicides or by other agricultural practices, such as tillage during seed bed preparation (Monsanto, 2007a).

Under Alternative 1, H7-1 sugar beet volunteers would be very unlikely. They could occur for several years in former sugar beet seed fields, but are not expected in root crops. In the long term, none would be expected under this alternative as H7-1 sugar beet production is phased out. Conventional sugar beet volunteers would be handled as they have always been handled. In Roundup Ready® crops, conventional sugar beet volunteers can easily be controlled with glyphosate.

(2) Alternative 2 – Full Deregulation

As mentioned under Alternative 1, the WCBS Protocol for GM Seed Production was implemented in 2006 (Loberg, 2010a). One of the provisions is: "For a minimum of five years or until no volunteers are observed and within a three mile radius of any Roundup Ready® field, West Coast Beet Seed Company will monitor for any volunteers in any fields used for past sugar beet production. This will protect [Swiss] chard, [table] beet, and sugar beet seed production in the area. The removal of the volunteers will be done under the supervision of West Coast Beet Seed Company representatives and will be recorded. The costs will be shared by West Coast Beet Seed Company and their growers" (Loberg, 2010a). The protocol also includes updating: "The protocol needs to be continually reviewed. During the review and handling of the crop, new areas of concern may become evident. When this occurs, the concern must be addressed and solutions implemented." Under Alternative 2, this company protocol would remain in place and presumably be updated as needed. The seed production protocol from Betaseed is similar to West Coast Beet Seed Company and is discussed in section III.B.1.b(11).

Other *Beta* crops such as Swiss chard and table beet are not grown in the same fields as sugar beet seed crops, so sugar beet volunteers from a previous crop are not expected to occur in Swiss chard or table beet fields.

In sugar beet root crops in the Great Lakes, Midwest, Great Plains, and Northwest, volunteer sugar beet have not been a problem most likely because bolters are rare and seed production from a bolter is not expected due to the short length of the growing season. Groundkeepers are not likely to survive the winters in the north or the summers of Imperial Valley. Even if groundkeepers did survive the winter, they would easily be controlled in the subsequent crop prior to producing seed.

In the Imperial Valley, H7-1 sugar beet have not been adopted. Under Alternative 2, APHIS anticipates that H7-1 sugar beet would be grown in the Imperial Valley region. Because the growing season is much longer in the Imperial Valley, it is possible for a sugar beet to bolt and set seed. Sugar beet volunteers are easily controlled in other crops with broadleaf herbicides. Control of sugar beet volunteers is not expected to change upon the adoption of H7-1 sugar beet as none of the rotation crops with California sugar beet is Roundup Ready® with the exception of sugar beet that is grown two years in a row. In that case no further control is likely to be necessary for sugar beet volunteers in a sugar beet field. Otherwise, glyphosate is not used for crop weed control or to manage sugar beet volunteers there. Volunteers from groundkeepers are not a concern in California because the roots cannot survive the heat of the summer. For discussion of sugar beet that escape agricultural fields in mild climates and become feral or wild, see section IV.C.3.c.

(3) Alternative 3 – Partial Deregulation

Several permit conditions proposed under Alternative 3 could influence H7-1 sugar beet volunteer occurrence. For example, a visual identification system, such as labeling must accompany all H7-1 seed and stecklings throughout the production system. H7-1 seed and stecklings need to be contained during transport to avoid inadvertent release into the environment. Measures to force post-harvest sprouting of H7-1 shattered seed in seed production fields are required. Other *Beta* crops such as Swiss chard and table beet are not grown in the same fields as sugar beet seed crops, so sugar beet volunteers from a previous crop would not occur in Swiss chard or table beet fields.

Alternative 3 requires surveying and removal of bolters from root production fields planted to H7-1 varieties, ensuring that H7-1 bolters do not produce seeds that could volunteer in rotation crops. Under Alternative 3, APHIS would enforce these requirements through inspections and third-party audits and compliance agreements can be terminated if compliance issues are a problem.

In the Imperial Valley, H7-1 sugar beet has not been adopted. Under Alternative 3, H7-1 would be prohibited in the Imperial Valley region and Western Washington, so Alternative 3 would not impact volunteer occurrence or control in either region.

e. Herbicide Use Estimate for Sugar Beet

(1) This section presents a discussion of the impacts of each of the alternatives on herbicide usage patterns and overall quantities. Alternative 1 – No Action

Under Alternative 1, commercial root crop production of H7-1 sugar beet would be stopped. The herbicide application rates and total rates per acre used on conventional sugar beet under Alternative 1 is assumed to be comparable to the herbicide used on conventional sugar beet grown in Minnesota and Eastern North Dakota in 2011 (Stachler et al., 2012a). From the average national and regional USDA data available from 2000, which were collected prior to the commercial availability of H7-1 sugar beet, there are some regional differences noted in the types of herbicides used. For example, quantities and types of preplant incorporated herbicides differed between regions as did the use of herbicides for grass control (Tables 3-14 and 3-15). For example, in 2000, the Great Lakes region used the most pyrazon, an herbicide used to control broad leaf weeds. In the Midwest, clethodim was used preferentially to control annual grasses whereas annual grasses were preferentially controlled with sethoxydim in California. The Northwest makes heavy use of three residuals, EPTC, cycloate, and ethofumesate. EPTC use was not reported for any of the other regions. Presumably, this regional effect is ascribed to soil type, where EPTC is avoided in regions with sandy soils due to potential injury to plants that may occur from leaching.

Nevertheless, the Minnesota/Eastern North Dakota data are informative for several reasons. They are applicable to more than 50% of the sugar beet grown in the U.S., the data was collected in the most current growing season, and the data was collected for both H7-1 and conventional sugar beet in the same region in the same year thereby minimizing seasonal/weather related variation. Without a doubt they represent the best data set available to APHIS to compare herbicide use on conventional and H7-1 sugar beet. At the very least, this data set provides a meaningful estimate of herbicide use under the three alternatives in Minnesota and Eastern North Dakota

As described in section III.B.1.e, the survey data were supplemented by information supplied by a university weed science expert and agronomy managers from the three sugar beet cooperatives in the area. These experts provided typical single use or seasonal rate data for the various herbicides as well as the amount of acreage used to grow conventional (72,900 acres) and H7-1 sugar beet (620,840 acres) in 2011. APHIS calculated the actual amount of herbicide used on 72,900 acres for conventional sugar beet and 620,840 acres for H7-1 sugar beet. To compare herbicide use expected under each alternative, the total amount of actual herbicide applied was adjusted to 100% of acres (693,740 acres) (Table 3-17) and these numbers are compared in Table 3-18.

Nine herbicides were used on conventional sugar beet in 2011 in Minnesota and Eastern North Dakota (Tables 3-17 and 3-18). The most heavily used herbicide in terms of pounds applied was ethofumesate followed by clethodim, glyphosate, desmedipham, and phenmedipham. Quite a bit of glyphosate is used on conventional sugar beet as a pre plant burn down. Ethofumesate is used both as a preplant incorporated protectant and for post-emergent microrate applications. Clethodim, Clopyralid, Desmedipham, Ethofumesate, Phenmedipham, and Trisulfuron-methyl are all expected to be applied in combination at micro rates and applied several times as described in section III.B.1.d(3).

In summary, under Alternative 1, at least 9-13 herbicides are expected to be used on conventional sugar beet. Many can be expected to be used up to six times in combination at microrates (USDA, 2011b) p.51. Residual herbicides such as ethofumesate are expected to be the dominant herbicide used.

(2) Alternative 2 – Full Deregulation

Alternative 2 would likely result in herbicide usage patterns similar to what was estimated for H7-1 sugar beet grown in 2011 (Tables 3-17 and 3-18). Alternative 2 would result in much larger quantities of glyphosate applied compared to Alternative 1. Glyphosate was the dominant herbicide representing 98% of the total pounds applied. In 2011, the amount of glyphosate use increased seven fold from conventional to H7-1 sugar beet. This fold increase is smaller than our original estimate in the dEIS which was based on comparing estimates of herbicide usage on conventional beet in 2000 to estimates of herbicide usage on H7-1 sugar beet in 2010. The smaller increase can be attributed to much higher use of glyphosate prior to planting the conventional sugar beet crop in 2011 compared to 2000.

Of the eight other herbicides used on conventional sugar beet four, desmedipham, dimethenamid-p, phenmedipham, and trisulfuron-methyl, were not used on H7-1 sugar beet. Ethofumesate, which was used substantially as a post-emergent herbicide on conventional sugar beet was not used as a post-emergent herbicide on H7-1 sugar beet, though it was used as a pre-emergent herbicide on both. The remaining four herbicides were used as greatly reduced rates ranging from a decrease of 15 fold for quizalofop, to 25 fold for ethofumesate, to 43 fold for clethodim and clopyralid. In terms of total pounds of herbicide applied, there was a 22% decrease in pounds applied to H7-1 sugar beet relative to conventional sugar beet.

There is a potential for total glyphosate applied to increase by 2.7 fold on H7-1 sugar beet above the current rate, under current pesticide labeling. However as explained below, APHIS considers this unlikely. The maximum allowed rate of application (per EPA) is 7.32 lb a.i. per acre per year (Table 3-13). The current rate estimate for Alternative 2 is 2.7 lb a.i. per acre per year which reflects 2 applications/per year at the maximum rate of 1.37 pounds a.i./acre/application (Table 3-13). If a third application on average were to occur, for example to control late emerging weeds, the seasonal rate would jump to 4.11 pounds a.i. per acre per year. Further applications seem unlikely because the lack of control is likely due to glyphosate-resistant weeds which would not be controlled by additional glyphosate applications. Thus while it is possible that glyphosate use would increase, it seems unlikely that it will increase above 4 pounds a.i/acre/year.

If glyphosate-resistant weeds become problematic use of some of the non-glyphosate herbicides are expected to increase. This topic is discussed in more detail in section IV.C.3.

In summary, under Alternative 2, glyphosate is expected to be the dominant herbicide. Glyphosate use is expected to increase at least seven fold on H7-1 sugar beet and non-glyphosate herbicides are expected to decrease 10 to 40 fold or even their use will be discontinued.

(3) Alternative 3 – Partial Deregulation

As with Alternative 2, Alternative 3 would result in higher quantities of glyphosate applied and decreased quantities of all other herbicides applied as depicted in Table 3-18 and described under Alternative 2.

Under Alternative 3, the Imperial Valley would not adopt H7-1 sugar beet because they could not be grown in California, so for Alternative 3 there would some regional differences in herbicide usage from that described for Alternative 1 based on data in Minnesota and Eastern North Dakota.

2. Swiss Chard

Potential impacts of the environmental release of H7-1 sugar beet on both Swiss chard seed and greens production are described separately below.

The discussion that follows does not address all aspects of Swiss chard seed and vegetable (greens) production, but rather focuses on only those aspects that are expected to change as a result of the three action alternatives. In terms of seed production, the majority of the practices used to produce Swiss chard seed have not changed with the adoption of H7-1 sugar beet and therefore are not discussed below. For example, the breeding methods used to produce Swiss chard seed, the planting and lifecycle of seed production, the use of formal or informal isolation distances and/or pinning maps in areas where sexually compatible *Beta* species are grown, land preparation, the use of both the direct-seeding and stecklings methods, fertilization, crop rotation, and disease management have all remained the same. Additionally, APHIS does not anticipate any changes in these production practices as a result of any of the three alternatives. Therefore, these Swiss chard seed production practices are not discussed in detail below. For more information on these seed production practices, see the corresponding sections in III.B.2.a(1) through III.B.2.a(11).

The aspects of Swiss chard seed production that have changed with the adoption of H7-1 sugar beet seeds, or are predicted to be affected by the three alternatives, include: the counties in which Swiss chard seeds are produced, the ratio of the steckling method used compared to the direct-seeded method, the isolation distances used between Swiss chard seed and H7-1 sugar beet seed production, roguing for off-types, testing for low level presence (LLP) in seeds, and cost of testing for LLP.[28] These production practices relate to the concern of organic seed and vegetable producers, of the potential for LLP of the H7-1 trait in Swiss chard seed or food crops. These issues, and the associated changes that are expected to occur with each of the three alternatives, are discussed in detail below.

In terms of vegetable production (leafy greens), most of the practices used to produce Swiss chard are believed to be unchanged with the adoption of H7-1 sugar beet. These practices include vegetable production location, planting, bolting, and harvesting dates, fertilization and pH adjustment, crop rotation and pest management practices including disease and insect management. As sugar beet is not planted in rotation with Swiss chard greens production, sugar beet volunteers do not occur in Swiss chard fields. Additionally, APHIS does not anticipate any changes in these production practices as a result of any of the three alternatives. Therefore, these Swiss chard vegetable production practices are not discussed in detail below. For more information on these vegetable production practices, see the corresponding sections in III.B.2.b(1) through III.B.2.b(5).

The aspects of Swiss chard greens production that have changed with the adoption of H7-1 sugar beet, or are predicted to be affected by the three alternatives, include: enhanced attention to roguing for sugar beet/Swiss chard off-types in Swiss chard greens production, testing for LLP of the H7-1 trait in greens, and the costs associated with testing for LLP in greens. These issues, and the associated changes that are expected to occur with each of the three alternatives, are discussed in detail below.

a. Seed Production

[28] As discussed in section III.B.5.e, LLP testing includes strip tests that detect H7-1 protein, PCR tests that detect H7-1 DNA, and seed lot grow-out that detects the phenotypic expression of the H7-1 trait.

As Swiss chard seed can be produced by both commercial and noncommerical growers, APHIS believes there could be the following four categories of Swiss chard seed producers:

(1) Commercial Swiss chard seed producers who produce and sell seeds under contract and/or use industry mandated isolation distances and/or participate in pinning programs;

(2) Swiss chard seed producers who produce and sell seed but are not under contract and may or may not follow industry mandated isolation distances and/or participate in pinning (APHIS is not aware of any growers in this category);

(3) Swiss chard farmers who sell food crops and also produce seed for themselves, but do not sell seed (including, but not limited to hobby farmers); and

(4) Home gardeners who produce Swiss chard for greens and for seed for their personal use.

APHIS believes that the vast majority of Swiss chard seed sold and produced in the United States is produced by growers in category 1. As there are no available data regarding the acreage and location of producers in categories 2 through 4, the primary focus of the analysis in this chapter is on Swiss chard seed producers in category 1 above. When possible, growers in the other categories are also discussed.

As described in section III.B.2.a, in the United States in 2011, APHIS is aware of commercial Swiss chard seed production occurring on approximately 600[29] acres in Arizona, California, Washington, and Oregon.

(1) Alternative 1 – No Action

Isolation distances would remain under the control of pinning organizations and are expected to revert to isolation distances used prior to the introduction of H7-1 sugar beet under Alternative 1. In the Willamette Valley, isolation distances between Swiss chard and other *Beta* crop species are described in section III.B.2.a(7) but briefly summarized here: 1 mile between open-pollinated fields, or between hybrid-pollinated fields of the same color and group; 2 miles between hybrid and open-pollinated of the same color and group and between stock-seed and hybrid; 3 miles between different colors within a group, between stock seed and open

[29] Note: the information APHIS received on acreage of Swiss chard production in California for Glenn, Colusa, and Butte Counties was aggregate data with combined acreage for Swiss chard and table beet. Therefore,actual acreage of table beet and Swiss chard in each of the individual counties is not known. For the purposes of the EIS, APHIS will assume the highest possible acreage for both of the crops by estimating that the acreage of each is 125 acres.

pollination, or between GMOs and any other *Beta* species (though with the removal of H7-1 sugar beet, this last category would be unneeded); 4 miles between hybrid and open pollination of different groups.

Some vegetable beet seed producers have reported testing for H7-1 LLP, and in one field in 2007 and another in 2008, it was detected (Tichinin, 2011). Under Alternative 1, it is expected that testing will no longer be practiced by vegetable beet seed producers because H7-1 sugar beet seed production will cease.

Beta seed producers must remain vigilant in the removal of off-types in breeder lines so it is unlikely that practices for rouguing have changed since the introduction of H7-1 sugar beet or will change under Alternative 1.

Swiss chard seed growers that save seed for their own purposes, but do not sell it, also are likely to rogue off-types to maintain varietal purity. If they are located in Oregon or eastern Washington, or parts of Idaho, the only areas of the country where sugar beet seed production occurs, and if they do not participate in the pinning process and they end up inadvertently near a sugar beet seed field, then there is a possibility that their Swiss chard plants would cross pollinate with sugar beet. If the grower does not examine his plants for off-types, then it is possible that the grower will consume a sugar beet-Swiss chard hybrid or will continue to breed with one. Under Alternative 1, these growers would not have concerns that the sugar beet-Swiss chard hybrid has the H7-1 trait.

In summary, under Alternative 1 isolation distances are likely to revert to the guidelines that existed before the introduction of H7-1 sugar beet. Swiss chard seed producers would likely cease to test their seed for the H7-1 trait, and unsuspecting seed savers that fail to eliminate hybrid off types from their seed supply would not have the H7-1 trait in their off-types.

(2) Alternative 2 – Full Deregulation

The 600 known acres of commercial Swiss chard seed production in 2011 include 301 acres in Oregon, 150 acres in Washington, up to 125 acres in California, and 20 acres in Arizona.

The primary method that Swiss chard and other *Beta* crop seed producers utilize to ensure varietal purity, regardless of production area, are through isolation distances. Of the three main areas where multiple *Beta* species are grown, Oregon (Willamette Valley and Jackson County), western Washington, and California, Swiss chard seed production and H7-1 sugar beet seed production both occur only in the Willamette Valley and Jackson County, Oregon.

As described in III.B.1.b(2), all growers of commercial specialty seed in the Willamette Valley, including all commercial companies producing Swiss chard, table beet and sugar beet seeds, are members of the WVSSA that has strict (although not mandatory) isolation distances and pinning guidelines for growers to follow. The minimum isolation distance between Swiss chard and H7-1 sugar beet is 3 miles if both are hybrids and 4 miles if one of the crops is open pollinated (WVSSA, 2008). Note that the sugar beet seed producer Betaseed uses a minimum of a 4-mile isolation distance between H7-1 sugar beet seed production and other *Beta* species. For more information see section III.B.1.b(11).

In 2011, H7-1 sugar beet seed is being produced in all of the same counties in Oregon in which Swiss chard seed is being produced with the exception of Yamhill County (Dorsing, 2011; USDA-APHIS, 2011d; Wahlert, 2011). These seven counties account for 38.9 percent of the total known U.S. commercial Swiss chard seed production in 2011. For a map of the counties in which H7-1 sugar beet seed and Swiss chard seed production both occur see Fig. 4–1 below.

As described in section III.B.1.b(6), all commercial sugar beet seed is produced using two different parents; a 'male sterile' seed parent and a male fertile, pollen parent. Gene flow from H7-1 sugar beet seed production to Swiss chard seed production can essentially occur only if the H7-1 trait is on the male, pollen producing plant. As described in sections III.B.1.b(6) through III.B.1.b(9), in the State of Oregon for 2011, 15 percent of the H7-1 sugar beet seed production acres was conducted with H7-1 pollinators. For more information on gene flow see section III.B.5.

As described in section III.B.5.b., there are two major factors that determine the likelihood of cross pollination. One is the relative size of the pollen clouds produced by the two fields, the other is the isolation distance.

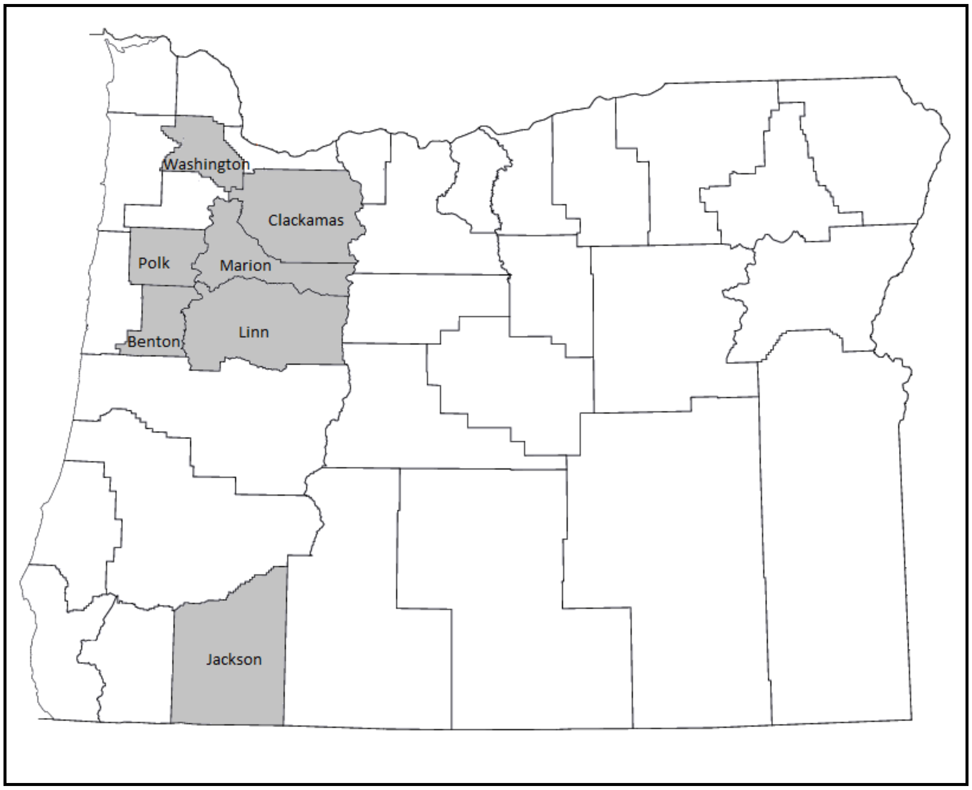

Figure 4-1. Map of the counties in Oregon in which known commercial Swiss chard seed production and H7-1 sugar beet seed production are occurring in 2011

(Sources:) (McReynolds, 2011; USDA-APHIS, 2011d; Wahlert, 2011)

Acreage is a good indicator of the relative sizes of the two pollen clouds. Table 4–1 shows the ratio of the acreage of male fertile H7-1 sugar beet fields compared to Swiss chard fields. Only in Polk and Washington Counties does the acreage of H7-1 male fertile sugar beet plants exceed that of Swiss chard. As mentioned in section III.B.2.a., hybrid fields typically produce 25 percent as much pollen as open pollinated fields because pollinators are planted every fourth row. Dividing the acreage ratios in Table 4–1 by 4 provides a more realistic estimate of the relative pollen contribution of Swiss chard and sugar beet to the respective pollen clouds. Considering this difference in pollen production, only Polk County would be expected to produce more pollen with the H7-1 trait than Swiss chard pollen, and not by much. The fact that pollen with the H7-1 trait is typically in shorter supply than Swiss chard pollen suggests that Swiss chard pollen can be an effective competitor against cross pollination by pollen with the H7-1 trait.

Another important consideration is the isolation distance between male fertile H7-1 sugar beet fields and Swiss chard fields. As stated previously, gene flow risk decreases quickly as the distance from the source increases (Darmency et al., 2009). All H7-1 sugar beet seed fields must be at least 4 miles away from any commercial Swiss chard seed field. APHIS obtained sector locations of all vegetable beet seed fields planted in 2011 in the north and south ends of the Willamette Valley from the WVSSA pinning maps

Table IV-1. Ratio of Acres of Male Fertile H7-1 Sugar Beet Seed and Known Commercial Vegetable Beet Seed Produced by County

Location	Crop	Ratio Male Fertile H7-1 Acres/Veg Beet acres
Benton	Swiss Chard	<0.2
Clackamas	Swiss Chard	<0.2
Jackson	Swiss Chard	<0.2
Marion	Swiss Chard	<0.2
Linn	Swiss Chard	1
Polk	Table Beet	<2
Washington	Swiss Chard	<3
Polk	Swiss Chard	<6

and used earthpoint to convert the sector locations into GPS data. Under the terms of the partial deregulation, APHIS obtained GPS information for each sugar beet seed field planted including those where the H7-1 trait was on the pollen producing parent. APHIS used Google Earth® to calculate a minimum and maximum distance from each sugar beet seed field ,that produces pollen containing the H7-1 trait, from the nearest vegetable seed field. Only one field was 4-5 miles away; the remaining fields exceeded this distance. On average, fields were somewhere between 8.7-9.6 miles apart (Table 4-2). The median distance between fields was 7 to 7.7 miles. Considering the actual isolation distances between sugar beet fields producing H7-1 pollen and vegetable beet seed fields and the relative size of the pollen clouds, APHIS expects that gene flow from H7-1 sugar beet into Swiss chard will be below detectable levels (<1 in 10,000 seeds) throughout Oregon.

Table IV-2. Distances Between Seed Fields for Vegetable Beet and H7-1 Male Fertile Sugar Beet

Vegetable Beet Field Number	Minimum Distance (miles)	Maximum Distance (miles)
1	3.8	5.1
2	4.9	5.6
3	5.3	5.9
4	5.8	7.1
5	6.0	7.1
6	6.3	7.7
7	6.7	7.4
8	6.7	7.8
9	7.0	7.5
10	7.0	7.7
11	8.7	10.0
12	9.1	9.7
13	9.1	9.8
14	13.0	13.5
15	13.1	13.8
16	18.1	19.4
17	18.1	18.8
Mean	8.7	9.6
Median	7.0	7.7

Vegetable beet field locations were determined from WVSSA pinning map data and converted to GPS using earthpoint (http://www.earthpoint.us/townships.aspx)

Sugar beet field locations from APHIS proprietary data

Distances calculated using Google Earth

Industry best practices that have been established would still be in place under Alternative 2 ("Industry Provisions to Prevent Inadvertent Mechanical Mixing in Seed Production"). Although adequate isolation distances and pinning maps are used by commercial Swiss chard and other *Beta* seed producers, post-harvest seed cleaning and processing presents another opportunity for H7-1 sugar beet seeds to become mixed with Swiss chard seed. Such mixtures of seed can cause LLP of GE seed in an otherwise non-GE seed lot. LLP of the H7-1 trait is a serious concern for GE-sensitive Swiss chard seed purchasers. Such admixtures are unlikely as there are no commercial seed producers that grow H7-1 sugar beet seed and Swiss chard seed (Loberg, 2010a), and H7-1 sugar beet processing facilities do not process other *Beta* seed resulting in no opportunities for mechanical mixing of sugar beet seed with other *Beta* seed (Loberg, 2010a). Additionally, as discussed in section III.B.1.b(18), sugar beet seed producers do not share equipment with Swiss chard seed producers. This practice greatly reduces the potential for seed admixture and LLP.

Taken together, APHIS believes that there is a very low potential for unintended gene flow from H7-1 sugar beet seed production into Swiss chard seed production. APHIS recognizes that the distribution of both Swiss chard and sugar beet seed fields are not static and will vary from year to year. APHIS assumes that isolation distances recommended by the WVSSA will continue to be followed by its members.

GE-sensitive markets may require assurances from seed producers that gene flow or post-harvest seed mixing has not occurred, usually through LLP testing for the H7-1 trait. These tests may be requested as GE-sensitive markets may perceive current isolation distances to be inadequate even though LLP of the H7-1 trait has yet to be detected (Navazio et al., 2010). The result is that even though Swiss chard without detectible levels of the H7-1 trait can be produced in Willamette Valley, GE-sensitive markets may continue to insist on LLP testing for the H7-1 trait and GE-free certification. These tests can increase production costs. For more information on LLP testing see sections III.B.2.a(11) and III.B.5.e.

Under Alternative 2, Swiss chard seed producers could alter or enhance their practices for roguing off-types due to concern that any off-types may be the result of a cross with H7-1 sugar beet. However, as there is no indication that practices for roguing off-types have changed between 2005 and 2010 (the period of H7-1 sugar beet deregulation), this is unlikely.

As described in sections III.B.2.a(4) through III.B.2.a(6), Swiss chard seed can be produced using either the steckling method or the direct-seeded method. While the steckling method is more labor intensive, it allows Swiss chard seed producers to consider root appearance when roguing for off-types. Under Alternative 2, producers who produce Swiss chard seed near H7-1 sugar beet seed production and are concerned about LLP may choose to use the steckling method over the direct-seeded method. The percentage of producers who might switch to the steckling method and the associated costs of switching methods are unknown.

If LLP of the H7-1 trait were found in Swiss chard breeder stock, it can be removed as described in III.B.5(e). If seed companies that produce Swiss chard seed for GE-sensitive clients discover LLP of the H7-1 trait in their seed, such companies could be required to recall products, to replace products, to handle losses from customers, or suffer losses to their business reputation (Stearns, 2010).

Because there are vegetable beet seed producing areas such as western Washington, California, and Arizona where no H7-1 sugar beet seed is produced, it is possible that seed producers in Oregon will be disadvantaged relative to their out of State competitors in the GE-sensitive marketplace concerned about potential LLP. Consequently, it is possible that under Alternative 2, negative market perceptions may induce Swiss chard seed producers to contract their vegetable beet seed operations with growers outside of the Willamette Valley.

As described previously, under Alternative 2, H7-1 sugar beet seed production could occur anywhere in the United States. However, as described in IV.B.1.a(2) it is very unlikely that H7-1 sugar beet seed producers would move to locations where other *Beta* seed crops are currently being produced.

Under Alternative 2, Swiss chard seed growers that save seed, but do not sell it, might worry that LLP of the H7-1 trait is in their seed stock. This is only a concern for Swiss chard seed growers who are producing seed near areas where male fertile H7-1 sugar beet plants are grown (Oregon, Washington, and Idaho). Options for these seed savers would be either to participate in pinning to maintain isolation distances or to avoid seed saving and purchase seeds from a trusted source that produced seed in regions that H7-1 sugar beet are not grown or purchase seed tested for the presence of the H7-1 trait. It is also possible that they could inspect their vegetables and rogue out hybrid off-types that resulted from a sugar beet Swiss chard cross. Such plants would have a mix of morphological traits that are intermediate to both Swiss chard and sugar beet.

In summary, Alternative 2 would be expected to result in a continuation of the current rate of potential gene flow of the H7-1 trait into Swiss chard seed, which, to date, has not been detected. The only counties which have the aforementioned potential impact of gene flow are those in which both crops are grown, which currently occurs only in Willamette Valley. Given that 3 to 4 mile isolation distances are used (depending on whether the Swiss chard crops are hybrid or open pollinated), only 15 percent of H7-1 sugar beet seed production acreage produces pollen with the H7-1 trait, pollen clouds from these sources are generally smaller that Swiss chard pollen clouds, and commercial seed producers currently follow production practices to reduce accidental admixtures of seed, APHIS believes that there is a very low potential for unintended gene flow from H7-1 sugar beet seed production into Swiss chard seed production.

Swiss chard seed producers that are perceived to have fields that are "too close" to H7-1 sugar beet seed producers may be required to test for LLP of the H7-1 trait to satisfy the concerns of GE-sensitive customers. This perception may occur regardless of whether or not gene flow from H7-1 sugar beet into Swiss chard seed has actually occurred, or is likely to occur (see above and section III.B.5). Although detectable gene flow is very unlikely, if a Swiss chard seed producer sells seeds to clients in a zero-tolerance market and LLP of the H7-1 trait was detected, then the producer may lose his customer, damage his reputation, and have to sell that seed lot at a loss to a more tolerant market.

(3) Alternative 3 – Partial Deregulation

Under Alternative 3, APHIS would adopt the partial deregulation of the H7-1 root crop indefinitely, as long as certain specific mandatory conditions are complied with. Similar to a permit, the compliance agreements would impose certain mandatory conditions and be used to authorize the movement and release into the environment of H7-1 sugar beet seed for root crop production. H7-1 sugar beet seed production activities such as breeding and production of commercial seed for the planting of the root crop would be allowed only under permit.

Under Alternative 3, planting of H7-1 sugar beet for root or seed production would not be allowed in California and western Washington: Outside of California and western Washington, APHIS would issue permits with specific conditions for nonflowering steckling production, and seed production from flowering stecklings or directly from seed. The isolation distances for H7-1 sugar beet seed fields (as discussed in section II.D) would be determined and enforced by APHIS. These distances are 4 miles between H7-1 plants and table beet and Swiss chard seed production. In addition to the geographic restrictions, no H7-1 sugar beet seed would be cleaned or processed in any processing facility that also cleans and processes Swiss chard seed or table beet seed.

Under Alternative 3, Swiss chard seed growers in California and western Washington would likely not experience impacts from H7-1 sugar beet seed production as sugar beet seed has not traditionally been produced in those regions and H7-1 sugar beet seed would not be allowed to be produced in these regions.

The greatest potential for impact from H7-1 sugar beet produced under Alternative 3 would likely be on Swiss chard seed producers in the Willamette Valley, which would be similar to Alternative 2, resulting in increased testing for LLP and the potential loss of customers from the perceived but unsubstantiated risk of LLP.

Under Alternative 3, highly GE-sensitive markets may choose to purchase seed from production areas other than Willamette Valley due to fears of LLP. As a result, Swiss chard seed companies may contract Swiss chard seed production outside the Willamette valley, which, in turn, could result in increased competition for Swiss chard seed production fields in these areas. Ultimately, the amount that production could increase in these areas would be limited by the isolation distances required. Growers in the Willamette Valley who had previously raised Swiss chard seed may instead grow alternate seed crops.

Alternative 3 has mandatory isolation distances of 4 miles between H7-1 plants and table beet and Swiss chard seed production which is greater than the 3-mile isolation distance required by the WVSSA. This increase in mandatory isolation distance could result in Swiss chard seed producers having fewer land options available to them (Hoffman, 2010) Additionally, small producers are likely to have lower priority in the WVSSA pinning schemes. However, as some of the H7-1 sugar beet seed producers already require a 4-mile isolation distance between H7-1 sugar beet seed production and other *Beta* species (Lehner, 2010) the actual impact of this mandatory increase in isolation distance on Swiss chard seed producers is expected to be low. For more information, on WVSSA guidelines and pinning rules, see section III.B.1.b(10).

Under Alternative 3, the impacts on Swiss chard seed producers in Arizona would likely be minimal because H7-1 sugar beet seed is not produced in Arizona.

Under Alternative 3, similar to Alternative 2, Swiss chard seed producers in areas close to H7-1 sugar beet seed production might alter their practices for roguing off-types due to concerns about LLP. Also, Swiss chard seed growers that save seed near areas close to H7-1 sugar beet production would face the same concerns as described in Alternative 2.

In summary, for Swiss chard seed producers in the counties that overlap with H7-1 sugar beet seed production in Willamette Valley and southern Oregon, implementation of Alternative 3 would likely not result in impacts different from those expected under Alternative 2. Swiss chard seed producers could be required by their GE-sensitive customers to test their seed lots for LLP despite the likelihood of detection being low. If seed producers sell to a zero-tolerance market, then detection of LLP would likely result in the seed company having to sell the seed lot to a more tolerant market. Growing Swiss chard seeds in Oregon may become less attractive compared to growing it in other areas where no H7-1 sugar beet seed is produced. Swiss chard seed producers in the counties of overlap with H7-1 male fertile sugar beet also might be more vigilant about roguing off-types due to concerns about LLP. APHIS would continue to oversee conditions that mitigate gene flow.

b. Vegetable Production

As Swiss chard grown for leafy greens can be produced by both commercial and noncommerical growers, APHIS believes there could be the following three categories of Swiss chard vegetable producers:

(1) Commercial growers who purchase seed and sell their vegetable crop,

(2) Farmers who grow their own seed (save seed) and sell their vegetable crop, and

(3) Home gardeners who grow Swiss chard as a vegetable but do not sell it. These farmers may purchase seed or grow their own (save seed).

The potential impacts of each of the alternatives on root crop production practices of each of these grower types are discussed below.

(1) Alternative 1 – No Action

Because Swiss chard grown for vegetables is harvested prior to flowering, there is no potential for H7-1 sugar beet to directly impact the production of Swiss chard vegetable production through gene flow. Vegetable beet producers who cater to a GE-sensitive market may want to ensure that their seed does not test positive for the H7-1 trait. Under Alternative 1, where no H7-1 sugar beet seed is produced, these producers are unlikely to be concerned with LLP in Swiss chard seed. In terms of LLP, there is no indication that practices for roguing off-types when growing Swiss chard for greens have changed between 2005 and 2010 (the period of H7-1 sugar beet deregulation). Therefore, Alternative 1 is not expected to have any effect on these practices.

Under Alternative 1, farmers who save seed and sell their Swiss chard vegetable crop and home gardeners who either buy seed or save seed would not be expected to have concerns that their crops contain LLP.

(2) Alternative 2 – Full Deregulation

Under Alternative 2, because H7-1 sugar beet root crops are harvested prior to flowering, there is no potential for H7-1 sugar beet to directly impact the production of Swiss chard as a vegetable. Additionally, sugar beet root growers do not rotate their fields with other *Beta* species so it is extremely unlikely there would be any H7-1 sugar beet volunteers in a commercial Swiss chard vegetable field.

Swiss chard vegetable growers who cater to a GE-sensitive market may decide to only purchase seed from areas where no H7-1 sugar beet is grown or seed that has been tested.

Under Alternative 2, farmers and home gardeners who save seed and sell or directly consume their Swiss chard vegetable crop may have concerns that their crops contain the H7-1 trait. Farmers or gardeners located near H7-1 sugar beet seed production who save their seed and are concerned about H7-1 gene flow could purchase seeds from producers who are not near H7-1 sugar beet seed production, or they could continue to save their own seed and rogue off-types, eliminating potential LLP (except in baby greens where off-types are difficult to detect).

In summary, Alternative 2 is expected to have minimal impact on Swiss chard vegetable producers.

(3) Alternative 3 – Partial Deregulation

As with Alternative 2, there are minimal impacts on Swiss chard vegetable crop producers under Alternative 3.

3. Table Beet

Unlike Swiss chard, which is mostly grown for the fresh market, the majority of table beet grown in the United States is for canning (see section III.B.3.) which is not a GE-sensitive market. However, table beet seed is produced for export and domestic fresh market use, both of which can be GE-sensitive markets. As with all other *Beta* crops commercially grown in the United States, table beet is grown for both seed and food (root and greens), and it is also produced by home gardeners.

Potential impacts of the environmental release of H7-1 sugar beet on both table beet seed and vegetable production are described separately below.

As with Swiss chard in section IV.B.2, the discussion that follows also does not address all aspects of table beet seed and root production, but rather focuses on only those aspects that are expected to change as a result of the three action alternatives. The same production practices that did not change for Swiss chard seed production are also not expected to change for table beet seed production.

The aspects of table beet seed production that have changed with the adoption of H7-1 sugar beet seed or are expected to be affected by the three alternatives are the same as described for Swiss chard. These include: the counties in which table beet seed is produced, the ratio of the steckling method used compared to the direct seeded method, the isolation distances used between table beet seed and H7-1 sugar beet seed production, roguing for off-types, testing for LLP in seeds, and cost of testing for LLP.

Much like with Swiss chard vegetable production, most of the practices used to produce table beet vegetables are believed to be unchanged with the adoption of H7-1 sugar beet.

The aspects of table beet vegetable production that have changed with the adoption of H7-1 sugar beet or are expected to be affected by the three alternatives are the same as those listed for Swiss chard vegetable production. These include enhanced attention to roguing for off-types in table beet production, testing for LLP, and the costs associated with testing. For more information see section IV.B.2

a. Seed Production

As table beet seed can be produced by both commercial and noncommercial growers, APHIS believes there could be the same four categories of table beet seed producers as there are for Swiss chard seed producers:

(1) Commercial table beet seed producers who produce seed under contract and/or use industry mandated isolation distances and/or participate in pinning programs;

(2) Table beet seed producers who produce and sell seed but are not under contract and may or may not follow industry mandated isolation distances and/or participate in pinning;

(3) Table beet farmers who sell fresh vegetables and also save seed, but do not sell seed (including, but not limited to, hobby farmers); and

(4) Home gardeners who produce table beet for greens, roots, and/or for seed for their personal use.

APHIS believes that the vast majority of table beet seed sold and produced in the United States is produced by growers in category 1. As there are no available data regarding the acreage and location of producers in categories 2 through 4, the primary focus of the analysis in this chapter is on table beet seed producers in category 1 above. When possible, growers in the other categories are also discussed.

As described in section III.B.3.a, in the United States in 2011, APHIS is aware of commercial table beet seed production occurring on up to 550[30] acres in California, Washington, and Oregon.

(1) Alternative 1 – No Action

The effects of Alternative 1 on table beet seed production are expected to be similar to those described for Swiss chard seed production as described in IV.B.2.a(1). In summary, Alternative 1 would allow isolation distances used before the adoption of H7-1 sugar beet, would eliminate the need for table beet seed producers to conduct LLP testing, and would reduce concerns about roguing off-types. Growers would still need to be concerned about roguing phenotypic off-types from hybrids to conventional sugar beet and Swiss chard.

(2) Alternative 2 – Full Deregulation

[30] Note: the information APHIS received on acreage of table beet production in California for Glenn, Colusa, and Butte Counties was aggregate data with combined acreage for Swiss chard and table beet. Therefore,actual acreage of table beet and Swiss chard in each of the individual counties is not known. For the purposes of the EIS, APHIS will assume the highest possible acreage for both of the crops by estimating that the acreage of each is 125 acres.

The approximately 550 known acres of commercial table beet seed production in 2011 include 27 acres in Oregon, 405 acres in Washington, and up to 125 acres in California.

Like other *Beta* crops, table beet seed producers also use isolation distances to keep their seeds genetically pure. Of the *Beta* seed producing regions listed in III.B.2.a(7), Willamette Valley has the only county in which both table beet seed production and H7-1 sugar beet seed production is occurring in 2011. Therefore, if gene flow between H7-1 sugar beet seed production and table beet seed production were to occur, it is most likely to occur in Willamette Valley.

In 2011, H7-1 sugar beet seed production and table beet seed production are both occurring in Polk County, Oregon (see Fig. 4-2). It is possible that in other years, table beet seed production would occur in other counties in the Willamette Valley.

As stated above and in sections III.B.1.b(6) though III.B.1.b(9) in Willamette Valley, only 15 percent of the H7-1 sugar beet seed production acres used H7-1 pollinators. For more information on gene flow see section III.B.5. Furthermore, the ratio of the acreage of male fertile H7-1 sugar beet fields compared to table beet fields is less than 2.0 (see Table 4–1). Table beet may be produced as hybrids or open pollinated so the ratio of pollen producing sugar beet to table beet plants is likely under 1.0. From this information the agency concludes that there are comparable amounts of pollen producers with the H7-1 trait and table beet pollen producers, and with a 4 mile isolation distance, APHIS expects that gene flow from H7-1 sugar beet into table beet will be below detectable levels (<1 in 10,000 seeds) in Polk County.

As described in section IV.B.2., seed admixtures between sugar beet and table beet are unlikely as there are no commercial seed producers that grow H7-1 sugar beet seed and table beet seed (Loberg, 2010a), H7-1 sugar beet processing facilities do not process other *Beta* seed, and neither sugar

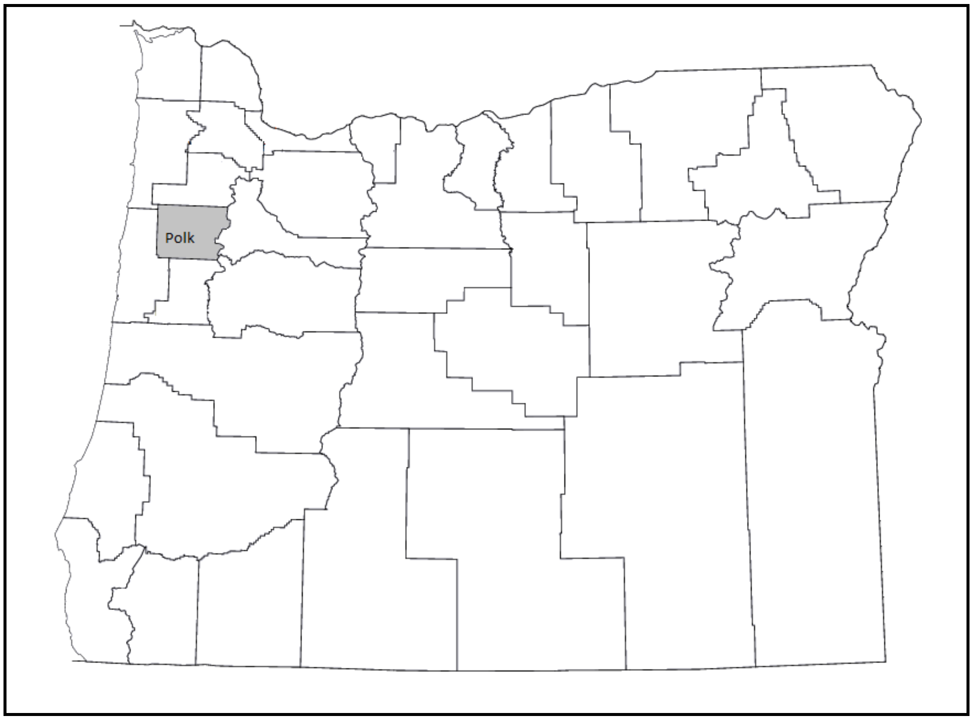

Figure 4-2. Map of the county (Polk) in Oregon in which known commercial table beet seed production and H7-1 sugar beet seed production occurred in 2011

(McReynolds, 2011; USDA-APHIS, 2011d).

beet seed producing companies or table beet seed producers share equipment for the planting, harvest, and cleaning of seed. For more information see section III.B.1.b(18),

Taken together, APHIS believes that there is a very low potential for unintended gene flow from H7-1 sugar beet seed production into table beet seed production. APHIS recognizes that both table beet and sugar beet seed field distributions are not static and will vary from year to year. Given the widespread use of male sterile H7-1 sugar beet lines, the relative sizes of the sugar beet and table beet seed production fields, and the isolation distances routinely employed, APHIS concludes that LLP is unlikely to be detected in Oregon vegetable beet seed crops.

Under Alternative 2, the rest of the potential impacts on table beet seed producers are expected to be the same as those for Swiss chard seed producers. See section IV.B.2.a(2) for more information.

As discussed for Swiss chard seed producers in section IV.B.2.a, table beet seed producers in the Willamette Valley who cater to a GE-sensitive market may be disadvantaged compared to producers outside the State of Oregon. The impact on table beet seed producers may be less than on Swiss chard seed producers given the sizeable beet canning industry which is not a GE sensitive market.

(3) Alternative 3: Partial Deregulation

Under Alternative 3, the potential impacts on table beet seed producers are expected to be the same as those for Swiss chard seed producers. See section IV.B.2.a(3) for more information.

b. Vegetable Production

As table beet grown for its root and or leafy greens can be produced by both commercial and noncommerical growers, APHIS believes there could be the following three categories of table beet vegetable producers:

(1) Commercial growers who purchase seed and sell their vegetable crop,

(2) Farmers who grow their own seed (seed savers) and sell their vegetable crop, and

(3) Home gardeners who grow table beet as a vegetable but do not sell it. They may purchase seed or grow their own (save seed).

The potential impacts of each of the alternatives on vegetable crop production practices of each of these grower types are discussed below.

(1) Alternative 1 – No Action

Impacts on table beet vegetable producers are expected to be similar to the impacts described on Swiss chard greens producers. For more information see section IV.B.2.b(1).

In summary, Under Alternative 1, commercial farmers who produced table beet, farmers who save seed and sell their table beet vegetable crop, and home gardeners who either buy seed or save seed would not have concerns that their crops contain LLP.

(2) Alternative 2 – Full Deregulation

As was described for Swiss chard vegetable producers in section IV.B.2.b(2), no impacts are expected on table beet vegetable producers under Alternative 2.

(3) Alternative 3 – Partial Deregulation

As for Alternative 2, no impacts on table beet vegetable producers are expected under Alternative 3.

4. Fodder Beet

There is no evidence that commercial fodder beet seed production (Wahlert, 2011) or root production is currently occurring in the United States. APHIS also assumes that since fodder beet has not been widely used for livestock feed in the United States since the Second World War, there is no reason to expect that they would be adopted for such use in the future. Therefore,there are no expected impacts of H7-1 sugar beet on fodder beet seed or root production on any of the alternatives.

5. Gene Flow in *Beta* spp.

Gene flow, hybridization, introgression and the distance that pollen, seeds, or vegetative tissues move in the landscape will not change under any of the alternatives presented in chapter II. Gene flow will continue to occur between different plant populations whenever conditions conducive to successful pollen movement and cross fertilization occur.

While gene flow itself does not change under the different alternatives, the likelihood of successful gene flow between any population of H7-1 sugar beet and other fields or populations of *Beta* spp. does vary between alternatives. In the discussion below, the factors that contribute to or limit the potential impact of H7-1 on gene flow between sugar beet, vegetable beet, and wild beet are discussed. Table 4–3 provides an overview of the likelihood of gene flow between different *Beta* spp. populations under present-day conditions. These determinations are based on the current geographic distribution of sugar beet, vegetable beet, and wild beet. Additionally, factors including flowering time, potential for aberrant bolting and flowering, and vegetable crop versus seed crop are considered. The terms used in the table are intended to provide more of a relative ranking than an absolute conclusion, with “unlikely” indicating several factors currently act to limit the potential for seed or pollen flow between populations (e.g., extremely limited flowering potential in root crops), ”possible” indicating proximity between crops and flowering occurs, ”not currently possible” indicating that current conditions enforced by the regulatory mechanisms of the Final EA prevent gene flow from occurring (e.g., geographic restrictions), and “not possible” indicating no chance of pollen mediated gene flow due to lack of flowering (USDA-APHIS, 2011b).

The most important properties that limit gene flow among sugar beet, vegetable beet, and wild beet populations are the standard isolation distances that have been adopted and used in the past and present by growers to maintain seed crop purity.

As discussed in detail in section III.B.5, the following conditions could contribute to gene flow between *Beta* crop species:

- **Wind pollination.** Sugar beet pollen is small and light, and is released in large “pollen clouds” from actively flowering seed production fields. Sugar beet pollen has been observed to move up to 6 miles from source fields (Fénart et al., 2007). Insects can move sugar beet pollen but are not considered a major mechanism for gene flow in *Beta* crop species (Free et al., 1975; OECD; Desplanque et al., 2002).

- **Cytoplasmic male sterility (CMS) hybrid production**. CMS hybrid sugar beet production results from the mixed planting of a 14:4 (3.5:1) ratio of male-sterile: male-fertile plants. As such, pollen is primarily produced by one quarter of the plants and the local pollen cloud generated by CMS hybrid fields is smaller than the pollen cloud from open-pollinated *Beta* crops. As a result, local pollen competition is lower than at open pollination fields and incoming pollen has a (slightly) higher potential for successful pollination. Additionally, CMS hybrid production sometimes uses tetraploid male-fertile plants. Tetraploid male-fertile plants have been observed to have delayed pollen release, and also produce pollen with lowered competitive ability. These properties contribute to a higher potential for CMS fields to act as gene flow sinks.

- **Open pollination.** Open-pollinated *Beta* crops produce very large pollen clouds. Because the success of long-distance pollination increases with size of pollen cloud simply due to increased pollen in the air, open pollination fields have higher potential as gene flow sources.

- **Field size.** Similar to the differences between open-pollinated crops and hybrid production, fields of different sizes would be expected to produce different sized pollen clouds. Large fields would thus be expected to produce pollen clouds that are both more competitive at the local source and disperse at higher concentrations of pollen over distance.

Table IV-3. Matrix of Potential H7-1 Pollen Sources and Gene Flow Sinks Qualitative Assessment of Likelihood of Gene Flow Under Present-day Conditions Indicated

		Pollen Sources	
	Pollen Sinks	H7-1 Sugar Beet Seed Production	Bolters H7-1 Root Production
A	H7-1 Sugar Beet Seed	NA	Unlikely because: No proximity Different flowering times Bolters infrequent and usually removed
B	Conventional Sugar Beet Seed Production	possible in OR, WA, ID	Unlikely because: No proximity Different flowering times Bolters infrequent and usually removed
C	Swiss Chard/Table Beet Seed Production	possible in OR	Unlikely because: No proximity Different flowering times Bolters infrequent and usually removed
D	Seed Savers (Farmers who save Seed and Home Gardeners)	possible in OR, WA, ID	Proximity unknown Unlikely because: Different flowering times Bolters usually removed
E	Wild Beet	No proximity	Possible in CA. Unlikely because different flowering times Poor sexual compatibility
F	Bolters H7-1Sugar Beet Root Production	Unlikely No proximity Different flowering times Bolters infrequent and usually removed	NA
G	Bolters Conventional Sugar Beet Root Production	Unlikely No proximity Different flowering times Bolters infrequent and usually removed	Unlikely Bolters infrequent and usually removed
H	Bolters Swiss Chard/Table Beet Vegetable Production	Unlikely Vegetables usually harvested prior to flowering Different flowering times	Unlikely Vegetables usually harvested prior to flowering Bolters infrequent and usually removed
I	Bolters Home Gardens	Unlikely Different flowering times	Possible if proximity If occurred, seeds not valuable because selects for annual flowering.

J	Nonflowering Populations: Stecklings, Nonbolting Vegetable Beet, Nonbolting Vegetable Swiss Chard, Nonbolting Sugar Beet Root, Commercial or Nonbolting Home Gardens	Not possible-no seed produced	Not possible-no seed produced

- **Aberrant bolting.** All *Beta* crop species have the potential to bolt and flower in the first year of cultivation if vernalization conditions are met or if crop-weed hybrid seed is planted. Plants that successfully bolt and flower can act as both a gene flow source and a sink. The percentage of bolting plants within root crop fields is very low, 0.01 percent in most growing regions. Bolting is higher in California due to the length of the growing season. Bolters are easily identifiable and standard practice is for farmers to remove them, although standard practice is not always followed as noted below.

- **Seed dispersal.** Gene flow of H7-1 sugar beet is possible if seeds are accidentally dispersed from transportation trucks, seed separation in storage is lacking, or via extreme weather conditions. Sugar beet seeds can shatter during harvest (drop from mother plants) and dispersed seeds have the ability to persist in seed banks for several years.

- **Seed bank persistence.** *Beta* crop species produce a seed ball that can survive in the soil for several years. These seeds can germinate in subsequent years as volunteers in other crop rotations or fallow fields. If left unmanaged, these plants could act as pollen donors or recipients and contribute to gene flow.

- **Vegetative reproduction.** *Beta* crop species have a very limited ability to reproduce vegetatively from root and top remnants which are typically referred to as groundkeepers. Successful persistence via this mechanism requires survival of winter conditions and subsequent flowering in order to represent a significant vector for gene flow.

- **Sexually compatible weeds.** Hybridization from sugar beet into wild beet is possible if the distributions between H7-1 sugar beet production and wild species overlap. Sexually compatible wild species of *Beta* are found only in California. Hybridization between wild species and *Beta* crop species is possible if other conditions for gene flow occur, such as wind pollination, flower synchrony, self incompatibility, fertile pollen, chromosomal stability, and proximity. Hybrids produced by gene flow from wild populations into sugar or vegetable beet would introduce the bolting gene into crop fields if bolters escape roguing and disperse seeds into the seed bank.

- **Farmers that grow their own seed (seed savers).** These farms are a potential source of gene flow, predominantly as a source for pollen that would exist without adherence to pinning rules. These farmers primarily grow *Beta* crop species as vegetable crops. If these farmers bulk their own seeds for replanting, hybrid “off-types” could occur. Because hybrid plants are a mix of morphological traits, they would likely be weeded out. Because these farms might not follow rigorous industry seed production protocols, they could be subject to less oversight and thus unharvested vegetable crops could be left for longer than the first year, flowering in the second. These flowering *Beta* crops could act as pollen donors or recipients.

- **Lack of adherence to best management practices.** If growers do not abide by best management practices such as following isolation distances between fields or do not remove aberrant bolting plants, potential for gene flow would increase. Additionally, seed producers that cultivate sugar beet or vegetable beet outside of areas that utilize pinning maps and isolation distances may be unaware of local pollen sources that could cross pollinate their crops.

As discussed in detail in section III.B.5, the following conditions could decrease the likelihood of gene flow between *Beta* crop species:

- **Isolation distances.** Farmers are aware of the cross-compatibility of sugar beet, Swiss chard, table beet, fodder beet, and wild beet. To maintain crop purity, farmers have traditionally adopted isolation distances ranging from 0.49 to 4 miles between fields. Isolation is maintained between both different crop types (sugar beet versus Swiss chard) and open-pollinated versus hybrid production of the same crop type. Isolation distances suggested for the production of H7-1 sugar beet are 3–4 miles, depending on whether it is hybrid production or open pollination production.

- **Pollen dispersal.** Rates of pollen dispersal vary by experiment but all studies to date indicate that the rate of pollen dispersal and dilution in the environment decreases rapidly with distance from the pollen source. Effective pollen concentration at distances greater than 3,280 feet (0.6 mile) are estimated to be less than 0,1 percent of the original concentration.

- **Local pollen cloud competition.** Open-pollinated sugar beet (and other *Beta* crop) seed production fields produce very large “pollen clouds” during the flowering period. Pollen that has been released from other sugar beet or vegetable beet fields must travel from the donating field and consequently disperses in the air. When this incoming pollen reaches a sink field of sugar beet, it must compete with the local “pollen cloud.”

- **CMS hybrid production.** CMS hybrid seed production uses mixed fields of male-sterile and male-fertile plants. Pollen is produced only by male-fertile plants, reducing the quantity of pollen in the "pollen cloud" and thus reducing the donation and competiveness of long-distance pollen from these fields. Specifically, in regard to H7-1 sugar beet, if the male-sterile plants carry the genetically engineered (GE) gene, then CMS hybrid production greatly reduces the risk of unintended release of pollen with the H7-1 trait. In CMS hybrid production, male-fertile plants are destroyed after flowering to prevent seed contamination, further reducing the potential for successful gene flow. H7-1 sugar beet progeny from a cross consisting of a tetraploid male plant and a diploid female plant will be triploid. If a root crop is sown with triploid seed, plants that bolt will predominantly be sterile.

- **Hybrid "off-types."** Hybrids that form between sugar beet and vegetable beet cultivars are a 50:50 mix of both crop species. If hybrid seeds form and are planted for root or seed crops, these hybrid plants manifest a mixture of the morphological traits of both parents. As the different crops are cultivated for different properties, sugary root, edible leaves, and edible root, "off-types" are easily identifiable. Standard practice is to remove "off-types" in seed production and the production of mature vegetables.

- **Geographic restriction of wild species.** Wild sexually compatible beet species in the United States occur only in California. Overlap between sugar beet root production and these species occurs only in the Imperial Valley of California. Currently, no sugar beet or vegetable beet seeds are produced in the Imperial Valley. Thus flowering is restricted to bolting plants in root or vegetable production fields which is a tiny subset of the plants. In the Imperial Valley, currently the only region in California that grows sugar beet, the predominant wild species, *B. macrocarpa*, has limited compatibility with sugar beet and is self fertile Furthermore, flowering time is not typically synchronous between sugar beet root bolters and *B. macrocarpa* in the Imperial Valley.

- **Best management practices (BMPs) regarding seed storage, cleaning, and field cleanup.** Growers of H7-1 sugar beet are subject to contract restrictions imposed by the Monsanto TUG and grower cooperatives which necessitate stewardship requirements. As shattering of seed is common in sugar beet seed production, seed growers utilize specialized postharvest protocols to germinate and remove dispersed seeds in fields (see section III.B.1.b(18)). Additionally, BMPs used by sugar beet seed producers limit the potential for adventitious presence of seeds by prohibiting cross-equipment usage and storage.

- **Weediness.** Sugar beet are not considered a competitive weed species (see section III.C.3.c). Since H7-1 sugar beet do not have altered competitive ability compared with conventional sugar beet, H7-1 sugar beet plants that successfully disperse into another habitat area not expected to be more competitive than conventional sugar beet unless they are sprayed with glyphosate.

Sugar beet have a limited ability to vegetatively propagate (see section III.B.5) and several factors would have to occur in sequence to contribute to gene flow via this mechanism. First, small viable root fragments would have to be left behind after sugar beet harvest. Second, the groundkeepers would have to survive winter conditions (or solarization [extreme soil heat] in summer in California). Third, the plant would then have to survive the following year's crop rotation and tillage practice. Finally, the plant would have to survive farmer surveys to remove weeds and maintain crop purity. As such, gene flow between crop fields and other plant populations by H7-1 sugar beet via vegetative propagation of groundkeepers or other tissues is extremely unlikely.

The greatest potential for effective gene flow in regard to H7-1 sugar beet and vegetable beet crop production in the United States is via pollen-mediated gene flow. As sugar beet and other *Beta* crop species are wind-pollinated species and require the movement of pollen to set the seeds necessary for vegetable production, gene flow is necessary for sugar beet seed production. However, several factors need to be concurrently met for successful, unintended, pollen-mediated gene flow between beet populations (see section III.B.5). The potential for this occurring under each action alternative is analyzed below.

The following assumptions were used in the analysis:

- Previously measured pollen dispersal rates (reviewed by (Darmency et al., 2009)) and models (Westgate, 2010) accurately describe the dilution and dissipation of pollen as it leaves a field of flowering *Beta* spp.

- Pollen competition at open pollination sink fields is greater than that measured in gene flow studies using CMS male sterile receptor plants.

- A single sugar beet plant produces 1 billion pollen grains and approximately 10,000 seeds (10,000 ovules) (OECD). Pollen to ovule ratio is 100,000:1.

- In determining pollen clouds and competition, all *Beta* crops are assumed to produce equivalent pollen and seeds per plant.

- Isolation distances imposed by seed producers and the use of pinning maps are effective at reducing gene flow between sexually compatible *Beta* spp. Hybrids between different *Beta* crops are recognizable and undesirable, and isolation distances have evolved to minimize cross pollination even prior to the introduction of H7-1 sugar beet.

- 85 percent of H7-1 sugar beet seed production in the Willamette Valley is CMS with the H7-1 trait on female (male sterile) plants (APHIS proprietary data). Pollen producing plants rarely occur in the male sterile background (Lehner, 2010) and are rogued to improve the efficiency of the desired crosses.

- The remaining 15 percent of H7-1 sugar beet seed production has the H7-1 trait on male fertile pollinators. The pollen cloud from these fields is less than one fourth the density of open-pollinated *Beta* crops.

- BMPs (e.g., voluntary, Monsanto TUG) and economic incentives regarding quality seed production contribute to field monitoring and methods to remove dispersed sugar beet seed and control volunteers.

- Wild beet populations do not occur in sugar beet seed production areas.

- Wild beet populations in the sugar beet root production area of Imperial Valley are predominantly if not exclusively *Beta macrocarpa*, a different species than sugar beet (*Beta vulgaris*), and do not readily cross pollinate.

- *Beta macrocarpa* flowers before *Beta vulgaris* and is highly self-fertile.

- Crop rotations are used in both seed and root production for all *Beta* crop species. Weed control in subsequent crops will limit volunteers.

a. Impacts of Gene Flow Between H7-1 Sugar Beet and Conventional Sugar Beet or Vegetable Beet

(1) Alternative 1 – No Action

In the short term, gene flow potential from H7-1 sugar beet would be limited to gene flow into or out of APHIS permitted research plots. These plots are assumed to be very small in comparison with current seed production fields and thus represent a much reduced pollen source. Additionally, in the counties where sugar beet and vegetable beet seed production currently overlap (see section III.B.5.c, Fig. 3–12), research plots would be subject to both APHIS approval, and pinning and isolation distance rules. Pinning and isolation distances in the Willamette Valley of Oregon are administered by the WVSSA. While membership is voluntary, all current seed producers of *Beta* spp. crops are members of the WVSSA. Under the rules of the WVSSA, different isolation distances are used between sexually compatible crop types. For *Beta* spp. crops, the isolation distances are: 1 mile between open-pollinated fields and between hybrid fields for crops within a same color or group; 2 miles between open and hybrid production within the same group; 3 miles between crops of different colors within a group (e.g., orange versus red table beet), and also between any genetically modified crop (including H7-1) and non –GM crop; and 4 miles between hybrid and open pollination of different crop groups. For more information on the WVSSA and isolation distances, see the discussion in section III.B.1.b(10), Table 3–3).

In the long term, it is assumed that H7-1 sugar beet would disappear from the landscape as the lack of ability to move the product to commercialization would limit the utility of further research. Under these conditions, gene flow between H7-1 sugar beet and other sugar beet cultivars is not expected to occur.

Based on the above assumptions and analysis, Alternative 1 is expected to result in no gene flow from H7-1 sugar beet to conventional *Beta* spp. because H7-1 sugar beet seed production would not be expected to occur in proximity to vegetable beet seed production. Since the introduction of H7-1 sugar beet seed production in the Willamette Valley, vegetable beet seed producers may have felt compelled to test their seeds for the presence of the H7-1 trait, though they are under no obligation to do so (Stearns, 2010). Some seed companies that cater to the GE-sensitive market expect seeds to be tested when grown in proximity (within 10 miles) of a sexually compatible GE crop (Morton, 2010). Under Alternative, 1, it is likely that growers of GE-sensitive crops would not have the burden to test for cross pollination.

(2) Alternative 2 – Full Deregulation

There are two potential sources for gene flow of the H7-1 trait: (1) H7-1 sugar beet seed production, the majority of which occurs in the Northwest; and (2) H7-1 sugar beet root production, which currently occurs in the Northwest, Great Plains, Midwest, and the Great Lakes regions. Each of these sources is discussed below.

H7-1 Sugar Beet Seed Production. As discussed in section III.B.5, pollen-mediated gene flow between H7-1 sugar beet and other *Beta* spp. crops requires synchronously flowering plants grown in proximity. These conditions are most likely to occur during seed production where every plant is expected to flower as opposed to vegetable production where flowering plants are discouraged, and purposefully removed from fields. As discussed in section III.B.1.b, the vast majority of sugar beet seed is produced in the Northwest, and specifically in the Willamette Valley of Oregon and eastern Washington. If H7-1 sugar beet was wholly deregulated, farmers could hypothetically grow H7-1 sugar beet seeds in any region of the United States. However, the use of new seed growing regions is not expected because conditions for growing *Beta* crop species are optimal in the Northwest. Winter weather is cold enough to vernalize first year plants and induce flowering without killing plants. Additionally, dry summers reduce the occurrence of disease.

Currently, the only area in the United States where H7-1 sugar beet seed production occurs in the same counties as vegetable beet seed production is in six counties of the Willamette Valley in Oregon (see Fig. 3–12) and in Jackson County in southern Oregon. In these seven counties and any adjacent counties (e.g., Yamhill County), there is the potential for gene flow to occur. Additionally, under Alternative 2, there would be no restrictions on where H7-1 sugar beet seed production could occur. H7-1 sugar beet seed production could expand to western Washington or other counties where vegetable beet seed is produced. However, H7-1 sugar beet seed production is unlikely to move into western Washington because (1) this region uses pinning maps; (2) pinning priority is determined by historical precedent, so the vegetable seed production in the area would have priority over incoming sugar beet seed production; (3) similar to vegetable beet seed producers, sugar beet seed producers do not want to produce seeds near vegetable beet seed fields due to pollen flow concerns. In areas where pinning maps are not used, coordination between neighboring farms is more difficult to achieve and unintended gene flow is a more likely possibility. APHIS is not aware of competing vegetable and sugar beet seed production interests outside of Oregon.

The potential for gene flow between commercial seed fields is limited by isolation distances and pinning practices of seed producers as well as the management practices under the Monsanto TUG and grower cooperatives.

In the Willamette Valley, the primary region of H7-1 sugar beet seed production, all commercial seed producers and growers of *Beta* crops utilize a pinning map and established isolation distances between sexually compatible species, in accordance with guidelines provided by the WVSSA. This use of pinning and isolation distances is not unique to *Beta* crops. Under these guidelines, any sexually compatible *Beta* crop species must be isolated by a minimum of 3 miles from any field of H7-1 sugar beet seed production (see section III.B.1.b(10)). This is the same isolation distance used to maintain isolation between stock seed production and open-pollinated crops and between color variants within a group (e.g., orange and red table beet). These isolation distances have been adopted and successfully utilized by farmers even prior to the introduction of H7-1 sugar beet because hybridization and the resulting off-types between any two different *Beta* spp. populations are undesirable. Additionally, some seed producers have adopted isolation distances in excess of 3 miles (e.g., Betaseed uses 4 miles.). the WVSSA isolation guidelines also recommend 4 mile isolation distance between a hybrid species and open pollinated crop from different groups.

The potential for gene flow between commercial seed fields is also greatly limited by the use of the CMS hybrid method in H7-1 sugar beet seed production (see section III.B.1.b(8)). In Oregon, 85 percent of H7-1 sugar beet seed production utilizes the H7-1 trait on the female plant. These fields contain pollen parents that lack the H7-1 trait so pollen produced from these sources does not have the H7-1 trait. The female parent on occasion may produce pollen. However these occurrences are rare, are watched for, and plants are rogued when detected. Because pollen is released over a period of 2–3 weeks, these plants are typically identified and removed from fields using established BMPs, before most of their pollen is released. Additionally, there are economic incentives to monitor and rogue pollen producers from the female lines to assure that the hybrid seed produced results from the planned crosses. At most, only minute amounts of H7-1 pollen are expected to be produced in these fields and they will be substantially diluted by the non H7-1 pollen produced by the pollen parent. Thus the management of the H7-1 hybrid fields to minimize unwanted hybrid seed ensures that these fields pose a negligible risk for cross pollinating nearby vegetable beet seed with H7-1 pollen. The remaining 15 percent of 2011 H7-1 sugar beet seed production in Oregon uses male pollinator plants with the H7-1 trait. These plants produce and release H7-1 pollen into the environment and represent the greatest potential source for unintentional gene flow of the H7-1 trait into other *Beta* spp. seed production.

Several important factors regarding pollen production decrease the impact of this pollen source. Isolation distances used for H7-1 sugar beet seed fields in the Willamette Valley are currently 3 miles, while distances between unlike hybrid and open pollinated crops is 4 miles. Using best available data, estimates of pollen cloud dissipation from open pollination fields into open pollination fields of equal size at 3,280 feet (0.6 mile) indicate that pollen competition likely reduces pollen-mediated gene flow potential to <0.01 percent, or less than 1 in 10,000 seeds (see section III.B.5). Three miles is 15,840 feet, or roughly 5 times this distance. Because gene flow is expected to drop below 0.01 percent at 3,280 feet, APHIS expects that at 5 times this distance gene flow will be substantially lower than can be detected using current PCR testing. The PCR detection limit of the H7-1 trait is 1 in 10,000 seeds (0.01 percent).

Furthermore, the amount of pollen produced in a hybrid production field is less than that produced in open pollination fields because the pollinator plants typically constitute only one third to one fourth of the plants (see section III.B.1.b(8)). More importantly, most of the pollen produced in a source is rapidly dissipated with distance from the source. Within a given field there is a 100,000-fold excess of pollen to ovules, but according to (Darmency et al., 2009), by 0.6 mile, pollen density was reduced such that there was a 1,000-fold excess of ovules to pollen. That means that the pollen concentration was diluted by a factor of 100 million through the process of dispersal over this distance (0.6 mile). In a nearby field, the local pollen cloud is thus very concentrated relative to the incoming pollen cloud, further reducing the likelihood of a successful cross pollination. The isolation distances used by the WVSSA are expected to reduce gene flow to below detectable levels which APHIS defines as less than one seed in 10,000 seeds by PCR testing. This does not mean that seeds are GE free. A typical beet field may be planted with up to 80,000 plants per acre (see section III.B.1) and so a 1-acre field may contain a few off-types even if the seeds used to plant that field tested negative with a sensitive PCR test.

One of the methods the sugar beet industry uses to evaluate the purity of their seed is to grow out a lot of seed and score for off-types. Hybrid off-types to Swiss chard and table beet are easily recognizable. Occasionally these off-types occur even though the nearest known vegetable seed production meets or exceeds the WVSSA guidelines. Industry experts have suggested that the most likely explanation for the cross pollination is an unidentified local pollen source (Anfinrud, 2010). APHIS agrees for several reasons. First, gene flow experiments where the pollen source is known supports the conclusion that isolation distances used by the WVSSA should be adequate. Second, in most cases and in most years the isolation distances are found to be adequate. Third, when off-types occur, the pollen source is not known. Fourth, unknown sources could include unpinned and unmanaged fields and gardens which can be expected to occur from time to time. .

During the Public Meeting in Corvallis, OR on November 17, 2011 APHIS learned that certain batches of vegetable beet seed produced in the

Willamette Valley tested positive for the H7-1 trait (USDA, 2011a) p. 80-81) (Hake, 2011). These results are summarized in Table 4-4. Samples from a total of 28 fields were tested and two of the fields tested positive for H7-1 (Tichinin, 2011). Seed from these fields were grown in 2007 and 2008 while H7-1 sugar beet was fully deregulated (Tichinin, 2011). No beet seed was grown by this producer in 2009. All seed lots grown in 2010 tested negative for the H7-1 trait. All seed lots grown in 2011 while H7-1 was partially deregulated also tested negative for the H7-1 trait (Tichinin, 2011).

Table IV-4. Willamette Valley Vegetable Beet Seed Fields Testing Positive for H7-1 Trait [1]

Year seed grown	# of fields tested	# of positives	% positive
2007	13	1	7.7
2008	6	1	16.7
2009	0	NA	NA
2010	3	0	0.0
2011	6	0	0.0
Total	28	2	7.1

[1]Source: (Tichinin, 2011)

The frequency of the H7-1 trait in the vegetable beet seed lots was not determined. Vegetable beet seeds were grown without detectable cross pollination in the last two years. Based on this information, APHIS has concluded that the current isolation guidelines are working to reduce gene flow to non detectable levels.

The potential for gene flow between commercial seed fields and home gardens, or farmers who save seed is discussed separately because these sources may not follow pinning rules or isolation distances and also do not report to any of the recording agencies in regard to planting. As such, the geographic distribution of these sources may be different than that of commercial conventional sugar beet and vegetable beet seed production. It is also important to note that commercial *Beta* crop seed production utilizes crop rotations. As such, any pair of H7-1 sugar beet seed fields and fields where farmer save seed may only be in sufficient proximity for gene flow to occur once every 5 to 8 years (see section III.B.1.b (16)).

If fields where farmers save seed are close enough to fields of male fertile H7-1 sugar beet seed production and also have synchronously flowering *Beta* spp. crops, there is a chance that gene flow could occur. Farmers who save seed could be affected in certain parts of Oregon, Washington, and Idaho where male fertile H7-1 sugar beet seed production fields occur.

Successful gene flow would only occur if the plants were harvested for seeds and replanted in subsequent years (farmers who save seed). In these cases, hybrid seeds could result and could carry the H7-1 trait. These plants would also be intermediate in morphology between sugar beet and whatever variety of vegetable beet was being grown by the farmer who is saving seed. These "off-types" have undesirable mixed characteristics and would likely be detected when the user of the seed grew the vegetable. For example, table beet has a deep red or yellow color but hybrids to sugar beet have a white interior with concentric rings of color (2011) (see Fig 4-3). If the grower were producing micro greens, off-types would be difficult to detect. Farmers that usually save seed and are concerned about consuming GE crops may be discouraged from producing their own seed in favor of purchasing vegetable beet seed that has been tested for the H7-1 trait or has been produced in an area such as Washington or Arizona where no H7-1 sugar beet seed production currently occurs. Gene flow could also occur to flowering beet in abandoned fields; any hybrid seed that formed could potentially shatter and disperse in the field. If the seed survives winter conditions, the hybrid plant would have to compete with other weed species in the following year. As discussed in section III.C.3.c, sugar beet are not competitive weeds and hybrid plants would also not be expected to be any more competitive than sugar beet. If vernalization conditions were met in the overwinter period, it is possible that hybrid plants could flower. These plants would thus represent a potential source of H7-1 pollen. However, the same conditions of pollen competition, flower synchrony, and proximity would have to be met for this source to represent a legitimate gene flow source. Feral populations of *Beta vulgaris* have not occurred anywhere in the United States except in California. Therefore,beet seeds released into abandoned fields are unlikely to persist anywhere except California. However, in California, feral population of *Beta vulgaris* are found on the coast away from sugar beet production. Naturalized populations of *Beta vulgaris* have not been confirmed in the Imperial Valley. Therefore, no feral populations of H7-1 sugar beet are expected to result in the United States from gene flow into beet in abandoned fields.

In the opposite direction, pollen from fields where farmers are producing their own seeds or home gardens could result in gene flow and hybridization with CMS male-sterile plants in H7-1 sugar beet seed production fields. Many of the commercial seed producers regularly scout regions surrounding sugar beet fields and pin any fields where farmers are growing their own seed (2011). However, if flowering vegetable beet are nearby, hybrid seed could form and end up in a commercial seed bag for use in sugar beet root production areas. Off-types could then occur in sugar beet root production fields. Sugar beet are harvested mechanically so off-types are typically harvested with the rest of the crop. When off-types occur at the expected low frequencies of less than one off-type per 10,000 seeds, this level of impurity is not a problem.

The potential for transfer of the H7-1 trait between commercial seed fields due to seed movement is limited by the use of BMPs to control seed dispersal and adventitious presence. Currently, producers of H7-1 sugar beet seed implement both voluntary and mandated management practices designed to prevent admixture of seeds during harvest, seed cleaning, storage, and shipping of H7-1 sugar beet seeds (see section III.B.1.b(18)). These methods include watering fields after seed harvest to germinate shattered seeds in seed production fields followed by tillage or herbicide treatment to reduce the H7-1 sugar beet seed bank (see section III.B.1.b(18)). Additionally, field inspections of past sugar beet fields are conducted to monitor and destroy volunteers. Multi-year crop rotations are used in both sugar beet seed and root production, to facilitate the detection and elimination of sugar beet volunteers. While such BMPs may not always be followed or 100 percent effective, they help reduce the likelihood of gene flow.

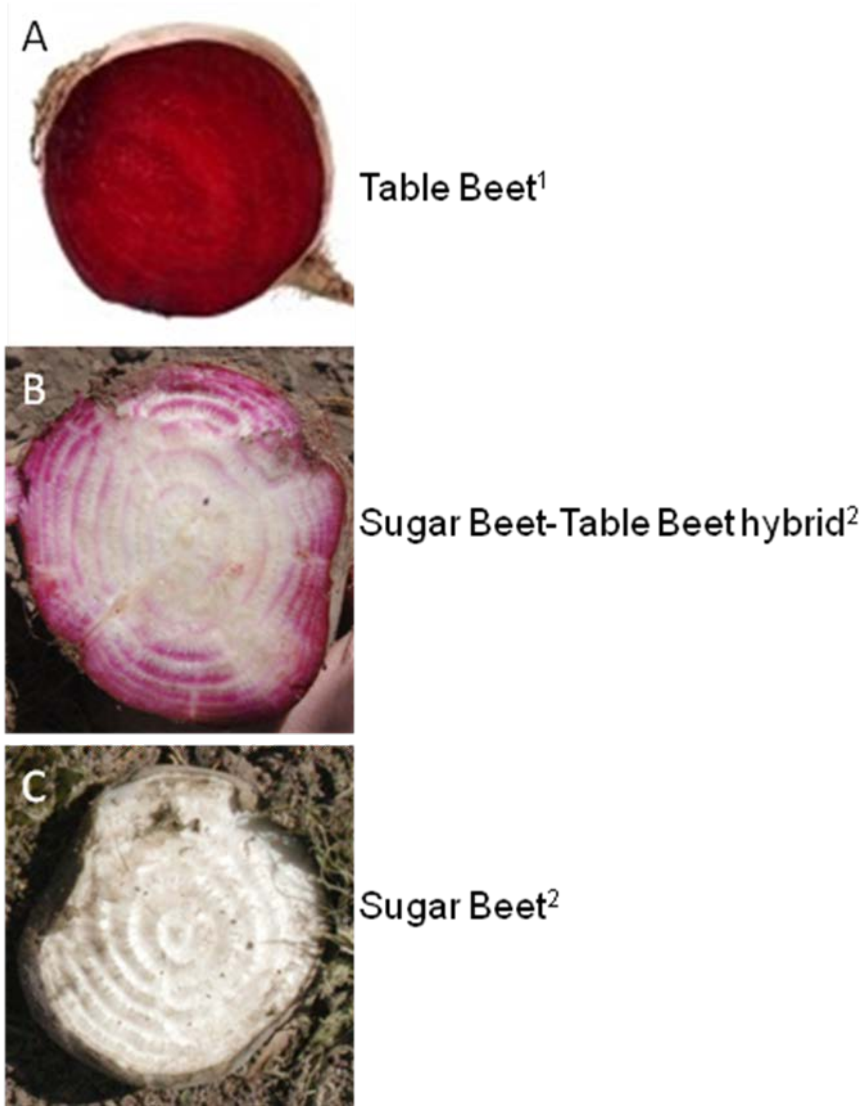

Figure 4-3. Sugar Beet Photos

A. Cross section of a red table beet. [1]Source: [http://us.cdn1.123rf.com/168nwm/skolodkin/skolodkin0709/skolodkin070900018/1738507- d.jpg](http://us.cdn1.123rf.com/168nwm/skolodkin/skolodkin0709/skolodkin070900018/1738507-d.jpg) accessed June 21, 2011.
B. Cross section of a root from a hybrid offtype identified in a sugar beet root production field. The seed planted was the progeny of a hybridization event between red table beet pollen and a sugar beet seed parent. It is clearly distinguishable from roots derived from either the pollen parent which would resemble the root shown in A or the seed parent which would resemble the root shown in C.
C. Cross section of a typical sugar beet root from the same root production field as the root shown in B. [2]Source: Neil Hoffman

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H7-1 Sugar Beet Root Production. Because flowering plants are essential for pollen-mediated gene flow, gene flow between sugar beet root production fields and any other *Beta* spp. population would only occur if the very low percentage of bolting plants in a given field, estimated at 0.01 percent of plants, is left unmanaged by farmers and plants survive to produce pollen and seeds. Standard practice is for farmers to remove bolting plants from the field to prevent harvest reductions of the sugary root crop. Similarly, bolters are undesirable to Swiss chard and table beet vegetable producers as the flowering process diminishes the quality of the vegetable. Typically Swiss chard and table beet are harvested prior to flowering in the crop. As such, if plants are harvested prior to bolting or if flowers are removed before pollen is released (which would be true in the overwhelming number of cases), there can be no gene flow of the H7-1 trait. Even if there were proximity between an H7-1 root crop and a vegetable beet crop and the two crops both contained bolters that were not removed and cross hybridized, then the resulting seeds would be unlikely to be saved for planting purposes because early bolting is an undesirable trait. If the seeds were abandoned in the field, they would not likely persist because *Beta vulgaris* has not naturalized anywhere in the United States except in coastal California. Additionally, if these seeds survived winter conditions and volunteered in subsequent years, they would likely be identified as weeds in rotational crops and be removed.

Gene flow is not likely from the H7-1 root crop to the vegetable beet seed crop for several reasons. First, there are no data to suggest that sugar beet root crop is grown in proximity to any commercial vegetable beet seed crop. Second, even if there were proximity, sporadic flowering of the root crop is not in synchrony with the flowering of the seed crop. For example, the root crop in all regions, except the Imperial Valley, is typically planted in April or May. If these plants bolt, pollen would not likely be released until August or September. The seed crop meanwhile is planted in September and would not be receptive to pollination until May and June, several months prior to the release of the pollen by the flowers in the root crop. In the Imperial Valley, flowering of the root crop could be in phase with the seed crop, as the root crop is planted in September. However, commercial production of vegetable beet seeds does not occur in the Imperial Valley; it has been attempted but abandoned because of poor results (2011).

For the reason stated above, managing bolters is not needed to prevent gene flow to another vegetable crop or another seed crop in the Great Lakes, Midwest, Great Plains, and Northwest regions. In the Imperial Valley it is conceivable that gene flow could occur between bolters in the root crop and a vegetable seed crop. This possibility is not a concern if no vegetable beet seed production is occurring and could be managed with isolation distances. In summary, even though sugar beet and vegetable beet seed production both occur in the Willamette Valley, the fact that isolation distances are estimated to be in excess of distances needed for detectable gene flow rates, that pollen clouds dissipate and are faced with high local pollen competition, and BMPs act to prevent seed admixture and seed dispersal, Alternative 2 is unlikely to result in LLP of the H7-1 trait in other *Beta* seed crops. However, as a result of the ability to test for the H7-1 trait, under Alternative 2, companies that produce seed for a GE-sensitive market would probably be required by their customers to test for LLP of the H7-1 trait (see section III.D.3).

(3) Alternative 3 – Partial Deregulation

The most important restriction with regard to gene flow under Alternative 3 is that isolation distances are enforced by APHIS and are increased beyond the currently WVSSA-adopted distances of 3 miles, to 4 miles. Alternative 3 also has mandatory conditions for production, processing and transport of H7-1 sugar beet, that are not present in other Alternatives, including reporting requirements, inspections, and audits.

Alternative 3 includes an increase in isolation distance to 4 miles in certain circumstances. For example, under the current WVSSA guidelines, 3 miles would be used between hybrid table beet and hybrid sugar beet but this distance would be increased to four miles if H7-1 sugar beet are introduced. In the Willamette Valley, this increase in isolation distance may slightly reduce the potential for gene flow into or from H7-1 sources compared to Alternative 2. Though low enough to result in nondetectable levels by PCR, a small amount of gene flow might occur and therefore the potential for gene flow is expected to be greater than under Alternative 1. Under Alternative 3, sugar beet seed production would not be allowed in western Washington whereas under Alternative 2, it would be allowed, but is unlikely to occur based on historical precedent. Under Alternative 3, no H7-1 sugar beet root production would be allowed in the Imperial Valley reducing the possibility of gene flow to wild beet compared to Alternative 2. As mentioned in Section IV.B.5.b., gene flow from H7-1 sugar beet to wild beet is not likely because of sexual incompatibility and flowering asynchrony. Alternative 3 includes mandatory measures that could reduce the possibility of seed admixture relative to Alternative 2 where these procedures are voluntary. Under Alternative 3, companies that produce GE-sensitive seed in regions other than western Washington or California may be required by their customers to test for LLP of the H7-1 trait.

b. Impacts of Gene Flow Between H7-1 Sugar Beet and Wild Beet
Currently, wild beet populations have only been identified in California and Pennsylvania. However, no sugar beet production occurs in Pennsylvania and the species detected, *B. procumbens*, is not sexually compatible with *B. vulgaris*, so gene flow between H7-1 sugar beet and *B. procumbens* is not expected. Because there are no wild beet in any of the sugar beet seed or root growing regions other than California, only California is discussed in this section. California wild beet is either *B. vulgaris ssp. maritima*, which is fully compatible with sugar beet, or *B. macrocarpa*, which does not readily cross (see section IV.5.b.(2)). *B. vulgaris ssp. maritima* grows along the coast and San Francisco Bay area whereas *B. macrocarpa* is found within sugar beet fields in the Imperial Valley. A detailed survey by the USDA failed to detect feral populations of *B. vulgaris* in the Imperial Valley. (2011).

(1) Alternative 1 – No Action

There is currently no H7-1 sugar beet seed or root production in California. Thus, there is currently no potential for gene flow between H7-1 sugar beet and wild beet species. Under Alternative 1, H7-1 sugar beet would not be present in California, so Alternative 1 would result in no change from the current situation.

In the short term, gene flow potential would be limited to gene flow into or out of research plots. These plots are assumed to be very small in comparison with current seed production fields and thus represent a much reduced pollen source. APHIS would maintain permit oversight and could restrict use of H7-1 sugar beet in California. In this case, gene flow potential would be zero.

In the long term, it is assumed that H7-1 sugar beet occurrence would be zero as the lack of ability to move the product to commercialization would limit the utility of further research. Alternative 1 would be expected to result in no gene flow between H7-1 sugar beet and wild beet.

(2) Alternative 2 – Full Deregulation

As discussed in the affected environment section (see III.B.5), the chances of unintended gene flow are greatest when there is limited isolation distance between H7-1 sugar beet seed production fields and populations of wild *Beta* spp. If H7-1 sugar beet was deregulated in whole, farmers could hypothetically grow H7-1 sugar beet in any region of the United States. The only geographic region of the United States that currently has sexually compatible wild beet species, *B. vulgaris ssp. maritima* , is California, specifically the San Francisco Bay area and southern coastal areas. A second wild species that has marginal compatibility with sugar beet, *B. macrocarpa*, grows in the Imperial Valley. Currently, only conventional sugar beet for root production are cultivated in California, and only in the Imperial Valley. Sugar beet production formerly occurred in the Central Valley of California but has been discontinued for economic reasons. It is unlikely to resume and the sugar beet processing plants in the area have closed (Table 3-31). In the long term, APHIS assumes that H7-1 sugar beet will eventually be developed for California's Imperial Valley. This assumption is supported by the use of H7-1 sugar beet in a variety trial and the interest of California sugar beet growers to grow H7-1 sugar beet in the Imperial Valley to control wild beet in their sugar beet root production fields (2011).

If farmers choose to cultivate H7-1 sugar beet for seed production in California, there would be potential for gene flow between H7-1 sugar beet and wild *B. vulgaris ssp. maritima* or *B. macrocarpa*. It is unlikely that sugar beet seeds would ever be grown in California because climatic conditions are not favorable and therefore this possibility is not reasonably foreseeable.

If farmers choose to cultivate H7-1 sugar beet for root production in California's Imperial Valley, which is very likely, there would be a potential for gene flow of the H7-1 trait to *B. macrocarpa*.

Varieties of sugar beet currently cultivated in the Imperial Valley have been specifically bred for very long vernalization times in an effort to reduce bolting (Lewellen, 2011). Nevertheless concern has been raised that the Imperial Valley root crop could cross pollinate to wild beet that grow in sugar beet fields. If H7-1 sugar beet was grown in the Imperial Valley and cross pollination occurred, this gene flow would be a concern to the sugar beet growers in the area because it would render glyphosate ineffective to control wild beet. The wild beet in the Imperial Valley is thought to be exclusively *Beta macrocarpa* which is a different species than sugar beet, *Beta vulgaris*, and the two species do not readily cross. Some evidence that introgression between sugar beet and *B. macrocarpa* occurred in one population of wild beet in the Imperial Valley has been reported (Bartsch and Ellstrand, 1999). This evidence, based on isozyme analysis, requires further testing with current and more sensitive molecular DNA markers before a conclusion can be reached that introgression has indeed occurred. This is because isozymes are shared by many populations while DNA markers are much more specific. Therefore,the DNA markers increase the certainty by which two populations and their offspring can be identified. Several observations are inconsistent with introgression of *B. vulgaris* into *B. macrocarpa*. First, greenhouse crosses using sugar beet as the pollen parent were unsuccessful with *B. macrocarpa* female plants. The reciprocal cross using *B. macrocarpa* pollen onto sugar beet was successful but the progeny were abnormal and showed signs of chromosomal instability (Lewellen et al., 2003). Second, *B. macrocarpa*, unlike *B. vulgaris*, is highly self-fertile and much less prone to outcrossing. Third, *B. macrocarpa* begins to flower in January and has largely gone to seed by May. Aberrant bolters of *B. vulgaris* root crop begin to flower in April, so there is little if any flowering overlap. If H7-1 sugar beet were to be grown in the Imperial Valley, it is expected that wild beet would be effectively controlled in sugar beet fields and would not have the opportunity to flower. Indeed, wild beet is effectively controlled in sugar beet rotation crops such as alfalfa or Sudan grass using several different herbicides. Surveys of the Imperial Valley by the USDA have failed to find *B. macrocarpa* growing outside sugar beet production fields (2011). Thus it is reasonable to expect that most if not all *B. macrocarpa* will be controlled in the valley through the use of glyphosate. Under Alternative 2, based on the poor hybridization potential between *B. macrocarpa* and *B. vulgaris*, the different flowering times, the likelihood that *B. macrocarpa* plants would be effectively eliminated from sugar beet production fields by glyphosate treatment, and the scarcity of *B. macrocarpa* plants elsewhere in the valley, APHIS concludes that the H7-1 trait is not likely to hybridize and introgress into *B. macrocarpa* populations.

There may be circumstances that slightly increase the likelihood of cross pollination between *B. macrocarpa* and *B. vulgaris*. Recently (Londo et al., 2011)found that simulated glyphosate spray drift, onto canola, caused a delay in flowering and a reduction in self fertility by preferentially interfering with pollen viability. Assuming *B. macrocarpa* has a similar response to sublethal exposure to glyphosate as does canola, a delay in flowering of *B. macrocarpa* could increase its flowering overlap with *B.vulgaris*. Together with a reduction in male fertility, the likelihood of cross pollination with *B. vulgaris* pollen would increase. *B. macrocarpa* could conceivably be exposed to glyphosate drift if it were to grow outside a field, for example in an irrigation ditch. For the effect to occur, the plants would need to be sufficiently close to a field sprayed with glyphosate to be exposed to drift (probably within 100 feet-see section IV.C.3.) and the glyphosate spray would need to occur at or near the time of pollen formation in *B. macrocarpa*. Typically sugar beet seed is planted in September and then irrigated which stimulates *B. macrocarpa* to germinate too. Two herbicide applications are made in October and occasionally a third is made in November while weeds are still young(Beet Sugar Development Foundation et al., 2011). In all likelihood, herbicide applications made at this time, would precede flowering of wild beet so the glyphosate effect reported by (Londo et al., 2011) seems unlikely in this scenario. As a special precaution, growers may choose to manage sugar beet bolters in their fields in April and May to further limit the likelihood that any cross pollination occurs to late flowering *B. macrocarpa*.

If *B. vulgaris ssp. maritima* were to be established in the Imperial Valley, and it were not controlled by herbicide treatment because it was growing outside a beet field, gene flow to *B. vulgaris ssp. maritima* could occur between root crop bolters and the wild beet plants. If the trait did move into wild species, these wild beet would become resistant to glyphosate and could not be controlled with glyphosate in H7-1 sugar beet. As glyphosate is not used to control wild beet in other *Beta* crops and other herbicides are effective to control wild beet in non *Beta* crops, the impact would be limited to H7-1 sugar beet. Because feral beet have not established in other sugar beet growing regions of the U.S,, the potential for wild beet having an H7-1 trait to establish in other sugar beet growing regions is low. Furthermore, the likelihood of such cross pollination between the sugar beet root crop and *B. vulgaris ssp. maritima* is expected to be low because the latter has not been confirmed to grow in the Imperial Valley, presumably because the climate is too hot and dry (2011) and the sugar beet root crop only occasionally flowers.

(3) Alternative 3 – Partial Deregulation

As sexually compatible wild beet have only been identified in California, Alternative 3 effectively prevents gene flow to wild beet populations. If wild beet expand their distribution beyond California into regions that grow H7-1 sugar beet then gene flow could occur. The likelihood of this occurring is low. Wild beet has been present in California for over 100 years (Bartsch and Ellstrand, 1999) and have not demonstrated a tendency to expand in range. Alternative 3, would be expected to result in no gene flow from H7-1 sugar beet to wild beet.

C. Biological Resources

In this section, APHIS evaluates how different aspects of sugar beet production under each of the three alternatives could impact biological resources. Potential direct and indirect environmental impacts of the alternatives on biological resources are discussed by resource area in sections IV.C.1 through IV.C.3 (i.e., impacts on animals, microbial communities, and plants, respectively). Cumulative impacts are discussed in section IV.H.

In section IV.C.1, for animals, potential impacts from H7-1 sugar beet and the amounts and toxicity of the herbicides applied (direct effects) or impacts on habitat (indirect effects), as well as the accompanying tillage practices for the three alternatives, are evaluated for different groups of organisms separately: (a) livestock, (b) mammals, (c) birds and reptiles, (d) amphibians and fish, (e) aquatic invertebrates, and (f) terrestrial invertebrates. These impacts are generally described qualitatively, although quantitative analyses of herbicide toxicities and application rates are presented to support conclusions about the risk tradeoffs of the different herbicides and action alternatives.

In section IV.C.2, for micro-organisms, possible impacts from the H7-1 sugar beet transgene DNA, including HGT or gene product, are examined.

The potential for the different herbicide applications and tillage practices associated with conventional and H7-1 sugar beet to alter soil microbial communities is examined for each alternative.

For plants, the possible impacts of gene flow from H7-1 sugar beet to closely related agricultural and wild species are analyzed in section IV.B.5. In section IV.C.3, three additional impact areas are considered: (a) development of herbicide resistance in weeds, (b) herbicide impacts on non-target plants, and (c) sugar beet weediness potential in non-agricultural settings.

Potential herbicide impacts are part of each section and the characteristics of the herbicides used on sugar beet are listed in Table 4–5 below. Only glyphosate is used differently on H7-1 sugar beet where it is additionally used as a post-emergent herbicide and non-glyphosate herbicides are used much less frequently on H7-1 sugar beet (see Table 3-18). Table 4-5 defines each herbicide's pre- or postemergence use, target weed groups, and mechanism of action. Application methods used on sugar beet and the maximum single application allowed are listed next. The maximum single application allowed is the benchmark for possible worst-case acute exposures at and soon after an application event. A value representing the half-life of each herbicide under typical agricultural conditions provides an indication of persistence in the environment. Finally, known degradation products in soil are listed, and those that might cause impacts beyond impacts of the parent herbicide are identified.

Previous EPA reports did not reveal evidence that sugar beet herbicides are endocrine disruptors. However all these herbicides will be reexamined under the EPA endocrine disruptor screening program. Therefore,no conclusions can be drawn from this absence of evidence.

APHIS does not address insecticides and fungicides in any detail. As noted in section III.B.1.c(5), insecticides and fungicides are believed to be similar across alternatives in terms of type, quantity, and potential impact. Herbicides, however, are expected to be used differently between the alternatives, especially between Alternative 1 and Alternatives 2 and 3.

1. Animals

As discussed in section III.C.1, animals that could be affected by the alternatives include livestock and wildlife including mammals, birds, reptiles, amphibians, fish, and terrestrial and aquatic invertebrates. The potential effects of the alternatives on these animal groups are discussed below.

a. Livestock

APHIS analyzed the potential effects on livestock from the availability and nutritional quality of sugar beet byproducts used as feed for livestock under the three alternatives.

(1) Alternative 1 – No Action

Under Alternative 1, farmers of commercial sugar beet would have to replace their H7-1 varieties with conventional sugar beet, and there might be a short-term shortage of sugar beet product (sugar beet tops, pulp, and molasses) for livestock feed. Several factors could influence farmers' decisions to replace H7-1 sugar beet immediately with conventional sugar beet, including availability and cost of herbicides, availability and cost of special cultivating equipment, short-term and longer-term availability of varieties of sugar beet with selected genetic traits (e.g., disease resistance, drought tolerance) suitable for the growing region, and the potential penalty or lost ownership shares in a sugar production cooperative for not growing sugar beet.

Table IV-5. Characteristics of Herbicides Used on Sugar Beet Root and Seed Crops

Active Ingredient (CAS number) [Formulated Product] References[1]	Use for Sugar Beet Production; Type of Herbicide – Mechanism of Action (MOA) on Target Weeds	Application Methods. Amounts and Frequency[2]	Half-life;[3] Toxic Degradation Products (TDP)
Clethodim (99129-21-2) [Select®] EPA-HQ-OPP-2008-0658	USE: Postemergence grass (monocot) control, annual and perennial, in a range of broadleaf crops. MOA: Cyclohexanedione herbicides; inhibits ACCase (in WSSA Group 1), which kills growing points of grasses – grasses are more sensitive than broadleaf weeds to these herbicides.	Broadcast or microrate (with Betamix® and Progress®). Maximum single application of 0.25 lb a.i./acre.	3 days for parent compound; 30–38 days for sulfoxide and sulfone metabolites.
Clopyralid (1702-17-6) [Stinger®] EPA-HQ-OPP-2009-0092; CHP 3/85	USE: Postemergence thistle and cocklebur control, applied after sugar beet are past cotyledon stage. MOA: Plant auxin mimic (in WSSA Group 4) – Causes rapid disorganized plant growth leading to death, with selective action on thistles, knapweeds, sunflower family, legumes, and knotweed families.	Broadcast, band, or microrate (with Betamix®, Progress®, or Poast®). Maximum single application of 0.33 lb a.i./acre.	30 days; degraded almost entirely by soil microbes.
Cycloate (1134-23-2) [Ro-Neet™] 2004 RED; CHP 3/85	USE: Selective herbicide for preplant incorporation 3–4 inches into soil to inhibit seed germination for annual grasses and a few specific types of broadleaf weeds. MOA: Thiocarbamate (in WSSA Group 8) – Inhibits a single key enzyme in the biosynthesis of very-long-chain fatty acids, which are essential parts of plant waxes and other plant structures.	Broadcast, band, lay-by, or sprinkler at end of irrigation cycle to penetrate to 3–4 inches. Maximum single application of 4 lb a.i./acre.	30 days; 3HC and 4HC.
Desmedipham (13684-56-5) [Betanex®] 1996 RED	USE: Selective, postemergence control of various dicot weeds of sugar beet. MOA: Carbanilate herbicide (in WSSA Group 5) – Inhibits photosynthesis. EPA concluded that the adjuvants in the TEPs are required for the a.i. to express toxicity to plants. Egg shell thinning – effect in birds.	Broadcast, band, or microrate. Maximum single application of 1.28 lb a.i./acre.	30 days; MHPC and conjugated O- and N-glucosides of MHPC and desmedipham.
EPTC (759-94-4) [Eptam®] 1999 RED; 1969 RED; CHP 10/83	USE: Preplant control of annual grasses and broadleaf weeds primarily in corn, potatoes, peas, dry beans, alfalfa, and snap beans. Also can be applied after October 15, before freeze or snow. MOA: Thiocarbamate (in WSSA Group 8) – Inhibits key enzyme in fatty acid synthesis.	Must be incorporated into soil prior to planting by disking, applied with subsurface injection equipment, or metered into irrigation water (highly volatile). Maximum single application of 4.6 lb a.i./acre.	6 days; primary soil and water degradates are EPTC-sulfoxide and dipropylamine.

Table 4–5. (continued)

Active Ingredient (CAS number) [Formulated Product] References[1]	Use for Conventional Sugar Beet Production; Type of Herbicide – Mechanism of Action (MOA) on Target Weeds	Application Methods. Amounts and Frequency[2]	Half-life;[3] Toxic Degradation Products (TDP)
Ethofumesate (26225-29-6) [Nortron®] 2007 Revised RED; 2005 RED; EFED Risk Assess.	USE: Preplant and pre-emergent control of annual grasses, dicots, fungi, bacteria, and viruses in sugar beet and cool-season turf grasses. MOA: Thiocarabamate (in WSSA Group 8) – Inhibits key enzyme in fatty acid synthesis.	Soil incorporation for sugar beet. Maximum single application of 3.75 lb a.i./acre.	30 days; two benzofuranyl methanesulfonate metabolites.
Glyphosate (1071-83-6) [Roundup®, several others] EPA-HQ-OPP-2009-0361; EPA OPP EFED 2009; Tu et al., 2001	USE: Non-selective systemic herbicide to control both monocot and dicot weeds for a wide variety of agricultural crops and in silviculture and weed control along transportation routes and utility corridors. For agriculture, used preplant any time prior to crop emergence; postemergence foliar application on GT varieties. MOA: Phosphanoglycine herbicide (WSSA Group 9) – Inhibits the enzyme EPSPS synthase in the shikimate pathway essential for biosynthesis of aromatic amino acids in algae, higher plants, bacteria, and fungi. Vertebrate animals obtain those amino acids from their diet.	Broadcast or banded preplant; broadcast or banded postemergence only on GT crops or by direct application to soil between rows of conventional varieties. Maximum single application to sugar beet assumed to be 4.5 lb a.i./acre preemergence for conventional sugar beet and 3.0 lb a.i./acre preemergence for H7-1 sugar beet. H7-1 sugar beet also can receive 1.37 lb a.i./acre postemergence to 8-leaf stage, 0.94 lb a.i./acre later up to a total maximum of 7.32 lb a.i./acre/yr.	47 days; primary microbial degradate in environment AMPA; AMPA appears to be less toxic than parent compound through acute ecotoxicity studies on birds, fish, and freshwater invertebrates.
Phenmedipham (13684-63-4) [Spin Aid®] 2005 RED	USE: Postemergence broadleaf herbicide for foliar application to weeds; 98% of amount used annually is on sugar beet, primarily in North Dakota and Minnesota. MOA: Carbamate (in WSSA Group 5) – Photosynthesis inhibitor	Broadcast or spray when no water present. Maximum single application of 0.63 lb a.i./acre.	30 days; primary degradate is MHPC.

Table 4–5. (continued)

Active Ingredient (CAS number) [Formulated Product] References[1]	Use for Conventional Sugar Beet Production; Type of Herbicide – Mechanism of Action (MOA) on Target Weeds	Application Methods. Amounts and Frequency[2]	Half-life;[3] Toxic Degradation Products (TDP)
Pyrazon (1698-60-8) [Pyramin®] 2005 RED; CHP 2/85	USE: Pre- and early-postemergence control for annual broadleaf weeds (e.g., mustard, ragweed) in beet fields only (i.e., 100% of use is on sugar beet fields). MOA: Substituted pyridazinone herbicide (in WSSA Group 5) – photosynthesis inhibitor. Beet have ability to transform parent compound to less toxic metabolites in the leaves.	Broadcast or banded, with moisture present. Preemergence maximum single application of 7.3 lb a.i./acre.	21 days; primary degradate in soil = dephenylated pyrazon “Metabolite B-1.”
Quizalofop-p-ethyl (100646-51-3) [Assure® II] EPA-HQ-OPP-2007-1089	USE: Postemergence application to control annual and perennial grass weeds in a small number of broadleaf crops. MOA: Aryl-oxy-phenoxy herbicide (in WSSA Group 1) – complex action with inhibition of ACCase and essential amino acid and lipid biosynthesis as well as inhibition of mitosis.	Broadcast or microrate. Maximum single application of 0.0825 lb a.i./acre.	Parent compound 1 day; degradate quizalofop acid half-life of 216 days, very persistent.
Sethoxydim (71441-80-0, 74051-80-2) [Poast®] 2005 RED	USE: Postemergence control of annual and perennial grasses in a large number of broadleaf crops. MOA: Cyclohexenone herbicide (in WSSA Group 1) – inhibits ACCase enzyme, which is key in lipid biosynthesis; grass species ACCase more sensitive than dicots.	Broadcast, banded, or microrate applications. Maximum single application of 0.47 lb a.i./acre.	5 days; sulfoxide and sulfone, which have longer half lives.
Trifluralin (1582-09-8) [Treflan® HFP] 1996 RED; Health Canada 1999 Regulatory Note REG 99-03	USE: Preemergence application for control of annual grasses and certain broadleaf weeds primarily in soybean and cotton, but also approved for other crops. MOA: Dinitroaniline herbicide (in WSSA Group 3) – Inhibits mitosis and cell division, stops growth.	Broadcast, banded, lay-by (does not need irrigation to activate), or via irrigation. Maximum single application of 0.75 lb a.i./acre.	60 days; degradation products in soil primarily trifluoromethyl; also some benzene-1,2-diamine.

Table 4–5. (continued)

Active Ingredient (CAS number) [Formulated Product] References[1]	Use for Conventional Sugar Beet Production; Type of Herbicide – Mechanism of Action (MOA) on Target Weeds	Application Methods. Amounts and Frequency[2]	Half-life;[3] Toxic Degradation Products (TDP)
Triflusulfuron-methyl (126535-15-7) [Pinnacle®, Upbeet®] EPA-HQ-OPP-2002-0082	USE: Postemergence selective herbicide for several annual broadleaf weeds (e.g., kochia, redroot pigweed, common lambsquarters, nightshades, and mustards). MOA: Sulfonylurea herbicide (in WSSA Group 2) – Inhibits ALS enzyme, thereby inhibiting amino acid synthesis.	Broadcast, banded, or microrate (with Betamix® or Progress®). Maximum single application of 0.032 lb a.i./acre.	6 days; major soil degradation products triazine amine, methyl saccharin, NDM-DPX-66037, and NFM-triazine amine.

Sources: U.S. Environmental Protection Agency (EPA) Office of Pesticide Programs (OPP) Reregistration Eligibility Decision (RED) documents and associated ecological risk assessment documents included in online herbicide dockets named in the first column. Additional references cited in first column.

1 Sources: Identified in first column.

2 Data from tables 3–14 and 3–11.

3 Sources for half-life values: USDA NRCS, 2011c. Note that degradation/dissipation rates due to photolysis, hydrolysis, biodegradation, and other loss processes in the field depend on many factors, including sunlight, microbial communities in soils, soil texture and moisture, soil pH, and others.

Abbreviations: MOA = Mechanism of action, TDP = Toxic degradation products, ACCase = acetyl-CoA carboxylase (enzyme), WSSA =Weed Science Society of America, RED = Registration or Reregistration Eligibility Decision, CHP = CHP = Cornell University Herbicide Profile (http://pmep.cce.cornell.edu/profiles), 3HC = cis-+trans-3-hydroxycycloate, 4HC = cis+trans-4-hydroxycycloate, TEP = typical end-use product or formulation, MHPC = N-(3-hydroxylphenyl)-methylcarbamate, EFED = Environmental Fate and Effects Division (EPA/OPP), EPSPS = 5-enolpyruvylshikimate 3-phosphate (enzyme), AMPA = Amino methyl phosphonic acid, Some farmers might allow H7-1 fields to lie fallow for a year or two while waiting for appropriate conventional sugar beet varietal development. Some sugar beet growers have found that incorporating a fallow year into crop rotations in sugar beet fields can improve the productivity of sugar beet in the year following (Cattanach et al., 1991). Where farmers opt to include one (or more) fallow years, a temporary shortage of livestock feed from sugar beet root crop byproducts might occur, and farmers reliant on those feeds would have to supplement their livestock feed from other sources. In the longer term, if farmers returned to producing conventional sugar beet, availability of beet tops, pulp, and molasses could return to 2005 levels of availability for animal feed. Under Alternative 1, almost all (if not all) of the sugar beet product fed to livestock would come from conventional sugar beet. As discussed in more detail under Alternative 2 below, several studies have shown that the composition and nutritional quality of H7-1 sugar beet is similar to conventional sugar beet plants with the exception of the presence of the EPSPS enzyme. Also as discussed under Alternative 2 below, feeding trials designed to identify adverse effects of feed products from H7-1 sugar beet (e.g., nutritional deficits or toxic compounds) did not detect adverse effects.

In summary, no long-term impacts on livestock are anticipated under Alternative 1. The availability and quality of sugar beet root crop byproducts for livestock feed over the long run would be comparable with pre-2005 conditions. Some short-term shortages of sugar beet tops and pulp might occur where farmers choose to leave fields fallow for a few years.

(2) Alternative 2 – Full Deregulation

Alternative 2 would avoid any potential short-term shortage of sugar beet byproduct for livestock feed. Farmers could grow either conventional or H7-1 sugar beet varieties. It is anticipated that most farmers will choose H7-1 sugar beet based on the widescale adoption during the past three years. This EIS assumes close to 100% of sugar beet crops will be H7-1.

To evaluate the potential for impacts on livestock from Alternative 2, APHIS assessed whether any nutritional differences exist between livestock feed products from H7-1 sugar beet and conventional sugar beet. Such differences might result from either unintended nutritional changes associated with the H7-1 gene event in sugar beet or from possible adverse effects of the gene product itself. APHIS considered the assessments conducted by the U.S. Food and Drug Administration (FDA), EPA, the European Food Safety Authority (EFSA), and the Canadian Food Inspection Agency (CFIA).

FDA published a policy in 1992 on foods derived from new plant varieties, including those derived from biotechnology (U.S. FDA, 1992). FDA's policy requires that foods produced using biotechnology meet the same rigorous safety standards as is required of all other foods. The FDA completed a consultation on H7-1 sugar beet with a memorandum dated August 7, 2004, and a response letter to the developer dated August 17, 2004 (U.S. FDA, 2004). FDA stated, “The notifiers conclude that glyphosate-tolerant sugar beet event H7-1 is not materially different in composition, food and feed safety, or other relevant parameters from sugar beet now grown, marketed, and consumed. At this time, based on the notifiers’ data and information, the agency considers the notifiers’ consultation on glyphosate-tolerant sugar beet H7-1 to be complete.” In summary, as part of its consultation regarding H7-1 sugar beet FDA concluded that the Agency had no questions about the developer's determination that H7-1 sugar beet is not materially different in composition, food and feed safety, or other relevant parameters from conventional sugar beet (U.S. FDA, 2004).

EPA sets tolerances to ensure food safety. A tolerance is the maximum amount of pesticide that EPA determines is allowable in or on foods. Pesticides in foods above the tolerance level are unlawful. The CP4 EPSPS protein present in H7-1 sugar beet is also present in other crops that have been evaluated by EPA. On August 2, 1996, EPA granted a tolerance exemption for the CP4 EPSPS protein in all raw agricultural commodities (U.S. EPA 1996a). This regulation eliminates the need to establish a maximum permissible level for the EPSPS protein in any agricultural commodity based on the lack of toxicity of the protein,

In Europe, EFSA’s Scientific Panel on Genetically Modified Organisms (GMO) compared the reported safety and nutritional value of H7-1 sugar beet with conventional sugar beet (EFSA, 2006). The Scientific Panel concluded that “products from sugar beet H7-1 are safe as food and feed, and, that the nutritional value of the sugar beet H7-1 and the derived sugar beet products is comparable to that of analogous products from conventional sugar beet.” (Hartnell et al., 2005)reported a similar finding. In response to EFSA information requests, Monsanto/KWS SAAT AG conducted a 90-day dietary study providing processed pulp as feed to rats and found no indication of any adverse effects. Monsanto/KWS SAAT AG’s assessment of H7-1 sugar beet and non-genetically engineered sugar beet suggested no difference in the composition and nutritional quality of H7-1 sugar beet compared with conventional sugar beet, apart from the presence of the EPSPS enzyme (Monsanto and KWS SAAT AG, 2004). The EFSA GMO Scientific Panel reported on additional studies of feeding sugar beet pulp to sheep that similarly indicated no adverse effects (EFSA, 2006).

The CFIA approved H7-1 sugar beet for livestock feed in 2005. As summarized in Decision Document DD2005-54, the CFIA “determined that this plant with a novel trait (PNT) and novel feed does not present altered environmental risk nor does it present livestock feed safety concerns when compared to currently commercialized sugar beet varieties in Canada" (CFIA, 2005).

The EPSPS enzyme that confers glyphosate tolerance is from the bacterium *Agrobacterium* sp. strain CP4. The gene that produces this protein is similar to the gene that is normally present in sugar beet and is not known to have any toxic property. Schneider and Strittmatter (Monsanto and KWS SAAT AG, 2004) considered the environmental consequences of the introduction of H7-1 sugar beet and concluded there is no reason to believe that the H7-1 plant would harm non-target animals because, among other reasons, the EPSPS family of proteins, and specifically CP4 EPSPS as produced in several glyphosate-tolerant crops (corn, soybean, canola, cotton, and sugar beet), has been shown to be comparable to the EPSPS proteins present in other food crops and common microbes. An acute toxicity study was conducted in mice where the mice were dosed by gavage with up to 572 mg/kg of CP4EPSPS and no adverse events were observed at any dose level. Furthermore, the amino acid sequence of the CP4 EPSPS protein was compared to protein sequences in the ALLPEPTIDES data base and no biologically relevant sequence similarities were observed between CP4 EPSPS and known toxins. The high specificity of the enzyme for its substrates makes it unlikely that the introduced enzyme would metabolize endogenous substrates (i.e., non-target substrates within plants or animals) to produce compounds toxic to other organisms, including livestock. Based on the lack of known toxicity for this enzyme, the absence of sequence similarity to known toxins, and the high enzyme substrate specificity, the potential for adverse effects in livestock feed is low. The potential for the CP4 EPSPS protein to be a food allergen is discussed further in section III.F.1.a.(5).

In summary, as part of its consultation regarding H7-1 sugar beet FDA concluded that the Agency had no questions about the developer's determination that H7-1 sugar beet is not materially different in composition, food and feed safety, or other relevant parameters from conventional sugar beet (U.S. FDA, 2004). Also, EFSA's GMO Panel concluded that "products from sugar beet H7-1 are safe as food and feed, and, that the nutritional value of the sugar beet H7-1 and the derived sugar beet products is comparable to that of analogous products from conventional sugar beet" (EFSA, 2006). Furthermore, the CFIA approved H7-1 sugar beet for livestock feed in 2005, because it determined that H7-1 sugar beet do not present altered environmental risk or livestock feed safety concerns compared with conventional sugar beet.

Under Alternative 2, no adverse effects on livestock are expected from feeding of H7-1 sugar beet tops, pulp, and molasses compared with conventional sugar beet, as discussed above. In contrast to Alternative 1, no short-term sugar beet byproduct shortages are expected under Alternative 2.

(3) Alternative 3 – Partial Deregulation

Under Alternative 3, farmers would have increased costs associated with growing H7-1 sugar beet which may lead to a decreased adoption rate compared with Alternative 2. Some of the sugar beet products fed to livestock under this alternative could come from H7-1 varieties.

As discussed above for Alternative 2, regardless of whether the food products are H7-1 or conventional sugar beet, there would not be any impact to livestock since both products have been determined to be safe for food and feed and nutritionally equivalent. Also under Alternative 3, no short-term shortages of sugar beet byproducts for livestock feed are anticipated.

b. Mammals

For each alternative, APHIS analyzed the potential effects on mammalian wildlife from (1) exposure to the H7-1 gene product, (2) herbicide use, and (3) crop management practices such as tillage. Agricultural production practices prevent wildlife from consuming crops where possible.

(1) Alternative 1 – No Action

Impacts on Mammals from Exposure to the H7-1 Gene Product. If mammalian wildlife consumed H7-1 sugar beet plant parts (seeds, leaves, stems, or roots) in permitted fields, no adverse effects from consumption are expected because event H7-1 sugar beet is not materially different in composition, food and feed safety, or other relevant parameters from conventional sugar beet. Similarly, the replacement of H7-1 sugar beet with conventional sugar beet under Alternative 1 is not expected to change the quality of animal browse.

Impacts on Mammals from Herbicide Use. Under Alternative 1, H7-1 sugar beet would be replaced with conventional varieties, resulting in greater use of nonglyphosate herbicides. The amount of glyphosate used on conventional sugar beet in 2011 would probably decline about seven fold compared to what is used on H7-1 sugar beet and use of non-glyphosate herbicides would increase more than 10 fold (Table 3-17). Furthermore, non-glyphosate herbicides would be applied more frequently.

Small mammals, including voles, mice, and shrews, which might use sugar beet fields for transit between habitats (e.g., migration, dispersal), could be exposed to herbicides in-field as they are applied. For small mammals, like shrews, that feed on soil-dwelling insects (e.g., grubs), substantial time might be spent in-field under cover of the beet top canopy, increasing the possibility of an in-field exposure or exposure to residues on insects that might remain for some days. Mice typically feed on seeds and therefore would not likely be found in sugar beet root crop fields. However, there may be mice in the limited locations where sugar beet seed crop is grown.

Larger mammals (e.g., deer) might pass through beet fields during foraging or migration travels. Herbivorous mammals (e.g., deer, rabbits) might attempt to forage on beet tops during the growing season, although farmers would try to minimize that possibility. Mammals also could be exposed to herbicides in the immediate vicinity of sugar beet fields from aerial drift during applications or from runoff to small water bodies, particularly soon after rain storms, but those exposure levels should be lower than in-field exposures. .

Table 4-6 displays some mammalian (primarily tested on rats) toxicity parameters for the herbicides commonly used on sugar beet. The comparisons are all made on the technical grade active ingredient (TGAI) or the technical grade acid equivalent (TGAE). Most herbicides are formulated with other ingredients to improve their effectiveness. The formulated product is called the typical end-use product (TEP). APHIS did not think it was meaningful to compare the typical end-use products for the sugar beet herbicides for two reasons. First, APHIS was unable to find toxicity data for most of the TEPs. In some cases, a formulated product is more toxic than the technical grade active ingredient. This is likely to be true when the active ingredient is practically non-toxic. Therefore,it is not valid to compare toxicity data of the TEP of one herbicide with the TGAI/TGAE of another. Second, the formulations are proprietary introducing an additional unknown into the comparison. For these two reasons, APHIS compared the toxicity of the known active ingredients in the herbicides.

In Table 4-6, the first column lists the LD_{50}, the dose of the herbicide that kills half the members of a test population. EPA describes a substance as very highly toxic when the LD50 is <10 mg/kg. It is rated highly toxic when the LD_{50} is 10-50 mg/kg, moderately toxic when 51-500 mg/kg, slightly toxic when 501-2,000 mg/kg, and practically non- toxic when >2,000 mg/kg. As shown in Table 4-6, most of the herbicides are in the practically non- toxic category with respect to mammals. Clethodim, quizalofop-p-ethyl, and sethoxydim are all considered to be slightly toxic.

In cases where acute toxicity can be measured, chronic studies are also performed where animals are exposed to lower doses of the herbicide for months to years. In chronic studies two additional parameters are often reported. NOAEL, the no observed adverse effect level is the highest dosage at which chronic exposure to the substance shows no adverse effects. LOAEL, the lowest observed adverse effect level, is the lowest dosage at which chronic exposure to the substance shows adverse effects. Table 4-6 also reports the mammalian NOAEL/LOAEL values for the thirteen herbicides. The lower the value, the greater the risk to wildlife. Values range from a low of <1 for trifluralin to a high of 500 for glyphosate and phenmediphan.

For this EIS, a quantitative comparison of the relative toxicity and relative risks of the 13 herbicides used on sugar beet is presented in Table 4–7 below. The toxicity of the nonglyphosate herbicides are normalized to the toxicity of glyphosate TGAI to estimate their toxicity relative to glyphosate in the second column. For example, EPTC has an acute LD_{50} value approximately 6.4 times lower than the value for glyphosate a.i., and so could be considered to be 6.4 times more toxic than glyphosate to mammals, with the caveat that only rats have been tested. The glyphosate LD_{50} was estimated to be *greater than* 5,586 mg a.i./kg body weight; how much higher is not known because higher doses were not tested. Thus, EPTC is *at least*, and possibly more than, 6.4 times more toxic than glyphosate. The relative toxicity values are listed in column (A).

As shown in Table 4–7 , for an acute exposure, the a.i. clethodim, EPTC, and quizalofop-p-ethyl are 4.3, 6.4, and 6.7 times more toxic, respectively, to mammals than glyphosate. Pyrazon and sethoxydim are 2.7 and 2.19 times more acutely toxic to mammals, respectively.

Table IV-6. Toxicity Values and EPA OPP Toxicity Category of Herbicides for Mammalian Wildlife [1]

Active Ingredient	Lowest Toxicity Value: Acute LD_{50} (mg a.i./kg bw)[2]	Lowest Toxicity Value: Chronic NOAEL/LOAEL (mg a.i./kg-bw day)	EPA OPP Acute Toxicity Category	Chronic Endpoints
Clethodim	1,360	25[3] / NL	Slightly toxic	No reproductive effects up to 2,500 ppm in diet
Clopyralid	4,300	ND / 50	Practically nontoxic	Developmental: skeletal abnormalities in rabbits
Cycloate	>2,150	50/400	Practically nontoxic	Reproduction
Desmedipham	>5,000	5.4/20	Practically nontoxic	Blood effects/hemolytic anemia
EPTC	916	50 / NL	Slightly toxic	ND
Ethofumesate TGAI	>6,400	>50 / 250[3]	Practically nontoxic	Decreased pup weight
Glyphosate TGAE	>4,800	500 / 1,500	Practically nontoxic	Reduced reproduction
Phenmedipham	>8,000	500 / ND	Practically nontoxic	2-generation study
Pyrazon TGAI	2,140	10 / 50	Practically nontoxic	Reduced maternal body weight
Quizalofop-p-ethyl	878	5 / NL	Slightly toxic	Decreased pup weight
Sethoxydim TGAI	2,676	30 / 150	Practically nontoxic	2-generation study, malformations in pups
Trifluralin	>5,000	0.75/3.75	Practically nontoxic	Increased liver weight
Triflusulfuron-methyl	>5,000	6/130	Practically nontoxic	Decreased body weigh gain

Sources: EPA OPP RED documents and EPA OPP Ecological Fate and Effects Division (EFED) ecological risk assessment documents available from the herbicide dockets.

[1] Categories of acute toxicity to terrestrial birds and mammals from EPA's Office of Pesticide Programs: LD_{50} (mg/kg bw-day): <10 very highly toxic; 10-50 highly toxic; 51-500 moderately toxic; 501-2,000 slightly toxic; >2,000 practically non-toxic.

[2] Unless otherwise noted in row header as acid equivalents (AE or a.e.).

[3] Converted from ppm in diet assuming rats consume 5 percent of their body weight daily.

[4] In this table, glyphosate toxicity values are reported using the units as initially reported, in mg acid equivalent (a.e.)/kg body weight. The active ingredient (a.i.) equivalent would be approximately 1.22 times greater.

Abbreviations: EPA OPP= Environmental Protection Agency Office of Pesticide Programs; LD_{50}= dose required to kill half the members of a test population; LOAEL=Lowest Observed Adverse Effect Level; NOAEL=No Observed Adverse Effect Level; NR = Test not required because of low acute toxicity; ND = no data; NL = not listed; might be unbound NOAEL; TGAI = technical grade active ingredient; TGAE = technical grade acid equivalent.

Table IV-7. Relative Risk of Herbicides to Mammalian Wildlife for Herbicides Used on Sugar Beet [1]

Herbicide	Acute Oral Toxicity		Maximum Single Application Rate		Relative[5] Risk (RR) = (A) x (B)
	LD_{50}[1] (mg a.i./kg bw)	(A)[2] Relative to Glyphosate TGAI	Rate[3] (lb a.i./ acre/ app)	(B)[4] Relative to Glyphosate TGAI	
Clethodim	1,360	**4.31**	0.25	0.056	0.239
Clopyralid	4,300	**1.36**	0.33	0.073	0.100
Cycloate	>2,150	>2.72	4.0	0.889	>2.42
Desmedipham	>5,000	>1.17	1.28	0.338	>0.333
EPTC	916	**6.39**	4.6	1.02	**6.54**
Ethofumesate	>6,400	>0.92	3.75	0.833	>0.763
Glyphosate AI[6]	>5,856	1.00	4.5	1.000	>1.000
Phenmedipham	>8,000	>0.73	0.63	0.140	>0.102
Pyrazon	2,140	**2.74**	7.3	1.622	**4.439**
Quizalofop-p-ethyl	878	**6.67**	0.0825	0.0183	0.122
Sethoxydim	2,676	**2.19**	0.47	0.104	0.229
Trifluralin	>5,000	>1.17	0.75	0.167	>0.195
Triflusulfuron-methyl	>5,000	>1.17	0.032	0.00711	>0.00833
TOTAL					

Sources: Identified in endnotes for column headers.

[1] Toxicity values from Table 4–6. Where greater than sign (>) precedes the value, the LD_{50} value was higher than the listed value, either because a smaller proportion of animals died (e.g., 30%) at the highest dose tested or because no excess mortality was observed at the highest dose tested. (EPA generally only requires testing up to approximately 5,000 mg a.i./kg animal body weight.)

[2] Column (A): Acute oral toxicity relative to glyphosate, calculated as (1/herbicide LD_{50}) / (1/glyphosate LD_{50}). Numbers bolded are relative toxicity values for which a definitive LD_{50} was determined for the nonglyphosate herbicide. For the remaining herbicides and glyphosate, LD_{50} values were not reached at the doses tested, and so the number reflects doses tested, not relative toxicity.

[3] Maximum rate allowed for a single application of the herbicide in pounds of active ingredient (a.i.) per acre for that application.

[4] Column (B): Maximum single application rate relative to (divided by) the maximum single application rate for glyphosate TGAI applied preemergence.

[5] Relative risk (RR) = relative toxicity in column (A) multiplied by relative acute exposure in column (B). Values in bold are for herbicides that show higher RR values than glyphosate a.i. to mammals based on a definitive LD_{50} value (not a > value) for that herbicide.

[6] Toxicity values for glyphosate were converted from mg acid equivalents (a.e.) presented in Table 4–6 to mg a.i. – glyphosate a.i., for the salts of glyphosate most commonly applied, = a.e. x 1.22

Abbreviations: "–" = blank cell (value is either pre or postemergence, not both). LD_{50} = lethal dose for 50% of animals in a toxicity test. ND = no data. NR = not relevant because glyphosate pre and postemergence are in two different rows. NC = not calculated because row is for a formulation, not the active ingredient alone. TGAI = technical grade active ingredient or test materials close to that (e.g., >98% a.i.). PRE = preemergence. POST = postemergence. a.i. = active ingredient. RR-WTQI = relative-risk weighted total quantity index. mg/kg bw = mg chemical/kg animal body weight. lb a.i./acre/app = pounds of active ingredient per acre per single application.

To estimate relative risk (RR), relative exposure values are also needed for the herbicides. The highest concentrations of herbicides in the environment should occur during and shortly after herbicide application events. To compare risks of acute toxicity to mammals among the herbicides, an exposure metric is needed. Either the typical herbicide application rate (i.e., rates actually used as summarized in section III.B.1.f. from data compiled by the National Agriculture Statistics Service in its Agricultural Chemical Use Database) or the maximum allowed single application rate could serve as the metric for exposure. Actual use rates might change (e.g., increase) over time with changes in climate, increases in herbicide-resistant weeds, and other factors. The maximum single application rate is the upper bound on what EPA allows. The maximum single application also represents the "worst-case" scenario for all of the herbicides. For those reasons, the maximum allowed single application rate is the metric used to represent relative acute exposures among the herbicides. The maximum single application rates relative to (normalized to) glyphosate are listed in column (B) in Table 4–7.

Relative risk (RR) is the product of relative toxicity value (A) and the relative maximum single application rate value (B). For glyphosate technical grade a.i. (TGAI), relative toxicity, relative application rate, and RR equal 1.0, because glyphosate a.i. is the herbicide to which toxicity and exposure values were normalized for the remaining herbicides. With a maximum single application rate similar to that of glyphosate, the risk relative to glyphosate (RR) calculated for EPTC, for example, is 6.5 times higher. Values in the RR column in bold are those that are higher than glyphosate and those for which an LD_{50} could be calculated for the herbicide (i.e., mortality at the highest dose tested exceeded 50 percent, and so the LD_{50} is not indicated as a "greater than" value). Note that a significant assumption for glyphosate in the RR analysis is that the maximum single application allowed (4.5 lb a.i./acre) equals the total allowed for all preemergence applications. It is more likely that farmers would use two or more applications (with less glyphosate in each) a week or two apart to catch weeds emerging at different times. In that case, the relative risk is over estimated by this assumption. Based on this analysis, EPTC and pyrazon have the potential to be more toxic to mammals than glyphosate.

In evaluating some of the herbicides, EPA has estimated the environmental concentration (EEC) on food sources or in water. From the estimated environmental concentration (EEC), an acute risk quotient (acute RQ) or a chronic risk quotient (chronic RQ) is calculated by dividing the EEC by an acute toxicity measure (such as LD50 or LC 50) or a chronic toxicity measure (such as NOAEL) listed in Table 4-6. For mammals, if the acute RQ > 0.5, EPA presumes there is a potential acute risk (U.S. EPA 2004) If the acute RQ > 0.2, EPA presumes there is a potential risk that may be mitigated through restricted use. If the chronic

RQ > 1, the EPA presumes that potential chronic effects may occur in mammals. Table 4–8 lists EPA-estimated risk quotients (RQs), both acute and chronic, for mammals adjacent to crop fields to which the herbicide is applied according to the scenarios listed in the first data column. For example, a single application of cycloate of 4 lb. ai./acre results in an estimated environmental concentration of 960 ppm on grass, 540 ppm on broadleaf plants, and 60 ppm on seeds. As cycloate is practically non toxic for mammals (Table 4-6), an LD50 endpoint was not determined and so no acute RQ value was calculated. However the dosage for no observed adverse effect (NOAEL) for effects on reproduction was determined and a chronic RQ was calculated. Depending on the food source, the chronic RQ was estimated to range from 1.2 to 19.2; thus a potential chronic risk exists for mammals in or near cycloate treated fields. Examining the other herbicides, EPTC is the only sugar beet herbicide that poses a potential acute risk for mammals. The potential acute risk is overestimated for sugar beet because the maximum rate allowed on sugar beet, 4.6 lb. a.i/acre. is less than the rate used for this calculation (6.1 lb.a.i./acre). In addition to cycloate, glyphosate, and quizalofop-p-ethyl pose a potential chronic risk depending on the dosage. For glyphosate, the RQ did not pose risks of concern for application rates of 1.55 lb a.e/acre or 1.89 lb a.i./acre or less.

From the data in Table 4–8, EPTC might pose acute risks to individual mammals in or adjacent to conventional sugar beet crops when used within label limits. Similarly EPTC and cycloate pose potential sublethal or chronic effects to individual mammals in or adjacent to conventional sugar beet crops. Both herbicides are used pre-emergence so there is more risk to mammals from this use. Herbicides could also cause indirect effects due to depletion of prey for birds and reptiles that might feed on small mammals. In areas where natural areas abut agricultural land used to raise sugar beet, there is a possibility that runoff or drift from lands treated with EPTC, and cycloate may reduce the numbers of mammals in that area and animals that feed off mammals, such as birds and reptiles, will not have access to that resource in that very localized area.

Impacts on Mammals from Crop Management Practices. Under Alternative 1, for those agricultural lands that would no longer be allowed to grow H7-1 sugar beet, farmers could allow the land to become fallow (unplanted) for a few years until local varieties of conventional sugar beet are available, plant an immediately available variety of conventional sugar beet, plant other agricultural crops (e.g., a crop used in rotation with sugar beet), or use the land for other purposes. Growers would be unlikely to adopt a different crop over the long term because sugar beet is usually the most profitable crop in the rotation and because most

Table IV-8. EPA Estimated Environmental Concentrations (EECs) of Herbicide Residues and Risk Quotients (RQs) for Mammalian Wildlife from Exposures Following Herbicide Applications[1]

Herbicide	Scenario (lb a.i./acre)	Max EEC short grass (ppm)	Max EEC tall grass (ppm)	Max EEC broadleaf forage, small insects (ppm)	Max EEC fruit, pods, seeds, lrg insects (ppm)	Acute EEC (ppm)	Chronic EEC (ppm)	Acute Risk Quotient (RQ)	Chronic Risk Quotient (RQ)
Clethodim	2 x 0.25	105	48.34	59.33	6.59	105	105	<0.1	<0.1
Clopyralid	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cycloate	1 x 4	960	ND	540 (broadleaf) 440 (insects)	60 (seeds)	ND	ND	NC	**1.2–19.2**
Desmedipham	2 x 0.98	348	≈162	194 (insects)	21.7 (seeds)	ND	ND	<0.00070–<0.043	NC
EPTC [2]	1x 6.1 1 x 3	1,464 720	671 330	823 405	9 45	91–1,464 45-720	ND	0.6 (granular) <0.1–**1.5** (spray) 0.3 (granular) <0.1-0.7 (spray)	ND
Ethofumesate	1 x 3.75	900	413	506	56.3	ND	ND	<<0.01–<0.13	<<0.01–<0.27
Glyphosate[3]	1 x 4.5	900	413	506	56.3	ND	ND	<0.01–<0.08	0.01–**2.23** (dose-based)
Phenmedipham[4]	1 x 0.975	ND	ND	ND	ND	ND	234	NC	0.47
Pyrazon	1 x 7.3	1,754	804	987	109.7	ND	ND	0.00–0.35 (dose-based)	0.43–**75.83** (dose-based)
Quizalofop-p-ethyl	1 x 0.17	40.8	18.7	23.0	2.55	ND	ND	<<0.01–0.02	0.02–**3.54**
Sethoxydim	2 x 0.47	240	110	135	15	ND	ND	NC	0.5
Trifluralin	1 x 2	480	ND	250 (fruit/veg leaves) 116 (legumes, insects)	24 (seeds) 14 (fruits)	ND	ND	0.002–0.15	ND
Triflusulfuron-methyl	1 x 0.03	ND	ND	ND	ND	25.22	ND	0.143–0.252	ND

Sources: EPA Registration or Reregistration Eligibility Documents (REDs), EPA OPP EFED ecological risk assessment documents in EPA docket online, and other sources.

[1] EPA-estimated EECs on four mammalian food types or unspecified food type (labeled acute and chronic EEC).

[2] Postemergence applications are a maximum of 3.0 lb a.i./acre; however, fall treatment applications are a maximum of 4.6 lb a.i./acre. Therefore, 6.1 lb a.i./acre is an overestimation while 3 lb a.i./acre may be an underestimation.

[3] Scenario single application rate lower than maximum single application assumed for conventional sugar beet preemergence application but higher than maximum single application assumed for H7-1 sugar beet preemergence.

[4] Maximum rate for sugar beet is actually 1.012 lbs a.i./acre, but this rate not assessed.

Abbreviations: EEC = estimated environmental concentration (herbicide residue) on indicated plant and animal groups. lb a.i./acre = pounds active ingredient/acre. lrg = large. ND = no data. NC = not calculated (when toxicity data indicated that the RQs would be far below any level of concern, EPA did not calculate the quotient). ppm = parts per million or mg/kg diet. RQ = risk quotient (EEC/toxicity value).

growers are shareholders that have a mandatory supply relationship growers with sugar beet processing facilities. Changes in land use are not expected because the land is likely to remain agricultural for crop production (see Table 3–6 in section III.B.1.c(4) for a list of rotational crops). Available data indicate that the amount of U.S. sugar beet crop area has remained approximately the same since 2005 (see Table 3–5). Therefore, the potential impacts of using the land for other purposes were not analyzed for this EIS.

Several factors could influence growers' decisions if and when to begin growing conventional sugar beet, including availability of herbicides, availability and cost of specialty cultivating equipment, availability of desirable varieties of sugar beet, and the potential penalty or lost ownership shares in the cooperative for not growing sugar beet. APHIS assessed the potential impacts on mammals from either (1) farmers allowing the land to go fallow for a few years or (2) farmers immediately planting conventional sugar beet (or another rotational crop).

Farmers are not likely to allow the land to go fallow for long for the reasons described above. APHIS assessed potential short-term impacts of allowing the land to go fallow for a few years to improve the yield of sugar beet once planted. Some farmers have found that incorporating a fallow year into crop rotations in sugar beet fields can improve the productivity of sugar beet in the year following (Cattanach et al., 1991). If a farmer allows the land to become fallow and continues to plow the land in spring and fall to prevent establishment of weed populations, the amount of groundcover available for mammalian wildlife (e.g., rabbits, mice, voles, and other small mammals) that use the agricultural field for foraging or transit during the growing season would be reduced (relative to planting sugar beet or another crop). During the nongrowing season, no plant cover would be available because the fall tillage would eliminate free-standing stalks.

Most small mammals would not move into an open field without cover, and those that do would be susceptible to predation (e.g., hawks). The population density of small mammals adjacent to plowed fallow fields might temporarily increase during the growing season due to movement from the fields to surrounding areas. This may increase inter- and intra-specific competition for resources (e.g., soil insects). Where local populations of small mammals are isolated in habitat fragments with few to no effective transit corridors to other populations in other habitats, the smaller populations might crash in numbers. They would likely recover rapidly once normal crop rotations were reestablished.

Where farmers allow fallow land to rest unplowed for a few years, grasses and herbaceous plants could become established. Continual cover of the fields with live or dead tall grasses and associated herbaceous plants stems and leaves would offer year-round cover for small mammals. Such fields also would provide more diversified forage for small insectivorous, gramnivorous (seed-eating), herbivorous, and omnivorous small mammals, and would likely support more diversified and abundant small mammal populations than planted sugar beet or fallow plowed lands. Availability of plant seeds could allow small mammal population increases in the fields. These changes would, however, be short term and last only until the fields are retilled and treated for weed removal and another crop is planted.

If farmers immediately plant conventional sugar beet (or another rotational crop) rather than allowing the land to go fallow, the potential for the short-term impacts discussed above with respect to groundcover would be eliminated or reduced. Vegetation/groundcover would be present during the growing season, but not over the winter, for small mammals for foraging on insects and hiding from predators. Areas that have H7-1 sugar beet will have slightly more vegetation cover since the management practices allow the rows to have narrower spacing. The availability of browse for larger mammals (e.g., rabbits, deer) is not considered under any of the alternatives, because farmers generally take measures to discourage herbivorous wildlife from browsing any parts of growing crops in their fields.

In summary, under Alternative 1, herbicide use patterns would likely return to the patterns characteristic of each growing region before the large scale introduction of H7-1 sugar beet. Acute exposures are possible from EPTC used as a pre-emergence herbicide. Sublethal or chronic effects are possible from pre-emergent use of EPTC , and cycloate.

Over the short-term, allowing fields to remain fallow, yet plowed, in preparation for arrival of conventional sugar beet suited for the location, might result in no vegetative cover year-round for a short time. Small mammals would be unlikely to use such fields for migration or dispersal until crops were again planted and at least summer cover is available. Whatever impacts restricted travel might cause over the short term, no long-term impacts are expected from crop-management practices under Alternative 1.

(2) Alternative 2 – Full Deregulation

As mentioned previously, Alternative 2 would result in the greatest adoption rate of H7-1 sugar beet. In the long term, it is expected that up to 100 percent of the sugar beet crop would be H7-1. Under Alternative 2, the overall acreage under sugar beet production is not expected to change substantially from current levels. Regulation of the U.S. sugar market is likely to keep the contractual requirements for sugar beet roots for sugar production approximately constant.

Impacts on Mammals from Exposure to the H7-1 Gene Product. Exposure of mammalian wildlife to the H7-1 gene product would be greatest under Alternative 2. Mammals would only be exposed to the H7-1 gene product by consumption of H7-1 sugar beet crop material. As discussed in section IV.C.1.a(2), impacts on livestock under Alternative 2, several agencies have concluded that products from H7-1 sugar beet are safe for food and feed, and there are no adverse nutritional or toxicological effects expected for mammals that might consume H7-1 sugar beet plant parts (seeds, leaves, stems, or roots).

Impacts on Mammals from Herbicide Use. Alternative 2 would result in higher amounts of glyphosate-based herbicides used on sugar beet than under Alternative 1 and a large reduction in all non-glyphosate herbicides (see Tables 3-17, 3-18). As a result, Alternative 2 would lead to larger areas over which mammals might be exposed to glyphosate incidentally compared with Alternative 1 but would significantly reduce their exposure to nonglyphosate herbicides including EPTC which could result in acute and chronic effects under Alternative 1 and cycloate which could cause chronic effects to mammals under Alternative 1. Glyphosate is not expected to cause any direct effects on mammals so indirect effects on animals that prey on mammals are similarly not expected.

As discussed under Alternative 1, different groups of mammals could be exposed to herbicides used on sugar beet fields in different ways. In-field exposures could occur at herbicide application for small mammals in a sugar beet field at the time, most likely for small mammals that forage on soil-dwelling insects (e.g., shrews). Mammals transiting through fields when herbicides are applied also would be exposed. A wider variety of mammals might be exposed to herbicides in the immediate vicinity of sugar beet fields from aerial drift during applications or from runoff which may enter small water bodies, particularly soon after rain storms, but those exposure levels should be lower than in-field exposures.

Glyphosate is considered to be a toxicologically and ecologically low-risk herbicide (Cerdeira and Duke, 2006). As noted in Table 4-8, the acute RQ does not pose risks of concern for mammals. The chronic RQ does pose risks of concern for high applications of glyphosate (>3.75 lbs a.e./acre or 4.51 lb/a.i./acre) for food sources consisting of short grasses and broadleaf plants. However glyphosate is not registered for such high application rates on sugar beet. The maximum application rate for post-emergent use of glyphosate on sugar beet is 1.55 lbs a.e/acre (1.89 lbs a.i./acre). At this level of application, the chronic RQ does not pose risks of concern for all food sources for mammals. Under Alternative 2, glyphosate could be applied multiple times to the H7-1 sugar beet, on average 2.5 times per year, with 1.4 applications on postemergence sugar beet plants. Thus, under Alternative 2, the timing and dosage of applications of glyphosate are different than they are under Alternative 1. Under Alternative 2 the applications are more likely to occur when mammals are rearing offspring born in the early spring. However, the dosages are lower and do not pose risks of concern. Therefore, APHIS does not expect glyphosate to result in chronic effects on mammals.

EPTC and cycloate are expected to be used on 6% and 5% of sugar beet acreage, respectively under Alternative 1 (Table 3-14) while under Alternative 2, use of these residual herbicides would be expected to decline. Each of these herbicides poses greater potential chronic risks to mammals than does glyphosate. Therefore, Alternative 2 poses less potential risk to mammals than does Alternative 1.

Impacts on Mammals from Crop Management Practices. As discussed in section III.B.1, growers have increased their use of strip-till with the adoption of H7-1 sugar beetThus, use of conservation tillage, is expected to be higher under Alternative 2 than Alternative 1. Under strip-till systems during the growing season, growers can plant sugar beet closer together than required for tillage-based weed control. Thus, Alternative 2 would allow more extensive sugar beet groundcover earlier in the season and total groundcover from the sugar beet foliage canopy for the latter part of the growing season than Alternative 1. The extended cover offered by growing sugar beet in strip-till systems would facilitate small mammals foraging on ground insects or dispersing or migrating between habitats separated by the sugar beet fields. Availability of browse for larger mammals (e.g., lagomorphs or rabbit, deer) would be slightly higher for H7-1 sugar beet fields than for conventional sugar bee; however, farmers generally take measures to discourage herbivorous wildlife from browsing in their fields.

In summary, exposure to or consumption of H7-1 sugar beet plant materials under Alternative 2 is not expected to impact mammalian wildlife. H7-1 and conventional sugar beet are similar in nutrition and equally nontoxic. Herbicide use patterns would be different under Alternatives 1 and 2. Potential acute and chronic risks to mammals from EPTC and potential chronic risks attributable to cycloate are expected to diminish under Alternative 2. Potential chronic risks from use of glyphosate at high doses as a pre-emergent herbicide would also be diminished under Alternative 2 because glyphosate would be used more frequently and at lower application rates than under Alternative 1.

(3) Alternative 3 – Partial Deregulation

Impacts on Mammals from Exposure to the H7-1 Gene Product. No adverse effects on mammals from exposure to the H7-1 gene product are expected for Alternative 3 as was described for Alternative 2.

Impacts on Mammals from Herbicide Use. Under Alternative 3, the extent of potential impacts on mammals from herbicide use would be very similar to Alternative 2 where glyphosate use would increase and use of non-glyphosate herbicides would substantially decrease except in Imperial Valley where non-glyphosate herbicides would continue to be used. In the Imperial Valley, the two herbicides identified as posing risks of concern for mammals when used as directed, EPTC andcycloate, are not among the non-glyphosate herbicides commonly used (Tables 3-14 and 3-15). Therefore,Alternative 3 is expected to result in a similar reduction, as Alternative 2, of the two herbicides with the greatest potential risk to mammals. Alternative 3 is expected to result in less glyphosate use than Alternative 2 but more use of non-glyphosate herbicides that similarly do pose risks of concern for mammals as described under Alternative 1.

Impacts on Mammals from Crop Management Practices. Under Alternative 3, in those areas where H7-1 sugar beet is grown, the potential impacts on mammals from crop management practices would be similar to Alternative 2. Due to glyphosate use to control weeds, farmers could plant H7-1 sugar beet closer together than if space for tillage were maintained between rows. Thus, areas planted in H7-1 sugar beet would provide earlier and more extensive groundcover for small mammals for foraging on soil-dwelling insects or moving between habitats with some protection from visual predators compared with conventional sugar beet.

In California where H7-1 sugar beet would not be grown, the potential impacts on mammals from crop management practices would be similar to Alternative 1. Thus, there should be no short-term effects likely from growers in those areas allowing land to go fallow during the growing season while waiting for varietal conventional sugar beet suitable for those two areas.

In summary, exposure to or consumption of H7-1 sugar beet plant materials under Alternative 3 is not expected to impact mammalian wildlife. Herbicide use patterns would be very similar under Alternatives 2 and 3. Potential acute and chronic risks to mammals from EPTC and potential chronic risks attributable to cycloate would be diminished under Alternative 3 compared to Alternative 1. Potential chronic risks from use of glyphosate at high doses as a pre-emergent herbicide would also be diminished under Alternative 2 because glyphosate would be used more frequently and at lower application rates than under Alternative 1.

c. Birds and Reptiles

As for mammals, APHIS analyzed the potential impacts of each alternative on birds and reptiles from (1) exposure to the H7-1 gene product, (2) herbicide use, and (3) crop management practices.

(1) Alternative 1 – No Action

Impacts on Birds and Reptiles from Exposure to the H7-1 Gene Product. Under Alternative 1, birds and reptiles would not be likely to be exposed to the H7-1 gene product so no impacts are expected.

Impacts on Birds and Reptiles from Herbicide Use. As discussed previously for mammals, under Alternative 1, there would be a rapid transition to greater use of non-glyphosate herbicides and much less use of glyphosate as H7-1 sugar beet is replaced with conventional sugar beet. Birds and reptiles that might use sugar beet fields as foraging areas and cover could be exposed directly to herbicides at the time of application; however, farmers generally discourage wildlife from using crop fields as feasible. If non-agricultural habitats are adjacent to sugar beet fields, birds and reptiles using those areas for foraging, shelter, cover, and nesting or egg laying could be exposed to herbicides via spray drift or direct inadvertent overspray during herbicide application.

The toxicity of the herbicides used on sugar beet to birds has generally been assessed using mallard ducks and bobwhite quail. As illustrated in Table 4–9, most of the herbicides used on sugar beet is practically nontoxic to birds on an acute basis (i.e., the LD_{50} value was not reached at the highest dose or dietary concentration tested). In addition, the herbicides used on sugar beet are generally in spray liquid aerosols or incorporated into the soil. The form of pesticide products that generally is most toxic to birds are granular particles, which birds consume as they would grit for digestive purposes (Best and Fischer, 1992). For the acute LD_{50} determination, the birds are administered a single bolus of carrier vehicle containing the herbicide and observed for several days following. For the subacute dietary test, the herbicide is mixed homogenously throughout a standard feed, and birds are exposed 5 to 8 days via their feed.

Table 4–9 below lists the acute (LD_{50}), subacute (LC_{50}), and chronic (NOAEC/LOAEC) avian toxicity values, as available, for herbicides commonly used on sugar beet. The subacute LC_{50} is the concentration of the herbicide in the birds' diet in units of ppm a.i. (or mg a.i. per kg diet).

Table IV-9. Toxicity Values and EPA OPP Toxicity Category of Herbicides for Birds[1]

Active Ingredient	Lowest Toxicity Value			EPA OPP Toxicity Category	
	Acute LD_{50} (mg a.i./kg bw)	Subacute Dietary LC_{50} (ppm diet)	Chronic NOAEC/ LOAEC (ppm diet)	Acute Toxicity Category	Subacute Dietary Toxicity Category
Clethodim[2]	>2,000	>4,000	250 / NL	Practically nontoxic	Practically nontoxic
Clopyralid	1,465	ND	ND	Slightly Toxic	ND
Cycloate	>2,150	>5,395	NR	Practically nontoxic	Practically nontoxic
Desmedipham	>2,000	>5,000	90 / 450	Practically nontoxic	Practically nontoxic
EPTC	>2,510	>5,280	ND	Practically nontoxic	Practically nontoxic
Ethofumesate	>3,445	>5,000	3,069 / >3,069	Practically nontoxic	Practically nontoxic
Glyphosate TGAE[5]	>3,196	>4,971	830 / >830	Practically nontoxic	Slightly toxic
Phenmedipham	> HDT	> HCT	>1,200	Practically nontoxic	Practically nontoxic
Pyrazon	>2,000	4,254	ND	Practically nontoxic	Practically nontoxic
Quizalofop-p-ethyl	>2,000	>5,000	500 / 1,000	Practically nontoxic	Practically nontoxic
Sethoxydim	>2,510	>5,620	<100 / 100	Practically nontoxic	Practically nontoxic
Trifluralin	>2,000	>5,000	452 / 910	Practically nontoxic	Practically nontoxic
Triflusulfuron-methyl[4]	>2,250	>1,535 mg/kg-d	ND	Practically nontoxic	Slightly toxic

Sources: EPA OPP RED documents and EPA OPP Ecological Fate and Effects Division (EFED) ecological risk assessment documents available from the herbicide dockets.

[1] Categories of acute toxicity to birds (EPA OPP 2004): LC_{50} (ppm in diet): <50 very highly toxic; 50-500 highly toxic; 501-1,000 moderately toxic; 1,001-5,000 slightly toxic; >5,000 practically non-toxic. LD_{50} (mg/kg bw): <10 very highly toxic; 10-50 highly toxic; 51-500 moderately toxic; 501-2,000 slightly toxic, >5,000 practically nontoxic.

[2] Clethodim reproduction study in table not accepted by EPA OPP as fulfilling guideline; accepted study had NOAEL of >833 ppm diet.

[3] In this table, glyphosate toxicity values are reported using the units as initially reported, in mg acid equivalent (a.e.)/kg body weight. The active ingredient (a.i.) equivalent would be approximately 1.22 times greater.

[4] Triflusulfuron-methyl: No avian toxicity data provided in EPA OPP docket. Data in this table from University of Hertfordshire, 2011d.

Abbreviations: NR = Data not required by EPA OPP because acute toxicity very low; ND = no data identified; > HDT = higher than highest dose tested (not stated), and therefore considered not acutely toxic; > HCT = higher than highest dietary concentration tested (not stated), considered not toxic that results in 50 percent mortality over a 5- to 8-day period of exposure. For glyphosate, a.e. units are used instead of a.i. because the latter includes inert salt materials. The chronic data are expressed as no-observed-adverse-effect concentrations (NOAEC) and lowest-observed-adverse-effect concentrations (LOAEC) in the diet in ppm.

For registration and reregistration of pesticides in general, including herbicides, EPA OPP assumes that birds serve as an adequate surrogate species for reptiles and terrestrial-phase amphibians (U.S. EPA 2011d). Thus, testing the toxicity of herbicides to reptiles generally does not occur.

The NOAEC/LOAEC values generally are assessed for long-term exposures assessing reproductive and developmental toxicity. Table 4–9 also presents the corresponding EPA OPP acute avian toxicity categories for the herbicides. Most of the herbicides in the table are practically nontoxic to birds, although clopyralid is slightly toxic in the acute avian toxicity category and trisulfuron-methyl is slightly toxic in the subacute avian toxicity category. The LD_{50} value for clopyralid is 1,465 mg a.i. per kg body weight. Clopyralid (Stinger®) is one of the most widely used herbicides on sugar beet. Under Alternative 1, it is expected to be used on 74% of acreage used to produce sugar beet (Table 3-14). For the other herbicides tested on birds, an LD_{50} value was not reached at the highest dose tested. EPA OPP generally does not require acute oral tests above 2,000 mg a.i. per kg body weight or above 5,000 ppm in the diet.

With respect to chronic toxicity, generally a long-term reproductive test is used in which the herbicide is mixed in feed and administered at mating through egg-laying and hatching, and subsequent chick morphology and vigor are evaluated. Chronic effects were noted for birds administered three herbicides: desmedipham, trifluralin, and sethoxydim. Birds administered desmedipham and trifluralin exhibited an increased incidence of egg-shell cracking (U.S. EPA 1996c; U.S. EPA 2005e). Sethoxydim is associated with a reduction in the number of eggs laid (U.S. EPA 2005b).

Table 4-10 lists the acute and chronic risk quotients (RQ) for herbicides where determined. As stated in the section on mammals, the risk quotient is based on dividing the estimated environmental concentration by an acute or chronic toxicity value. Three herbicides had RQ values that posed risks of concern and could therefore pose a potential risk to birds and reptiles. These are pyrazon, which has an acute RQ of 1.41 under certain scenarios, sethoxydim, which has a chronic RQ of up to 1.98, and trifluralin, which has a chronic RQ of up to 1.06. These three herbicides are expected to be used on 5-11% of the sugar beet acreage under Alternative 1. Desmedipham, which resulted in egg cracking but is expected to not pose risks of concern based on its RQ, is the most widely used herbicide under Alternative 1 where it is used on 94% of the acreage.

These three herbicides may also result in indirect effects on predators that feed on birds or reptiles. In natural areas that abut sugar beet production fields, runoff or drift into natural areas may reduce populations of birds and reptiles in that local habitat so predators will not have that resource in the local area.

No toxicity data for reptiles are available for the herbicides used on sugar beet. In general, EPA OPP considers toxicity data for birds adequate to serve as surrogate toxicity data for egg-laying reptiles. Because reptiles are cold-blooded instead of warm-blooded, their metabolic rates generally are much lower than that for birds. They therefore consume far less food per unit body weight, and so are expected to experience lower oral exposure overall. Nonetheless, the lack of information on lizards, snakes, and turtles is a large data gap.

Impacts on Birds and Reptiles from Crop Management Practices. As discussed previously, on those agricultural lands that would no longer be allowed to grow H7-1 sugar beet, farmers could allow the land to become fallow (unplanted), plant conventional sugar beet, plant a rotational crop, or use the land for other purposes. If farmers allow the land to go fallow for only a few years and continue to plow the land, the amount of groundcover for reptiles such as snakes and lizards that might use the agricultural field to forage on ground-dwelling insects, to feed on plants, or to transit fields to other habitats would be reduced. Also, allowing the land to go fallow for a few years and continuing to plow the land would temporarily reduce the amount of prey (e.g., small mammals, lizards, snakes, and large insects) available for predatory birds (e.g., hawks and owls). As described for mammals, small animals that are vulnerable to predation from the air in particular tend not to venture very far from cover. Predatory birds that include sugar beet field in their foraging range would have to forage in other nearby vegetative fields or forests until another crop was planted and the prey returns. If farmers do not continue to plow the fallow lands, reversion to more natural habitats (e.g., grasses and herbaceous growth) might provide more diversified foraging habitat for birds and reptiles and possibly year-round cover for small birds. Maintenance of cover for small animals year-round would keep local populations which could provide prey for raptors, although the cover would likely reduce opportunities for raptors to spot

Table IV-10. EPA-Estimated Environmental Concentrations (EECs) of Herbicide Residues and Risk Quotients (RQs) for Avian Wildlife from Exposures Following Herbicide Applications[1]

Herbicide	Scenario (lb a.i./acre)	Max EEC short grass (ppm)	Max EEC tall grass (ppm)	Max EEC broadleaf forage, small insects (ppm)	Max EEC fruit, pods, seeds, large insects(ppm)	Acute EEC (ppm)	Chronic EEC (ppm)	Acute Risk Quotient (RQ)	Chronic Risk Quotient (RQ)
Clethodim	2 x 0.25	105	48.3	59.3	6.59	105	105	<0.1	<1
Clopyralid	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cycloate	1 x 4.0	ND	ND	ND	ND	ND	ND	NC	ND
Desmedipham	2 x 0.98	353	162	198	22.1	ND	ND	<0.0044–<0.071	ND
EPTC[2]	1 x 6.1	1,464	671	823	9	ND	ND	NC	ND
Ethofumesate	1 x 3.75	900	413	506	56.3	ND	ND	<0.01–<0.17	0.02–0.28
Glyphosate[3]	1 x 3.75	900	413	506	56.3	ND	ND	<0.01– <0.09 <0.02– <0.09 (diet-based)	0.06–0.9 (diet-based)
Phenmedipham	1 x 0.975	ND	ND	ND	ND	ND	234	NC	0.195
Pyrazon	1 x 7.3	1,754	804	987	109.7	ND	ND	0.01–**1.41**[4] 0.03–0.41 (diet-based)	ND
Quizalofop-p-ethyl	1 x 0.17	40.8	18.7	23.0	2.55	ND	ND	NC	<<0.01–0.08
Sethoxydim	2 x 0.47	240	110	135	15	ND	ND	NC	>0.12– >**1.98** (max) >0.06->0.70 (mean)
Trifluralin	1 x 2 lb	480	ND	250 (fruit/veg/leaves) 116 (legumes, insects)	24 (seeds) 14 (fruits)	ND	ND	0.003–0.096	0.03–**1.06**
Triflusulfuron-methyl	1 x 0.03	ND	ND	ND	ND	1.69–4.15	ND	0.0003–0.0166	ND

Sources: EPA Registration or Reregistration Eligibility Documents (REDs), EPA OPP EFED ecological risk assessment documents in EPA docket online, and other sources; see Table 4–5, Characteristics of Herbicides Used on Sugar Beet Root and Seed Crops, for each herbicide.

[1] EPA-estimated EECs on four avian food types or unspecified food type (labeled acute and chronic EECs).

[2] Scenario single application rate higher than maximum single application rate of 4.6 lb a.i./acre for EPTC for sugar beet.

[3] Scenario single application rate for glyphosate lower than maximum single application assumed for conventional sugar beet preemergence, but higher than maximum single application rate assumed for H7-1 sugar beet preemergence. Glyphosate scenario expressed in lb. a.e./acre

[4] Bold value indicates a Risk Quotient that exceeds the Level of Concern (1.0) for non-federally listed species.

Abbreviations: EEC = estimated environmental concentration (herbicide residue) on indicated food/prey groups. lb a.i./acre = pounds of active ingredient/acre. ND = No data identified. NC = not calculated (when toxicity data indicated that the RQs would be far below any level of concern, EPA did not calculate the quotient).

small animals. Additionally, this would temporarily increase the amount of groundcover available year-round. Gramnivorous birds could consume seeds from grasses in fall through spring. Reptiles are likely to be in hibernation for the winter, but early spring cover would assist offspring in safe dispersal from where they were born. Several species of birds that nest in grasslands also might temporarily find expanded habitat for reproduction; however, that would cease once crops are again planted in the field.

If farmers immediately plant conventional sugar beet (or another rotational crop) rather than allowing the land to go fallow, the potential for the impacts discussed above with respect to lack of groundcover for reptiles and available prey for raptors would be eliminated or reduced. Vegetation/groundcover would be present for reptiles for foraging, dispersal, and migration, and existing prey populations would be maintained for raptors.

Conventional sugar beet is planted in rows with space between the rows to allow for in-crop tillage. Therefore, the amount of groundcover available for birds and reptiles feeding on the ground depends upon the sugar beet row width. The wider the rows, the lesser the ground coverage, and the greater the chances of being spotted by predators, which decreases the probability of long-term survival and reproduction.

In summary, under Alternative 1, no H7-1 sugar beet root crop would be commercially planted and herbicide use patterns would likely return to the patterns characteristic of each growing region prior to the widescale adoption of H7-1 sugar beet. The change from H7-1 sugar beet to conventional sugar beet could increase the risk of sublethal or chronic effects on birds (and possibly reptiles) from the application of sethoxydim postemergence and trifluralin applied preemergence (or early postemergence), at some locations. In addition, there could be a risk of acute effects on birds from the application of pyrazon at some locations. .

(2) Alternative 2 – Full Deregulation

Alternative 2 would result in the greatest adoption rate of H7-1 sugar beet. In the long term, it is expected that up to 100 percent of the sugar beet crop would be H7-1. Thus, the potential for bird and reptile exposure to the H7-1 gene product would be greatest under Alternative 2.

Impacts on Birds and Reptiles from Exposure to the H7-1 Gene Product. In general, birds and reptiles are not expected to use sugar beet as a food source. Some aquatic birds such as geese consume leaves and could potentially forage on beet tops. Some birds might be attracted to sugar beet grown for seed production. Of the reptiles, many turtle species are herbivorous (e.g., box turtle, painted turtle) and could consume sugar beet. Lizards are primarily insectivorous, but some are herbivores and would also consume sugar beet. Snakes are exclusively carnivorous, and so would not consume any parts of beet plants. Geckos require warmer climates than most areas that are conducive to growing sugar beet, with the exception of California.

If birds or reptiles do happen to consume the beet, byproducts from H7-1 sugar beet are reported as safe for food and feed for livestock and were found not to be toxic or nutritionally deficient to rats. APHIS anticipates that birds and reptiles would similarly be unaffected by the H7-1 CP4 EPSPS protein and consumption of H7-1 sugar beet plant parts given the lack of toxicity of the protein and the overall similarity in composition between H7-1 and conventional sugar beet.

Impacts on Birds and Reptiles from Herbicide Use. Birds and reptiles could be exposed to herbicides via spray drift or direct overspray if they were present within the sugar beet field during herbicide application. As described under Alternative 2 for mammals, Alternative 2 would lead to larger areas over which birds and reptiles might be exposed to glyphosate incidentally compared with Alternative 1 but would significantly reduce their exposure to nonglyphosate herbicides. All scenarios of glyphosate use do not pose risks of concern for birds and reptiles. Use of three herbicides on sugar beet, trifluralin, pyrazon ,and sethoxydim, are expected to decline. As these herbicides are not used extensively on sugar beet in Alternative 1 (5, 6, and 11% respectively) (Table 3-14), the potential risks to birds and reptiles from herbicide use is expected to be slightly less under Alternative 2 compared to Alternative 1. As direct effects on birds and reptiles are not expected from glyphosate use, indirect effects are similarly not expected.

Impacts on Birds and Reptiles from Crop Management Practices. As discussed in section III.B.1, growing H7-1 sugar beet may be accompanied by increasing conservation tillage thus reducing the amount of tillage compared to Alternative 1. Growers therefore can plant H7-1 sugar beet closer together compared to conventional sugar beet that require in-crop tillage. Under this conservation tillage system, there would be more extensive groundcover for reptiles to forage, disperse, and migrate than under Alternative 1, thus decreasing the probability of individuals being killed by predators and increasing chances of long-term survival and reproduction. More groundcover during the growing season potentially also could increase the amount of prey available for foraging raptors. Any increases in the numbers of prey, however, are not likely to substantially improve the hunting success of predators because of the increased cover.

In summary, exposure to or consumption of H7-1 sugar beet plant materials under Alternative 2 is not expected to impact avian or reptilian wildlife. Short-term impacts from land management practices are possible where farmers allow fields to lie fallow for a few years, but continue to plow them. Those impacts, however, would be short-lived, and no longer-term impacts are anticipated for avian and reptilian wildlife from differences in crop management practices. Increases in conservation tillage might provide more food and habitat for birds and reptiles.

Herbicide use patterns would be different under Alternatives 1 and 2 where Alternative 2 would result in more use of glyphosate which is not expected to pose acute and chronic risks to birds and reptiles and less use of three herbicides that under certain scenarios have the potential to pose acute and chronic risks.

(3) Alternative 3 – Partial Deregulation

Impacts on Birds and Reptiles from Exposure to the H7-1 Gene Product. Under Alternative 3, the potential for exposure to the H7-1 gene product would not exist for birds and reptiles in California or Western Washington. As discussed previously, exposure to the H7-1 gene product is not expected to have an adverse effect on birds or reptiles. Similarly, APHIS anticipates no adverse effects on birds and reptiles from exposure to the H7-1 gene product for Alternative 3.

Impacts on Birds and Reptiles from Herbicide Use. Alternative 3 would result in substantially higher amounts of glyphosate-based herbicide use than under Alternative 1 but less than under Alternative 2 due to the mandatory restrictions in two states. Similarly the reduction in the use of non-glyphosate herbicides would be less under Alternative 3 than under Alternative 2. Of the three herbicides that under certain scenarios have the potential to pose acute and chronic risks to birds and reptiles, sethoxydim and trifluralin are extensively used in Imperial Valley (Tables 3-14 and 3-15). Thus, the extent of potential impacts on birds and reptiles from sethoxydim and trifluralin use would be somewhat higher under Alternative 3 than under Alternative 2, but lower than Alternative 1.

Impacts on Birds and Reptiles from Crop Management Practices. Under Alternative 3, in those areas where H7-1 sugar beet is grown, the potential impacts on birds and reptiles from crop management practices would be similar to Alternative 2. Where strip till is adopted, farmers could plant H7-1 sugar beet closer together than if space for tillage were maintained between rows. Thus, areas planted in H7-1 sugar beet would provide earlier and more extensive groundcover for ground-foraging small birds and reptiles. Moreover, reptiles moving between habitats would be afforded more protection from visual predators compared with conventional sugar beet.

Because conservation tillage would not be used to grow sugar beet in California under Alternative 2, the potential impacts on birds and reptiles from crop management practices in California under Alternative 3 would also be similar to Alternative 2.

In summary, exposure to or consumption of H7-1 sugar beet plant materials under Alternative 3 is not expected to impact avian or reptilian wildlife. Alternative 3 would result in substantially higher amounts of glyphosate-based herbicide use than under Alternative 1 but less than under Alternative 2 due to the mandatory restrictions in the sugar beet growing area in California. Similarly the reduction in the use of non-glyphosate herbicides would be less under Alternative 3 than under Alternative 2. Of the three herbicides that under certain scenarios have the potential to pose acute and chronic risks to birds and reptiles, sethoxydim and trifluralin are extensively used in Imperial Valley. Thus, the extent of potential impacts on birds and reptiles from sethoxydim and trifluralin use would be somewhat higher under Alternative 3 than under Alternative 2, but lower than Alternative 1. Increases in conservation tillage might provide more food and habitat for birds and reptiles under Alternative 3 relative to Alternative 1.

d. Amphibians and Fish

For each alternative, APHIS analyzed the potential impacts on amphibians and fish from (1) exposure to the H7-1 gene product, (2) herbicide use, and (3) crop management practices.

(1) Alternative 1 – No Action

Impacts on Amphibians and Fish from Exposure to the H7-1 Gene Product. Under Alternative 1, amphibians and fish would not be likely to be exposed to the H7-1 gene product so no impacts are expected.

Impacts on Amphibians and Fish from Herbicide Use. There would be a rapid transition to greater use of non-glyphosate herbicides and much less use of glyphosate as H7-1 sugar beet are replaced with conventional sugar beet. Amphibian and fish exposure to herbicides is possible due to spray drift, inadvertent direct overspray, or transport (via wind or water flow from rainfall) of soil particulates with adsorbed herbicides and water runoff with dissolved herbicides.

Table 4–11 provides data on the acute toxicity of herbicides used on sugar beet to both coldwater (rainbow trout) and warmwater (bluegill sunfish) fish, as available. Table 4–11 includes the EPA OPP toxicity categories corresponding to the LC_{50} values. Many of the herbicides exhibit acute toxicity to fish. Trifluralin is the most severe as it is in the very highly toxic category for both species of fish. Quizalofop-p-ethyl is highly toxic to both species. Ethofumesate is highly toxic to trout and moderately toxic to sunfish. Cycloate, desmedipham, and phenmedipham, are all in the moderate toxicity category. Clethodim and pyrazon are slightly toxic to both species. EPTC is slightly toxic to trout and practically non toxic to sunfish. Glyphosate is listed as practically non toxic to trout and slightly toxic to sunfish. Clopyralid, sethoxydim, and triflusulforn-methyl are all listed in the practically non-toxic category.

Table IV-11. Acute (96-hr) Toxicity Values and EPA OPP Toxicity Categories of Herbicides to Freshwater Fish[1]

Herbicide Active Ingredient	Rainbow Trout (Coldwater)		Bluegill Sunfish (Warmwater)	
	LC_{50} (mg a.i./L)	Toxicity Category	LC_{50} (mg a.i./L)	Toxicity Category
Clethodim	15	Slightly toxic	ND	ND
Clopyralid[2]	350	Practically nontoxic	125	Practically nontoxic
Cycloate	4.5	Moderately toxic	4.6	Moderately toxic
Desmedipham	1.7	Moderately toxic	6.0	Moderately toxic
EPTC	14	Slightly toxic	125	Practically nontoxic
Ethofumesate	0.75	Highly toxic	2.5	Moderately toxic
Glyphosate (a.e.) [3]	140	Practically nontoxic	43	Slightly toxic
Phenmedipham	1.7	Moderately toxic	ND	ND
Pyrazon [4]	38[6]	Slightly toxic	88.7	Slightly toxic
Quizalofop-p-ethyl	0.87	Highly toxic	0.460	Highly toxic
Sethoxydim	170	Practically nontoxic	265	Practically nontoxic
Trifluralin	0.041	Very highly toxic	0.058	Very highly toxic
Triflusulfuron-methyl	730	Practically nontoxic	ND	ND

Sources: EPA OPP RED documents and EPA OPP Ecological Fate and Effects Division (EFED) ecological risk assessment documents available from the herbicide dockets.

[1] EPA OPP categories of acute toxicity for aquatic organisms based on LC_{50} values in mg a.i./L: <0.1 very highly toxic; 0.1-1 highly toxic; 1-10 moderately toxic; 10-100 slightly toxic; >100 practically nontoxic.

[2] Rainbow trout LC_{50} from (Fairchild et al., 2008). Bulltrout LC_{50} was 458 mg a.i./L; less sensitive than rainbow trout. Bluegill sunfish LC_{50} of 125 mg/L source TNC profile for the herbicide.

[3] Glyphosate Rainbow trout 48-hr LC_{50} with 83% pure glyphosate = 86 mg/L; rainbow trout 48-hr LC_{50} with 96.7% glyphosate = 140 mg/L; use latter because of possibility of surfactants in former.

[4] Pyrazon rainbow trout LC_{50} values ranged from 32 to 46 mg a.i./L; geometric mean of those two values (38) is used to represent the rainbow trout LC_{50}. Pyrazon metabolite B-1 less toxic (LC_{50} >105 mg/L) than parent pyrazon compound to rainbow trout; therefore, EPA OPP did not evaluate metabolite B-1 toxicity further.

Abbreviations: ND = no data; a.e. = acid equivalent; a.i. = active ingredient

For registration and reregistration of pesticides in general, including herbicides, EPA indicates that fish serve as an adequate surrogate species for aquatic life stages of amphibians (U.S. EPA 2008d). Thus, testing the toxicity of herbicides to amphibians generally only occurs if there is specific reason for concern, such as listed endangered or threatened species in the vicinity of fields on which the herbicide is used.

APHIS compared the relative toxicities of the herbicides to glyphosate a.i. in Table 4–12, which reveals that glyphosate a.i. alone is one of the least toxic herbicides to fish on an acute basis. Several herbicides are orders of magnitude more toxic to fish than glyphosate including trifluralin (1280 times), ethofumesate (70 times), quizalofop-p-ethyl (60 times), phenmedipham (31 times), desmedipham (31 times), and cycloate (12 times). Maximum application rate was used as an indicator of exposure. The risk of each sugar beet herbicide relative to glyphosate was calculated by dividing the maximum application rate by the acute toxicity value and dividing that risk value by the risk value of glyphosate. Considering application rate as well as toxicity, all the above herbicides, with the exception of quizalofop-p-ethyl, are expected to pose greater acute risks to fish than glyphosate.

EPA OPP has estimated risks to aquatic organisms from herbicide applications per label instructions. Exposure is represented by estimated environmental concentrations (EECs) in surface waters. EPA calculated EECs for all herbicides and the application scenarios indicated in the first column of the table. EPA calculated risk quotients by dividing each EEC by the appropriate toxicity value (acute or chronic) from tests with fish for each active ingredient. For acute RQs, EPA used 96-hour LC_{50} values, that is the concentration of the chemical in water required to kill 50 percent of fish over a 96-hour exposure period. For chronic RQ values, EPA used no-observed-adverse effect concentration/lowest-observed adverse effect concentration (NOAEC/LOAEC) data as available. The results of comparing the EECs to the benchmark toxicity values are listed in Table 4–13 below.

Even though many of the herbicides used on sugar beet are toxic to fish, when considering the estimated environmental concentrations of the herbicides based on use according to EPA label instructions, the potential risk to fish does not pose risks of concern for each herbicide. These results are summarized in Table 4–13 which indicates that all RQs are less than 1.0. EPA OPP's environmental assessment for clopyralid was not available, and EPA OPP did not report some of the EEC values used to develop the RQ values shown in the table (e.g., acute EECs for cycloate

Table IV-12. Alternative 1: Relative Toxicity and Risk of Herbicides Used on Sugar Beet to Fish

Herbicide	Acute Toxicity		Maximum Single Application Rate		Relative[5] Risk (RR) = (A) x (B)
	96-hr LC_{50}[1] (mg a.i./L)	(A)[2] Relative to Glyphosate TGAI	Rate[3] (lb a.i./ acre/app)	(B)[4] Relative to Glyphosate TGAI	
Clethodim	15	**3.5**	0.25	0.0554	0.19
Clopyralid	350	0.15	0.33	0.0732	0.011
Cycloate	4.5	12	4.0	0.887	10.3
Desmedipham	1.7	31	1.28	0.284	8.8
EPTC	14	3.8	4.6	1.02	3.8
Ethofumesate	0.75	70	3.75	0.831	58
Glyphosate T[6] PRE	52.5	1.00	4.51	1.000	1.0
Phenmedipham	1.7	31	0.63	0.140	4.3
Pyrazon	38	1.4	7.3	1.62	2.2
Quizalofop-p-ethyl	0.87	60	0.0825	0.0183	1.1
Sethoxydim	170	0.31	0.47	0.104	0.032
Trifluralin	0.041	1280	0.75	0.166	213
Triflusulfuron methyl	730	0.072	0.032	0.00710	0.00051

[1] Data from Table 4–11.
[2] Relative acute toxicity calculated as (1/LC_{50} herbicide) divided by (1/LC_{50} glyhosate a.i.). Numbers bolded are relative toxicity values for which a definitive LD_{50} was determined for the nonglyphosate herbicide.
[3] Maximum single application rate allowed from Table 4–5.
[4] Relative single maximum application rate calculated as rate for herbicide divided by rate for glyphosate a.i., assumed to be 4.5 lb a.i./acre preemergence in one application, although multiple applications of smaller amounts of each are more likely.
[5] Relative risk (RR) is the product of relative toxicity (A) and relative maximum single application (B). Bold numbers indicate herbicides exhibiting higher relative risks that glyphosate
[6] Toxicity values for glyphosate have been adjusted from values for acid equivalent (a.e.) to active ingredient (a.i.) in this table by multiplying the a.e. value by 1.22.
Abbreviations: a.i. = active ingredient. PRE = preemergence application; glyphosate is not applied postemergence to conventional sugar beet. TEP

and pyrazon). Additional data limitations are evident in the table. Data on the chronic toxicity of herbicides to fish are lacking for several herbicides used on conventional sugar beet. Most significant, however, is the lack of consideration of the "inert" ingredients in formulated herbicides when estimating surface water concentrations. Even if surface water concentrations of the inert ingredients also were estimated, toxicity data on formulated products for comparison with EECs are sparse. EPA announced that glyphosate formulations containing the surfactant polyethoxylated tallow amine (POEA) will be considered in the ecological and endangered species risk assessment to be conducted for the registration review for glyphosate (EPA, 2009; U.S. EPA 2009c). EPA's regulations specifying data requirements for pesticide testing, now require data to be submitted on typical end use products (TEP) to assess ecological effects of the formulated product on aquatic non-target organisms (40 CFR 158.630).

Trifluralin is highly toxic to fish and has the highest RQ value of the herbicides (chronic RQ of 0.4), although it does not pose risks of concern (<1.0) for non-listed fish. Trifluralin also has a longer half-life (e.g., 60 days) in the environment than the other herbicides, and a high bioaccumulation potential (see Table 3–22). Therefore, under Alternative 1, trifluralin appears to be the herbicide applied to conventional sugar beet that is of most concern, although none of the herbicides used are expected to cause adverse impacts, either acute or chronic, to fish populations in nearby surface waters.

As no direct impacts on fish and amphibians are expected from any of the herbicides used on sugar beet, indirect impacts on predator species from reducing prey species are not expected. either.

Impacts on Amphibians and Fish from Crop Management Practices. On those agricultural lands that would no longer be allowed to grow H7-1 sugar beet, farmers could allow the land to become fallow (unplanted), plant conventional sugar beet (or a rotational crop), or use the land for other purposes. If farmers allow the land to go fallow for a year and continue to plow the land, the amount of groundcover for terrestrial-phase adult amphibians that use the agricultural field to forage on ground-dwelling insects would be reduced. Individuals of these species likely would use adjacent areas of similar habitat. If farmers do not continue to plow the fallow lands, these fallow lands would revert to more natural grasslands/shrublands, which could provide groundcover and more diverse habitat for terrestrial-phase amphibians than planted sugar beet or fallow, plowed lands. This potentially could enhance local population size; however, that effect would be short term and only last until another crop is planted.

Allowing the land to go fallow for a year and continuing to plow the land could increase the erosion of topsoil via wind or rainfall, thereby indirectly impacting aquatic species that year. Soil erosion can result in the release of sediment and fertilizers into nearby surface waters, which could increase turbidity, contribute to algal blooms, and decrease dissolved oxygen concentrations, ultimately affecting fish and aquatic-phase amphibians. For flowing waters, increased turbidity and reduced concentration of dissolved oxygen might force fish and other mobile organisms to avoid such areas. For small isolated ponds and lakes, however, total kills of fish and amphibians that use the water for reproduction is possible. Also, any chemical that is bound to the eroded soil particles would be transported to the water bodies. Depending on the amount, concentration, and toxicity of the chemical(s) (e.g., insecticides, fungicides, rodenticides) bound to the eroded soil particles, fish and amphibians might experience toxic effects. Under Alternative 1, it is likely that plowed lands will be planted with conventional sugar beet or other crops (eventually) limiting these potential short-term impacts. If farmers do not continue to plow the fallow lands, the fallow lands would revert to more natural grasslands/shrublands, which could result in less soil erosion when compared to land that is planted with sugar beet or is fallow and plowed.

In the longer term, once farmers replace H7-1 sugar beet with conventional varieties, in-crop tillage practices would be required for weed control in those areas where strip tillage was practiced. Conventional sugar beet tillage generally results in more erosion of topsoil via wind or rainfall than conservation or strip-till options that are possible for H7-1 sugar beet. Alternative 1 therefore has the potential to increase adverse effects on fish and aquatic life stages of amphibians compared with the Alternative 2 where H7-1 sugar beet is widely adopted.

EPA OPP considers fish and early life-stage toxicity tests on fish adequate to define pesticide toxicity to amphibians for purposes of pesticide registration. If used according to label instructions, under Alternative 1, none of the herbicides are expected to pose risks of adverse effects in aquatic-stage amphibians or in fish. Trifluralin is the most likely herbicide to affect fish if mitigations from the label are not followed. Depending on location, use of conventional tillage across all sugar beet acreage could result in indirect adverse effects on aquatic life-stage amphibians and fish from soil erosion, including movement of herbicides, fertilizers, and other pesticides as well as soil particles into nearby surface waters. Small ponds are more susceptible than larger ponds or lakes or flowing waters.

Table IV-13. EPA-Estimated Environmental Concentrations (EECs) of Herbicides in Surface Waters from Drift and Runoff and Risk Quotients (RQs) for Fish

Herbicide	Scenario (lb a.i./acre)	Acute EEC in Surface Water (ppm)	Longer-Term EEC in Surface Water (ppm)	Acute Risk Quotient (RQ) for Fish	Chronic Risk Quotient (RQ) for Fish
Clethodim	2 × 0.25	0.007	ND	<0.05	ND
Clopyralid	ND	ND	ND	ND	ND
Cycloate	1 × 4.0	ND	ND	0.003 – 0.007	ND
Desmedipham	2 × 0.98	0.0145 (aerial) 0.0141 (ground)	ND	0.0024 – 0.0086 (aerial) 0.0024-0.0083 (ground)	NC
EPTC[1]	1 × 6.1	Refined aquatic exposure modeling resulted in a maximum peak concentration of 0.04 ppm. This is far lower than the lowest fish LC_{50} (14 ppm). This indicates that EPTC is unlikely to have acute effects on aquatic animals.			ND
Ethofumesate	1 × 3.75	0.0527	0.0438	0.07	0.02
Glyphosate a.e.[2]	1 × 3.75	0.028 (peak)	0.011 (90-day)	0.0006	0.0008
Phenmedipham	1 × 0.975	0.01695 (24-hr)	0.0135 (90-day)	<0.01	ND
Pyrazon	1 × 7.3	ND	ND	<0.001 – <0.00062	ND
Quizalofop-p-ethyl	1 × 0.165	.00257	.00203 (60-day)	<0.01	<0.01
Sethoxydim	2 × 0.47	0.087	ND	0.0005	ND
Trifluralin	1 × 2.0	0.00701	0.00039 (90-day)	0.03 – 0.08	0.3 – 0.4
Triflusulfuron-methyl	1 × 0.03	0.016068	ND	0.000134 – 0.0000766	ND

Sources: EPA Registration or Reregistration Eligibility Documents (REDs), EPA OPP EFED ecological risk assessment documents in EPA dockets online, and other sources; see Table 4–5 for each herbicide.

[1] Scenario single application rate higher than maximum single application rate of 4.6 lb a.i./acre for EPTC for sugar beet.

[2] Scenario single application rate for glyphosate lower than maximum single application assumed for conventional sugar beet preemergence, but higher than maximum single application rate assumed for H7-1 sugar beet preemergence.

Abbreviations: EEC = estimated environmental concentration. ND = no data. mg a.i./L = milligram active ingredient per liter water.
NC = not calculated (when toxicity data indicated that the RQs would be far below any level of concern, EPA did not calculate the quotient).

(2) Alternative 2 – Full Deregulation

Alternative 2 would result in the greatest adoption rate of H7-1 sugar beet. In the long term, it is expected that approximately 100 percent of the sugar beet crop would be H7-1. Thus, the potential for amphibian and fish exposure to the H7-1 gene product would be greatest under Alternative 2.

Impacts on Amphibians and Fish from Exposure to the H7-1 Gene Product. Fish and aquatic phases of amphibians would not be directly exposed to the H7-1 gene product. Terrestrial amphibians are carnivores and thus would not consume any part of the sugar beet plant. Terrestrial amphibian exposure to the H7-1 gene product would only occur if the individual consumed prey that had recently eaten part of an H7-1 sugar beet plant and the protein had survived intact in the digestive tract of the prey. As discussed previously, exposure to the H7-1 gene product is not expected to have an adverse effect on birds and reptiles. Simliarly, APHIS also anticipates no adverse effects on fish and amphibians from exposure to the H7-1 gene product.

Impacts on Amphibians and Fish from Herbicide Use. Alternative 2 would result in higher amounts of glyphosate-based herbicide used on sugar beet compared to Alternative 1 and greatly reduced levels of non-glyphosate herbicides. As described under Alternative 1, glyphosate is much less toxic to fish than are the non-glyphosate herbicides. However, exposure of fish to any of the herbicides is expected to be limited when the herbicides are used according to the label. Although, the potential chronic and acute risk to fish under Alternative 2 is expected to be reduced compared to Alternative 1, no unreasonable risks are expected under either Alternative.

Compared to glyphosate tested as an acid or isopropylamine (IPA) salt, amphibians exhibited greater sensitivity to Roundup® formulations, likely due to the surfactant POEA, which has been used for a long time in agricultural formulations. POEA has been found to be more toxic to amphibians and other aquatic animals than glyphosate a.i. alone (Lajmanovich et al., 2003) Some researchers have suggested that, in combination with POEA, Roundup® could cause high rates of mortality to amphibians, including species of frogs and toads that could lead to eventual population declines (Relyea, 2005a). However, glyphosate formulations containing POEA are not permitted in aquatic habitats so the these studies may not be relevant. Glyphosate products, such as Rodeo® are specifically designed for aquatic uses. At least one glyphosate formulation that contains surfactant is approved for use over or near surface waters. The label for this glyphosate product (Nufarm Credit Duo Herbicide, EPA Reg. No. 71368-25) contains use instructions for glyphosate-tolerant sugar beet (Nufarm Inc., 2010). The label instructs the user to apply the product over-the-top of sugar beet. The label states, “For terrestrial uses, do not apply directly to water, to areas where surface water is present or to intertidal areas below the mean high water mark."

Therefore, when using this product for weed control in sugar beet fields, farmers should not be applying the product directly over surface waters. Also, like the labels for Roundup Orginal MAX® (Monsanto, 2007b) and Roundup Weather MAX® (Monsanto, 2009), the label states "The pesticide should only be applied when the potential for drift to adjacent sensitive areas (e.g., residential areas, bodies of water, known habitat for threatened or endangered species, non-target crops) is minimal (e.g., when wind is blowing away from the sensitive areas)," and "Avoid direct application to any body of water."

Large numbers of amphibians are not expected to be present in sugar beet fields where direct application of surfactant-containing herbicide would occur. Thus, notable decreases in local populations of amphibians are not expected. Additionally, under current agricultural practices, runoff and erosional movement of soils with sorbed glyphosate and the surfactant to surface waters should be limited to storm events (Borggaard and Gimsing, 2008).

As noted by Mann (Mann et al., 2009), two points of view have developed regarding the environmental risk posed by the use of glyphosate formulations containing POEA and similar surfactants.

"One view is that when used in accordance with directions stipulated on product labels, the concentration of glyphosate (and by inference the concentration of POEA or associated surfactants) will be sufficiently diluted to avoid toxic concentrations in water-bodies likely to receive runoff or be contaminated by spray-drift. The opposing view is that amphibians may be particularly susceptible to the toxic effects of these pesticides because their preferred breeding habitats are often shallow, lentic or ephemeral pools that do not necessarily constitute formal waterbodies, and which can contain higher concentrations when compared to larger water-bodies."

Amphibians are most sensitive to glyphosate formulations in the larval stage where the LC50 is estimated to be 0.9 to 16 mg a.e./l depending on species, populations, and experimental conditions (Relyea, 2006). (Bernal et al., 2009) has concluded from his aquatic and terrestrial microcosm studies that responses of frogs under realistic field exposure conditions are less than would be predicted from laboratory toxicity studies and less than reported by some authors for other species. The reason for this has been attributed to the fact that glyphosate and the surfactant POEA adsorb rapidly to sediments and organic matter that is present in natural systems or are rapidly degraded. Relyea, however found soil did not markedly improve survival of frogs in mesocosm experiments testing the toxicity of glyphosate formulations (Reylea, 2005) suggesting there may be important differences among experiments that can affect the outcome. (Relyea, 2011)has criticized the interpretation of the (Bernal et al., 2009) experiment as not one of a mitigating effect of soil but an experimental effect of using a lower pH where glyphosate formulations are known to be less lethal. Furthermore, he has concluded that under field conditions, responses would be greater because of synergistic effects between the herbicide and other stressors (Relyea, 2005b). (Rohr et al., 2008) similarly concluded that sublethal herbicide concentrations can increase the susceptibility of amphibians to parasite infections.

Estimates of glyphosate concentration in surface waters in agricultural areas are usually well below the LC_{50} of amphibians. Maximum values ranged from 0.001 to 0.049 mg/l except in one case in Indiana where as much as 0 .43 mg/l was detected after a heavy storm (Coupe et al., 2011). (Battaglin et al., 2009) measured glyphosate in vernal pools and adjacent streams in areas where glyphosate was used and in one case (Rock Creek National Park) detected up to 0.32 mg/l in a nearby surface water after glyphosate was used for habitat restoration in the parkland. It is possible that in shallow ponds, glyphosate concentrations from runoff may be higher than detected in most of the sampled surface waters.

Most studies have looked at the LC_{50} of amphibian larva in the aquatic phase. (Bernal et al., 2009) studied impacts of glyphosate overspray on terrestrial frogs in connection with efforts to eradicate coca plants in Columbia. He determined that the $LC_{504\text{-}d}$ values ranged from 4.5 to 22.8 kg a.e./ha or 4.0-20.3 pounds a.e./acre. (Bernal et al., 2009). also determined LC_1 values, the exposure that would lead to death of 1% of the population for 8 species of amphibians. *S. ruber* had the most sensitive LC_1 value at 0.32 kg a.e./ha (28 pounds.acre) though its LC_{50} at 7.3 kg a.e./ha (6.5 pounds/acre) was not as sensitive as some of the other species. The next lowest LC_1 value was for *R. typhonius* at 1.56 kg a.e/h (1.39 pounds/acre). From these studies, (Bernal et al., 2009) concluded that,

> "Under realistic worst-case exposure conditions, the mixture of Glyphos and Cosmo-Flux as used for control of coca in Colombia exerts a low toxicity to aquatic and terrestrial stages of anurans and that risks to these organisms under field conditions are small."

Would amphibians that inhabit sugar beet fields be adversely impacted by application of glyphosate formulations? The maximum post-emergent application rate for glyphosate on sugar beet is 1.125 pounds/acre which is considerately below the LC_{50} for all the amphibians studied by (Bernal et al., 2009). With the exception of *S. ruber*, the maximum allowable glyphosate application is below the level that results in 1% mortality. This evidence suggests that glyphosate overspray in sugar beet fields would not be lethal for most species. (Relyea, 2006) noted that ponds and wetlands that are directly oversprayed with Roundup achieve considerably higher concentrations (1.1-5.2 mg a.e./L) than found in streams from runoff. While these concentrations would be above the LC_{50} for certain amphibians, ponds and wetlands are typically not found in sugar beet fields. Thus there may be isolated cases where amphibians could be exposed to glyphosate formulations that have direct effects especially for larva in shallow ponds. It is possible that if sensitive species were to be found in sugar beet fields, they could be exposed to herbicide that causes sublethal effects.

As noted above amphibians are most at risk to surfactants in the formulation and not the glyphosate itself, but surfactants have not been measured in the studies attempting to assess the impact of glyphosate formulations on amphibians. Instead it is assumed that surfactants have similar mobility as glyphosate so when glyphosate is measured, these surfactant are present too. APHIS did not find studies measuring surfactant levels of surface waters or soil so this assumption remains to be tested.

There are differences in the toxicity of various glyphosate formulations to amphibians, (Howe et al., 2004) found that technical grade glyphosate, Roundup Biactive, Touchdown, and Glyfos BIO had very low toxicity, while, the LC_{50} 4day for pure surfactant and other formulations were as follows: POEA (1.1 mg/L), Roundup Original (6.5 mg/L), Roundup Transorb (7.2 mg/L), Glyfos AU (28.6 mg/L). The formulations registered for use on sugar beet are Powermax and Weathermax which are assumed to have similar toxicity as Roundup Original.

There is a potential that indirect impacts to amphibians and fish could occur from glyphosate use under Alternative 2 if natural areas occur in proximity to sugar beet fields.As stated in the pesticide effects determination of the risks of glyphosate use to Federally Threatened California Red-legged frog (U.S. EPA 2008c),

> “Aquatic plants serve several important functions in aquatic ecosystems Non-vascular aquatic plants are primary producers and provide the energy base for aquatic ecosystems (U.S. EPA 2008c). Vascular plants provide structure as attachment sites and refugia for many aquatic invertebrates, fish, and juvenile organisms, such as fish and frogs. In addition, vascular plants also provide primary productivity and oxygen to the aquatic ecosystem Rooted plants help reduce sediment loading and provide stability to nearshore areas and lower streambanks.”

EPA further concluded that glyphosate is not expected to indirectly affect the aquatic-phase of the frog through the diet or habitat from aquatic non-vascular plants (U.S. EPA 2008c).

Also stated in (U.S. EPA 2008c),

> "Terrestrial plants serve several important habitat-related functions for the CRLF. In addition to providing habitat and cover for invertebrate and vertebrate prey items of the CRLF, terrestrial vegetation also provides shelter for the CRLF and cover from predators while foraging. Terrestrial plants also provide energy to the terrestrial ecosystem through primary production. Upland vegetation including grassland and woodlands provides cover during dispersal. Riparian vegetation helps to maintain the integrity of aquatic systems by providing bank and thermal stability, serving as a buffer to filter out sediment, nutrients, and contaminants before they reach the watershed, and serving as an energy source."

At high aerial application rates of 3.85 lbs a.e./acre and ground application rates of 7.5 lbs. a.e./A, glyphosate may cause indirect effects on habitat that could adversely impact the California red-legged frog (U.S. EPA 2008c). However they suggested that impacts on habitat could be mitigated by sufficient buffers. For ground applications of 0.75 lbs.a.e./A, a typical application rate used for post-emergent applications to sugar beet, the buffer estimated to dissipate the adverse impact of glyphosate on habitat is 25 feet. For ground applications of 1.54 lbs, a.e/A, the estimated buffer distance is 53 feet. For ground applications of 3.75 lbs. a.e./acre, the maximum amount permitted for pre-emergent applications per season, the estimated buffer is 125 feet. For aerial applications of 0.75 and 3.75 lbs, a.e/A, the estimated buffers are 312 and 1768 feet respectively (U.S. EPA 2008c).

Under Alternative 2, there is the potential for indirect effects on habitat for fish and amphibians from glyphosate use on lands that abut natural areas when the distance between the sugar beet field and the natural area is less than that recommended for mitigation. According to Stachler (Stachler et al., 2011) for the Midwest region, greater than 99% of sugar beet growers only use glyphosate for post-emergent applications. The maximum amount of glyphosate allowed on post-emergent applications of sugar beet is 1.125 lbs. a.e./application. At this application rate, it is predicted that a buffer of greater than 25 but less than 53 feet will mitigate potential impacts to habitat for ground applications of glyphosate and a buffer of greater than 312 feet but less than 1768 feet for aerial applications. According to Stachler (Stachler et al., 2012a),glyphosate is applied aerially to about 4% of sugar beet acreage in 2011. It is uncertain what number of sugar beet production fields are within 53 feet of natural areas for the 96% of acreage where glyphosate is applied by ground sprayers and within 1768 feet of natural areas on lands that are sprayed by air. As data is lacking for the non-glyphosate herbicides, there is uncertainty whether similar indirect effects on habitat would occur under Alternative 1.

Where H7-1 sugar beet is grown with soil conservation measures such as strip-till, the likelihood of offsite migration of glyphosate and associated surfactants by erosion or runoff is reduced. In these areas benefits to surface water quality (and thus amphibians and other aquatic organisms) in the watershed where such practices are followed could include decreased turbidity and sedimentation from soil erosion and decreased contamination with other pesticides and nutrients sorbed to soil particles.

Impacts on Amphibians and Fish from Crop Management Practices. As discussed in section III.B, adoption of H7-1 sugar beet has resulted in reduced tillage in some regions thereby allowing growers to plant H7-1 sugar beet closer together compared to conventional sugar beet that require in-crop tillage. Under this conservation tillage system, there would be more extensive groundcover for terrestrial-phase amphibians to forage and disperse compared to Alternative 1, thus decreasing the probability of an individual being preyed upon and increasing the individual's chances of long-term survival and reproduction.

Additionally, compared to tillage practices associated with conventional sugar beet, conservation tillage systems benefit fish and aquatic-phase amphibians by reducing the potential for topsoil erosion via wind or rainfall, thereby reducing the amount of sediment released into nearby surface waters and improving water quality. As discussed above, soil erosion can result in turbidity and decreased dissolved oxygen concentrations in the water body, ultimately affecting fish and aquatic-phase amphibians by impairing growth, reproduction, development, and long-term survival. Also, soil erosion can result in the transport of chemicals that are bound to soil particles to surface waters. Compared to Alternative 1, these potential impacts would be reduced under Alternative 2 in both the short and long term.

EPA OPP considers fish and early life-stage toxicity tests on fish adequate to define pesticide toxicity to amphibians for purposes of pesticide registration. If used according to label instructions, under Alternative 2, none of the herbicides are expected to pose risks of adverse effects in aquatic-stage amphibians or in fish. There is potential for TEPs of glyphosate to be more toxic to both fish and amphibians than glyphosate a.i., but how much more would depend on which surfactants are used in each formulation. As a consequence, strict label warnings are required on glyphosate products designed to be used on terrestrial crops to help farmers minimize the possibility of off-crop movement of glyphosate with surfactant. TEPs for most of the other herbicides have not been tested.

(3) Alternative 3 – Partial Deregulation

Impacts on Amphibians and Fish from Exposure to the H7-1 Gene Product. As discussed under Alternative 2, fish and aquatic phases of amphibians would not be directly exposed to the H7-1 gene product. Indirect ingestion of the H7-1 gene product via consumption of plant-eating insects is not expected to cause adverse effects, because the protein is not known to have adverse effects on animals. Therefore, no adverse effects on fish and amphibians are expected from exposure to the H7-1 gene product under Alternative 3.

Impacts on Amphibians and Fish from Herbicide Use. Under Alternative 3, H7-1 sugar beet would not be grown in California or Western Washington. In other locations, glyphosate would be the predominant herbicide applied, resulting in the same potential for impacts as described for Alternative 2. Currently, no H7-1 sugar beet is grown in California. However, as discussed in section III.B.1., in the 2010–2011 crop year, there were 25,000 acres of conventional sugar beet planted in California. Alternative 3 would not change the current risk to amphibians and fish in these localized fields in California, since a mix of conventional sugar beet herbicides would continue to be applied. Trifluralin is the herbicide of most concern used in California.

Impacts on Amphibians and Fish from Crop Management Practices. In those areas where H7-1 sugar beet is grown, the potential impacts on amphibians and fish from crop management practices would be similar to Alternative 2. In California, where H7-1 sugar beet would not be grown, the potential impacts on amphibians and fish from crop management practices would be similar to Alternative 1.

e. Terrestrial Invertebrates

For each alternative, APHIS analyzed the potential impacts on terrestrial invertebrates from (1) exposure to the H7-1 gene product, (2) herbicide use, and (3) crop management practices.

(1) Alternative 1 – No Action

Impacts on Terrestrial Invertebrates from Exposure to the H7-1 Gene Product. Under Alternative 1, levels of the H7-1 gene and its product in the environment eventually would return to pre-deregulation levels. Terrestrial invertebrates would have limited to no exposure to the H7-1 gene product.

Impacts on Terrestrial Invertebrates from Herbicide Use. There would be a transition to greater use of non-glyphosate herbicides and much less use of glyphosate as H7-1 sugar beet is replaced with conventional sugar beet. Terrestrial invertebrate exposure to herbicides is possible due to spray drift or direct overspray if they were present within the sugar beet field during herbicide application. Table 4–14 includes toxicity test data for herbicides to honey bees and earthworms where data were available. EPA OPP generally requires toxicity tests with honey bees as both a key pollinator species and as a surrogate species representing other beneficial insects. In general, most herbicides show slight to practically no toxicity to insects and earthworms. An LD_{50} from either contact over 24 h or an oral dose for 48 h was not achieved at the maximum concentrations tested for each herbicide. Earthworm toxicity is not a regular part of pesticide toxicity testing for EPA. As no direct impacts on terrestrial invertebrates are expected from herbicide use, no indirect impacts are also expected on animals that consume terrestrial invertebrates.

Impacts on Terrestrial Invertebrates from Crop Management Practices. Under Alternative 1, if farmers allow the land to become fallow for only a few years and continue to plow the land, the amount of ground cover/vegetation for terrestrial invertebrates that might use the agricultural field would be reduced; however, farmers generally try to prevent insect consumption of any parts of their crop that have commercial uses, as does all of the sugar beet root crop. In addition, sugar beet root crop growers have no need of pollinating insects. Under Alternative 1, however, conventional tillage would repeatedly disrupt the soil-dwelling invertebrates' habitat, which might reduce populations of beneficial invertebrates such as earthworms and grubs of predatory beetles.

If farmers do not continue to plow the fallow lands, these fallow lands would revert to more natural grasslands/shrublands, which could provide more diverse habitat for terrestrial invertebrates than planted sugar beet or fallow, plowed lands. Additionally, habitat conditions would be more stable (no plowing). This would be short term and only last until another crop is planted.

If farmers immediately plant conventional sugar beet (or another rotational crop) rather than allowing the land to go fallow, there would not be a reduction in ground cover/vegetation as discussed above. However, periodic disruption to terrestrial invertebrate habitat still would occur when farmers till the fields.

Table IV-14. Toxicity of Herbicides Used on Sugar Beet to Non-Target Terrestrial Invertebrates and EPA OPP Toxicity Category

Herbicide	Lowest Honey Bee Acute Toxicity Value		EPA OPP Toxicity Category Honey Bee	Earthworm Data (mg a.i./kg soil)
	LD_{50} 24-hr contact (µg/bee)	LD_{50} 48-hr oral (µg/bee)		
Clethodim TEP (26% a.i.)	>100	ND	Practically nontoxic	ND
Clopyralid	ND	ND	ND	ND
Cyloate	ND	>29	Practically nontoxic	ND
Desmedipham	>50	>50	Practically nontoxic	ND
EPTC	>12	ND	Relatively nontoxic	ND
Ethofumesate	>50	ND	Practically nontoxic	ND
Glyphosate	ND	>100[1]	Practically nontoxic	ND
Phenmedipham[2]	ND	242	Practically nontoxic	21-d LC_{50} = 129 21-d LOAEC = 51.8 21-d NOAEC = 1.6
Pyrazon	ND	>193[2]	Practically nontoxic	ND
Quizalofop-p-ethyl	50	ND	Practically nontoxic	ND
Sethoxydim	NR	NR	Practically nontoxic	ND
Trifluralin	>100	>50	Practically nontoxic	14-d LC_{50}: >500[3] 14-d LOEC: 14.19[3]
Triflusulfuron-methyl	>100	ND	Practically nontoxic	14-d LC_{50}: >1,000[4] 14-d LOEC: 250[4]

Sources: EPA OPP RED documents and EPA OPP Ecological Fate and Effects Division (EFED) ecological risk assessment documents available from the herbicide dockets unless noted otherwise.
[1] EPA/OPP/EFED 2009 Ecological Risk Assessment Problem Formulation document in the glyphosate docket did not specify a.i. or a.e.
[2] Source: (Van Gestel et al., 1992)
[3] Source: (EFSA (European Food Safety Authority), 2009)[4] Source: (Health Canada, 1999)Abbreviations: ND = no data available, a.i. = active ingredient only – not including additional chemicals used in formulations, TEP = Typical end-use product with typical additives to enhance fficacy, NR = not reported

Any exposure to H7-1 sugar beet is not expected to have adverse effects on terrestrial invertebrates. All of the herbicides typically used on H7-1 or conventional sugar beet fields have been tested on honey bees (except clopyralid), with the results categorized as practically nontoxic by EPA. Sugar beet root crops do not need pollinators. Conventional tillage under Alternative 1 might disrupt soil habitats for some beneficial invertebrates.

(2) Alternative 2 – Full Deregulation

As mentioned previously, Alternative 2 would result in the greatest adoption rate of H7-1 sugar beet. In the long term, it is expected that up to 100 percent of the sugar beet crop would be H7-1. Farmers are expected to try to prevent herbivorous insects from consuming sugar beet plants equally for H7-1 sugar beet and conventional sugar beet.

Impacts on Terrestrial Invertebrates from Exposure to the H7-1 Gene Product. The potential for terrestrial invertebrate exposure to the H7-1 gene product would be greatest under Alternative 2. Terrestrial invertebrates could be exposed to the H7-1 gene product if they consumed a part of the H7-1 sugar beet plant (e.g., leaves). Honey bees also could be exposed to nectar and pollen of H7-1 sugar beet, but only in the small areas where H7-1 sugar beet seed crops are in production. Bees typically do not forage on sugar beet pollen and nectar unless another source of pollen and nectar is not available (McGregor, 1976). The EPSPS protein is part of a metabolic pathway found in plants, fungi, and some bacteria, but not in animals. As discussed previously, exposure to the H7-1 gene product is not expected to have an adverse effect on animals.

Even though the likelihood of toxicity is low for the CP4 EPSPS protein, some researchers have conducted laboratory investigations with different types of arthropods exposed to genetically engineered crops containing the CP4 EPSPS protein (Goldstein, 2003; Harvey et al., 2003; Jamornman et al., 2003) Representative pollinators, soil organisms, beneficial arthropods, and pest species were exposed to tissues (pollen, seed, and foliage) from genetically engineered crops that contain the CP4 EPSPS protein. These studies, although varying in design, all reported a lack of toxicity in species exposed to these crops.

Impacts on Terrestrial Invertebrates from Herbicide Use. Alternative 2 would result in higher amounts of glyphosate-based herbicide and reduced amounts of non-glyphosate herbicides used on sugar beet compared to Alternative 1, because Alternative 2 would result in the greatest adoption of H7-1 sugar beet. This would lead to larger areas over which terrestrial invertebrates might be exposed to glyphosate compared with Alternative 1. However, glyphosate is practically nontoxic to terrestrial invertebrates, and therefore no adverse impacts are expected on terrestrial invertebrates from Alternative 2. Similarly, other non-glyphosate herbicides are practically nontoxic to terrestrial invertebrates so no differences in impacts on terrestrial invertebrates are expected from herbicide use between Alternatives 1 and 2. As no direct impacts on terrestrial invertebrates are expected from herbicide use, no indirect impacts are also expected on animals that consume terrestrial invertebrates. As described under the section “Impacts on Fish and Amphibians,” there is the potential for indirect effects on habitat for terrestrial invertebrates from glyphosate use on lands that abut natural areas when the distance between the sugar beet field and the natural area is less than that recommended for mitigation. The extent of this indirect effect is uncertain because the number of sugar beet farms that are within the recommended mitigation distance from natural areas is not known. Other non-glyphosate herbicides may have similar indirect effects if used in proximity to natural areas.

Impacts on Terrestrial Invertebrates from Crop Management Practices. As discussed in section III.B, growing H7-1 sugar beet has led to increased adoption of strip-till in some regions. Under conservation tillage systems, there would be more extensive groundcover/vegetation for terrestrial invertebrates compared to Alternative 1. Also, disruption or modification to the terrestrial invertebrate's soil habitat from tilling would not occur as often, which could lead to greater abundance and diversity of terrestrial invertebrates, including beneficial species.

In summary. exposure of terrestrial invertebrates to H7-1 sugar beet and glyphosate is not expected to have adverse effects on terrestrial invertebrates. Glyphosate is considered practically nontoxic to terrestrial invertebrates, as are the non-glyphosate herbicides used on sugar beet, and no differences are expected on the impacts to terrestrial invertebrates from herbicide use under Alternatives 1 or 2. The additional conservation tillage expected under Alternative 2 relative to Alternative 1 is expected to benefit soil invertebrates.

(3) Alternative 3 – Partial Deregulation

Impacts on Terrestrial Invertebrates from Exposure to the H7-1 Gene Product. Under Alternative 3, terrestrial invertebrates could be exposed to the H7-1 gene product if they consumed a part of an H7-1 sugar beet plant (e.g., leaves). As discussed under Alternative 2, exposure to the H7-1 gene product is not expected to have an adverse effect on terrestrial invertebrates.

Impacts on Terrestrial Invertebrates from Herbicide Use. No direct impacts to terrestrial invertebrates from herbicide use are expected under Alternative 3, as for Alternatives 1 and 2, as all of the sugar beet herbicides are considered practically non toxic to terrestrial invertebrates.

Impacts on Terrestrial Invertebrates from Crop Management Practices. In those areas where H7-1 sugar beet are grown, the potential impacts on terrestrial invertebrates from crop management practices would be similar to Alternative 2 as explained above. In California, where H7-1 sugar beet are not grown, the potential impacts on terrestrial invertebrates from crop management practices would also be similar to Alternative 1 and 2 because conservation tillage is not expected to be practiced in California sugar beet production even with the adoption of H7-1 sugar beet.

In summary, as for Alternatives 1 and 2, no differences in impacts to terrestrial insects are expected from exposure to H7-1 sugar beet or herbicides under Alternative 3. As for Alternative 2, under Alternative 3, benefits are expected to soil invertebrates from increased practice of conservation tillage.

f. Aquatic Invertebrates

For each alternative, APHIS analyzed the potential impacts on aquatic invertebrates from (1) herbicide use and (2) crop management practices. Regarding exposure to the H7-1 gene product, in general, the majority of H7-1 plant pieces that might reach surface waters would derive from detritus particles in soils and be transported from sugar beet fields by soil erosion and runoff from rain events. This material usually would have started to decompose on land. The integrity of plant cell membranes and contents would have degraded to the point that no appreciable, if any, intact and correctly configured H7-1 gene product proteins should remain in the material. If some proportion of freshly cut beet tops left in the field were to wash into nearby surface waters with a storm event (e.g., immediately after the farmer cuts the tops off the sugar beet prior to root removal from the ground), some aquatic invertebrates might be exposed to and consume fresh pieces of leaves that might contain H7-1 gene product. In most freshwater aquatic invertebrate communities, species or types of animals that are herbivorous and can consume pieces of fresh leaves (e.g., crayfish, some isopods, some amphipods) comprise a small fraction of the community. As discussed previously, exposure to the H7-1 gene product is not expected to have an adverse effect on animals. Therefore, no adverse effects on aquatic invertebrates are expected from exposure to the H7-1 gene product for all alternatives.

(1) Alternative 1 – No Action

Impacts on Aquatic Invertebrates from Herbicide Use. As discussed previously, under Alternative 1, there would be a transition to greater use of non-glyphosate herbicides and much less use of glyphosate as H7-1 sugar beet is replaced with conventional sugar beet. Aquatic invertebrate exposure to herbicides is possible due to spray drift or transport (via wind or water flow from rainfall) of soil particulates loaded with adsorbed herbicide.

Table 4–15 displays acute toxicity values and EPA toxicity categories of the sugar beet herbicides for aquatic invertebrates, as measured in laboratory tests. Almost all of the acute toxicity tests and the few chronic tests were conducted with the water flea *Daphnia magna*. Clopyralid, pyrazon, and trisulfuron-methyl are practically non toxic. Clethodim, ethofumesate, glyphosate, and sethoxydim are slightly toxic. Cycloate, desmedipham, EPTC, phenmedipham, and quialofop-p-ethyl are moderately toxic. Trifluralin is highly toxic.

APHIS analyzed the relative acute risk of herbicides used on conventional sugar beet on aquatic invertebrates. Relative toxicities of the herbicides compared with glyphosate a.i. were calculated as the inverse of the herbicide toxicity divided by the inverse of glyphosate a.i. toxicity. The results are displayed in Table 4–16, column (A), below for both Alternatives 1 and 2. The main difference is that glyphosate is used at lower maximum rates under Alternative 2 for pre emergence applications and is also used for post emergence applications. Table 4–16 indicates a similar pattern of acute toxicity and RRs for freshwater aquatic invertebrates under Alternative 1 as estimated for freshwater fish under Alternative 1 (see Tables 4–12 and 4-13). As for fish, glyphosate a.i. alone is one of the least toxic herbicides to aquatic invertebrates on an acute basis. The potential risk to aquatic invertebrates relative to glyphosate is greater from cycloate, desmedipham, EPTC, phemedipham, and trifluralin. Desmedipham and phenmedipham are expected to be widely used herbicides on sugar beet with 94% and 80% of crop acreage treated, respectively (Table 3-14). As such, potential adverse impacts to aquatic invertebrates from herbicide use are more likely under Alternative 1 than under Alternative 2 based on a comparison of the active ingredients. Certain glyphosate formulations are known to be more toxic to aquatic organisms than the active ingredient alone. A comparison of the glyphosate formulated product to the formulated products of the other sugar beet herbicides, however is not possible because in most cases their toxicity has not been evaluated and the composition of the ingredients are proprietary.

EPA OPP has estimated risks to aquatic organisms, living in small water bodies adjacent to sugar beet fields, from the application of herbicides per EPA label instructions based on the estimated environmental concentration in surface waters and acute or chronic toxicity values (see Table 4-17). EPA OPP's environmental assessment for clopyralid was not available, and EPA OPP did not report some of the EEC values used to develop the RQ values shown in the table (e.g., acute EECs for cycloate and pyrazon). Chronic toxicity values were only available for ethofumesate, glyphosate, and trifluralin. All acute RQ values were below 0.05 and all chronic RQ values were below 1 meaning that for each herbicide the potential risk does not pose risks of concern for fish and aquatic species (U.S. EPA 2004)Therefore, even though the non-glyphosate herbicides are more toxic to aquatic organisms than is glyphosate, exposure levels for all herbicides are expected to be low so the potential risk to aquatic invertebrates does not pose risks of concern under both Alternative 1 and 2. As no direct impacts on aquatic invertebrates are

Table IV-15. Acute and Chronic Herbicide Toxicity Values and Acute EPA OPP Toxicity Categories for Freshwater Aquatic Invertebrates[1]

Herbicide	Lowest Toxicity Value (species)		EPA OPP Acute Toxicity Category
	Acute (48-hr)[2] LC_{50} (mg a.i/L)	Chronic NOAEL/LOAEL (mg a.i./L)	
Clethodim	20.2	ND	Slightly toxic
Clopyralid	225	NR	Practically nontoxic
Cycloate	2.6	ND	Moderately toxic
Desmedipham	1.88	ND	Moderately toxic
EPTC	3.5	ND	Moderately toxic
Ethofumesate	64	0.25/0.75	Slightly toxic
Glyphosate a.e.	53.2	49.9/95.7	Slightly toxic
Phenmedipham	3.2	ND	Moderately toxic
Pyrazon	>131[3]	10/NL[4]	Practically nontoxic
Quizalofop-p-ethyl	2.12–6.4	ND	Moderately toxic
Sethoxydim	78	ND	Slightly toxic
Trifluralin	0.56	0.0024/0.0072	Highly toxic
Triflusulfuron-methyl	>960	11/NL	Practically nontoxic

Sources: EPA OPP RED documents and EPA OPP Ecological Fate and Effects Division (EFED) ecological risk assessment documents available from the herbicide dockets unless noted otherwise

[1] EPA OPP categories of acute toxicity for aquatic organisms based on LC_{50} values in mg a.i./L: <0.1 very highly toxic; 0.1–1 highly toxic; >1–10 moderately toxic; >10–100 slightly toxic; >100 practically nontoxic.

[2] Column header Acute LC_{50} assumes that immobility in small invertebrates, like water fleas, is equivalent to death. Values often reported as EC_{50}'s for immobilization because "death" not confirmed.

[3] Pyrazon metabolite B-1 is no more toxic than parent compound; water flea EC_{50} for pyrazon metabolite B-1 >100 mg/L.

[4] Chronic invertebrate test from comments on ecological risk submitted to EPA by BSAF Corp.

Abbreviations: a.e.=acid equivalent, a.i= active ingredient, NR = data not required by EPA OPP because acute toxicity very low, ND = no data available, NL = LOAEL not listed, TGAE = technical grade acid equivalent, TGAI = technical grade active ingredient,

Table IV-16. Alternatives 1 and 2: Relative Acute and Toxicity and Risk of Herbicides Used on Sugar Beet to Freshwater Aquatic Invertebrates

Herbicide	Acute Toxicity		Alternative 1: Maximum Single Application Rate		Alternative 2: Maximum Single Application Rate		Alt 1: Relative[6] Risk (RR) = (A) × (B)	Alt 2: Relative[6] Risk (RR) = (A) × (C)
	LC_{50}[1] (mg a.i./L)	(A)[2] Relative to Glyphosate TGAI	Rate[3] (lb a.i./acre/ app)	(B)[4] Relative to Glyphosate TGAI	Rate[3] (lb a.i./acre/ app)	(C)[5] Relative to Glyphosate TGAI		
Clethodim	20.2	**3.2**	0.25	0.055	0.25	0.083	0.18	0.27
Clopyralid	225	**2.9**	0.33	0.073	0.33	0.110	0.021	0.032
Cycloate	2.6	**25**	4.0	0.89	4.0	1.333	**22**	**33**
Desmedipham	1.9	**35**	1.28	0.28	1.28	0.427	**9.8**	**15**
EPTC	3.5	**19**	4.6	1.0	4.6	1.533	**19**	**28.4**
Ethofumesate	64	1.0	3.75	0.83	3.75	1.25	0.83	**1.25**
Glyphosate[7] PRE	65	1.0	4.51	1.00	3.00	1.00	1.0	1.0
Glyphosate[7] POST	65	1.0	0	0	1.37	0.46	0	0.46
Phenmedipham	3.2	**20**	0.63	0.14	0.63	0.21	**2.8**	**4.26**
Pyrazon	>131	<0.50	7.3	1.6	7.3	2.43	0.80	**1.21**
Quizalofop-p-ethyl	2.12	**30.6**	0.083	0.018	0.083	0.028	0.56	0.84
Sethoxydim TGAI	78	0.83	0.47	0.10	0.47	0.16	0.087	0.13
Trifluralin	0.56	**116**	0.75	0.17	0.75	0.25	**19**	**29**
Triflusulfuron-methyl	>960	<0.068	0.032	0.00710	0.032	0.011	0.00048	0.00072

[1] Acute toxicity data from Table 4–15; reported as mg a.i./L
[2] Relative acute toxicity calculated as (1/LC_{50} herbicide a.i.) divided by (1/LC_{50} glyphosate a.i.). Numbers in bold indicate acute toxicity values greater than glyphosate a.i.
[3] Maximum single application rate allowed from Table 4–5.
[4] Relative single maximum application rate calculated as rate for herbicide divided by rate for glyphosate a.i., assumed to be 4.5 lb a.i./acre preemergence in one application for Alternative 1 and 3.0 lb a.i./acre in one application preemergence for Alternative 2.
[5] Relative risk (RR) is the product of relative toxicity (A) and relative maximum single application (B for Alternative 1 and C for Alternative 2).
[6] Toxicity values for glyphosate have been adjusted from values reported on an acid equivalent (a.e.) basis to active ingredient (a.i.) in this table by multiplying the a.e. value by 1.22. Bold numbers indicate herbicides exhibiting higher relative risks than glyphosate.
Abbreviations: EC_{50} = Effective concentration for endpoint for 50 percent of organisms, endpoint is immobility or death, which cannot readily be distinguished with water fleas; LC_{50} = lethal concentration to 50 percent of animals; PRE = preemergence application, glyphosate is not applied postemergence to conventional sugar beet; TEP = typical end-use product; TGAI = technical grade active ingredient; NR = not relevant, maximum application rates not reported and no data on adjuvants in formulation

Table IV-17. EPA-Estimated Environmental Concentrations (EECs) of Herbicides in Surface Waters (from Drift and Runoff) and Risk Quotients (RQs) for Freshwater Aquatic Invertebrates

Herbicide	Scenario (lb a.i. /acre)	Acute EEC in Surface Water (ppm)	Longer-Term EEC in Surface Water (ppm)	Acute Risk Quotient (RQ)	Chronic Risk Quotient (RQ)
Clethodim	2 x 0.25	0.007	ND	<0.05	ND
Clopyralid	ND	ND	ND	ND	ND
Cycloate	1 x 4.0	ND	ND	0.001–0.012	ND
Desmedipham	2 x 0.98	0.0141(ground) 0.0145 (aerial)	ND	0.0075 (ground) 0.0077 (aerial)	NC
EPTC[1]	1 x 6.1	Refined aquatic exposure modeling resulted in a maximum peak concentration of 0.04 ppm. This is far lower than the lowest aquatic invertebrate EC_{50} (6.5 ppm). This indicates the EPTC is unlikely to have acute effects on aquatic animals.			ND
Ethofumesate	1 x 3.75	0.0527	0.0491	<0.01	0.16
Glyphosate[2]	1 x 3.75	0.028 (peak)	0.011 (90-day)	0.0005	0.0004
Phenmedipham	1 x 0.975	0.01695 (24-hr)	0.01351 (90-day)	<0.01	ND
Pyrazon	1 x 7.3	ND	ND	<0.0007– <0.0015	ND
Quizalofop-p-ethyl	1 x 0.165	.00257	.00257 (60-day)	<<0.01	ND
Sethoxydim	2 x 0.47	0.087	ND	0.001	ND
Trifluralin	1 x 2.0	0.00701	0.00039 (90-day)	0.006	0.2
Triflusulfuron-methyl	1 x 0.03	0.016068	ND	0.0000167	ND

Sources: EPA Registration or Reregistration Eligibility Documents (REDs), EPA OPP EFED ecological risk assessment documents in EPA dockets online, and other sources; see Table 4–5 for each herbicide.
[1] Scenario: single application rate higher than maximum single application rate of 4.6 lb a.i./acre for EPTC for sugar beet.
[2] Scenario: single application rate for glyphosate lower than maximum single application assumed for conventional sugar beet preemergence, but higher than maximum single application rate assumed for H7-1 sugar beet preemergence.
Abbreviations: EEC = estimated environmental concentration; ND = no data; mg a.i./L = milligram active ingredient per liter water

expected from herbicide use, no indirect impacts are also expected on animals that consume terrestrial invertebrates.

Impacts on Aquatic Invertebrates from Crop Management Practices. On those agricultural lands that would no longer be allowed to grow H7-1 sugar beet, farmers could allow the land to become fallow (unplanted), plant conventional sugar beet (or a rotational crop), or use the land for other purposes. Under Alternative 1, allowing the land to go fallow for a year and continuing to plow the land could increase the erosion of topsoil via wind or rainfall, thereby indirectly impacting aquatic invertebrates that year. Soil erosion can result in movement of herbicides, fertilizers, and other pesticides as well as soil particles from the fields into nearby surface waters, with a variety of indirect effects occurring in aquatic animals. Small ponds are more susceptible than larger ponds or lakes or flowing waters.

It is likely that plowed lands will be planted with conventional sugar beet or other crops (eventually) limiting these potential short-term impacts. If farmers do not continue to plow the fallow lands, the fallow lands would revert to more natural grasslands/shrublands, which could result in less soil erosion compared with land that is planted with sugar beet or is fallow and plowed. In the longer term, once farmers replace H7-1 sugar beet with conventional varieties, in-crop tillage practices could result in erosion of topsoil via wind or rainfall, thereby periodically indirectly affecting aquatic invertebrates as discussed in the paragraph above.

In summary, if used according to label instructions, under Alternative 1, the potential risks of all herbicides used on sugar beet are not expected to pose risks of concern for freshwater aquatic invertebrates. Cycloate, EPTC, and trifluralin are the herbicides that are most toxic to aquatic invertebrates. Phenmedipham and desmedipham are widely used sugar beet herbicides that are also more toxic to aquatic invertebrates than is glyphosate. The additional conventional tillage expected under Alternative 1 could result in indirect adverse effects on freshwater invertebrates from soil erosion, including movement of herbicides, fertilizers, and other pesticides as well as soil particles into nearby surface waters. Small ponds are more susceptible than larger ponds or lakes or flowing waters.

(2) Alternative 2 – Full Deregulation

Impacts on Aquatic Invertebrates from Herbicide Use. Alternative 2 would result in higher amounts of glyphosate-based herbicide used on sugar beet compared to Alternative 1 because Alternative 2 would result in the greatest adoption of H7-1 sugar beet. The geographic extent to which aquatic invertebrates might be exposed incidentally to glyphosate would be greater under Alternative 2 than under Alternative 1. The non-glyphosate herbicides would be used over much smaller areas compared with Alternative 1 (see Table 3-18).

As described under Alternative 1, Table 4–16 (above) compares the relative risks of acute impacts on aquatic invertebrates from single applications of herbicides as used on H7-1 sugar beet under Alternative 2 with single applications of herbicides as used on conventional sugar beet under Alternative 1. Under Alternative 2, glyphosate is used at lower maximum application rates than under Alternative 1 so the relative risk of using glyphosate is diminished relative to the non-glyphosate herbicides. As described under Alternative1, several widely used sugar beet herbicides are more toxic to aquatic invertebrates than is glyphosate and when considering the maximum application rate, the potential risk is also much greater. As mentioned above, these herbicides are cycloate, EPTC, desmedipham, phenmedipham, and trifluralin. Though these herbicides are more toxic, their corresponding acute RQ values do not pose risks of concern so no unreasonable adverse impacts are expected to aquatic invertebrates from either Alternative 1 or 2.

As described under the section "Impacts on Fish and Amphibians," there is the potential for indirect effects on habitat for aquatic invertebrates from glyphosate use on lands that abut natural areas when the distance between the sugar beet field and the natural area is less than that recommended for mitigation. The extent of this indirect effect is uncertain because the number of sugar beet farms that are within the recommended mitigation distance from natural areas is not known. Other non-glyphosate herbicides may have similar effects if used in proximity to natural areas.

Impacts on Aquatic Invertebrates from Crop Management Practices. As discussed in section III.B.1, growing H7-1 sugar beet would allow farmers to reduce the amount of tillage required under Alternative 2 compared with Alternative 1. Compared to tillage practices associated with conventional sugar beet, conservation tillage systems expected to be prevalent under Alternative 2 benefit aquatic invertebrates by reducing the potential for topsoil erosion via wind or rainfall. Depending on location, use of conservation tillage can reduce movement of herbicides, fertilizers, and other pesticides as well as soil particles into nearby surface waters. Adverse indirect effects on aquatic invertebrates from glyphosate spraying Thus, Alternative 2 would reduce potential indirect impacts on aquatic invertebrates in surface waters compared with Alternative 1.

If used according to label instructions, under Alternative 2, none of the herbicides are expected to pose unreasonable adverse effects in freshwater aquatic invertebrates even though non-glyphosate herbicides (cycloate, desmedipham, EPTC, phenmedipham, and trifluralin) are more toxic to aquatic organisms than is glyphosate. Alternative 2 would reduce potential indirect impacts on aquatic invertebrates compared with Alternative 1 due to the increased use of conservation tillage practices.

(3) Alternative 3 – Partial Deregulation

Impacts on Aquatic Invertebrates from Herbicide Use. Under Alternative 3, glyphosate would be the principal herbicide applied to H7-1 sugar beet root crop and non-glyphosate herbicide use would be reduced in all areas of the country except Imperial Valley. If used according to label instructions, none of the herbicides are expected to pose unreasonable adverse effects to aquatic invertebrates as discussed for Alternative 2. Of the five herbicides that pose a higher potential risk to aquatic invertebrates than glyphosate, desmedipham, phenmedipham, and trfluralin are all extensively used in Imperial Valley. Thus potential risk to aquatic invertebrates is greater under Alternative 3 than Alternative 2 but less than Alternative 1. Indirect effects from herbicide impacts on vegetation near streams and small water bodies are not expected to pose risks of concern as described under Alternative 2.

Impacts on Aquatic Invertebrates from Crop Management Practices. In those areas where H7-1 sugar beet is grown, the potential impacts on aquatic invertebrates from crop management practices would be similar to Alternative 2. In Imperial Valley, the potential impacts on aquatic invertebrates would be similar to Alternative 1 because conservation tillage is not expected to be practiced in Imperial Valley regardless of whether H7-1 sugar beet are grown.

2. Micro-organisms

For each alternative, APHIS analyzed the potential effects on micro-organisms from (1) exposure to the H7-1 gene and gene product, (2) herbicide use, and (3) crop management practices. (See section IV.E.2 for a discussion of soil quality changes as a result of impacts on micro-organisms.)

a. Alternative 1 – No Action

(1) Impacts on Micro-organisms from Exposure to the H7-1 Gene and its Product

Micro-organism exposure to the H7-1 gene might occur from residual H7-1 DNA in any plant materials remaining in the field that are tilled into soils after the final harvest of H7-1 sugar beet and from previous tillage of H7-1 plant remains into the soils. Similarly, exposure of soil microbial populations to the CP4 EPSPS protein is possible from tillage of H7-1 plant materials into soils.

Detailed discussion of potential impacts on micro-organisms from exposure to the H7-1 gene and its product is presented below under Alternative 2, because H7-1 sugar beet would be phased out of U.S.

agriculture under Alternative 1, and Alternative 2 would result in the greatest adoption of H7-1 sugar beet. Under Alternative 1, there would be little to no exposure of micro-organisms to the H7-1 gene and its product.

(2) Impacts on Micro-organisms from Herbicide Use

Under Alternative 1, there would be a rapid transition to greater use of conventional herbicides and much less use of glyphosate as H7-1 sugar beet is replaced with conventional sugar beet. The proportion of sugar beet acreage on which glyphosate is used and the rates and volumes of glyphosate applications on sugar beet would likely decrease to the level of use that is used on conventional sugar beet; see Tables 3–17 and 3-18). Micro-organism exposure to such herbicide applications would occur in the sugar beet fields and possibly in areas adjacent to the fields due to spray drift or direct overspray.

Agricultural practices that involve high disturbance and reliance on chemical additives can limit micro-organism diversity (Kennedy et al., 2004)and activity (Blasioli et al., 2011). Some herbicides are toxic to biota in general, while others show low toxicity to non-target organisms or even contribute to short-term stimulation of bacteria (Ratcliff et al., 2006; Damin and Trivelin, 2011). However, generalizations regarding herbicide impacts on microbial populations from specific active ingredients in the absence of available data are complicated by the fact that the effect is influenced by a wide range of factors. These factors include the physical and chemical properties of the herbicides, the species of micro-organism exposed (and therefore the metabolic route of impact), the rate of herbicide application, soil properties, and climatic factors (Damin and Trivelin, 2011). Table 3–50 displays the half-lives of the sugar beet herbicides. Clethodim, EPTC, sethoxydim, and triflusulfuron-methyl all have half-lives that are less than 10 days, indicating they are either degraded by soil micro-organisms relatively quickly or do not persist in the soil. The remaining herbicides have similar half-lives, ranging from 21 to 60 days, except for quizalofop-p-ethyl, which has a half-life of approximately 216 days.

Depending on the herbicides used under Alternative 1, micro-organisms might experience adverse effects from herbicide application to sugar beet fields. Phenmedipham, pyrazon, ethofumesate, and a phenmedipham-ethofumesate mixture have been found to temporarily adversely affect soil micro-organisms, as evidenced by decreased nitrification (phenmedipham-ethofumesate mixture) and reduced adenosine triphosphate (ATP) levels (ethofumesate, pyrazon, phenmedipham, and mixture) (NLM (National Library of Medicine), 2007). Some variation in inhibitory effect and duration was observed according to soil type (sandy clay versus sandy loam), though general trends were consistent with phenmedipham, ethofumesate, and pyrazon, respectively, demonstrating increasingly greater microbial inhibition (NLM (National Library of Medicine), 2007). EPTC also has been shown to be toxic to bacteria (Virág et al., 2007), and cycloate has been shown to significantly reduce fungi growth even with other nutrient additions (Campbell and Altman, 1977).

Not all observed effects on micro-organisms exposed to conventional sugar beet herbicides have been adverse, however. For example, in conducting a biological assessment on behalf of the U.S. Forest Service to consider the site-specific environmental consequences of treating invasive plants with herbicides, Scott and Haines (Scott and Haines, 2008)reported that no adverse effects on soil organisms were expected from application of sethoxydim at rates of 0.3 lb a.i. per acre (recall that the typical application rate of sethoxydim on sugar beet is 0.33 lb a.i. per acre as presented in Table 3–16). They reported that assays of soil micro-organisms noted transient shifts in species composition at soil concentration levels far exceeding concentrations expected from U.S. Forest Service application. Similarly, Roslycky (1986, as cited (Tu et al., 2001)) studied the effects of sethoxydim on populations of soil microbes. At sethoxydim concentrations less than 50 ppm, a negligible response was noted in microbial populations. At higher concentrations (1,000 ppm), soil actinomycetes and bacteria populations were stimulated, but fungal populations remained approximately the same.

An increase in microbial biomass was noted in a study carried out by Baeva (2000) where clethodim applied to a soybean field stimulated bacteria, actinomycetes, and fungi (particularly in surface soil). DEFRA (1993) reported that desmedipham application on a sandy loam soil and a silt loam soil produced slight variations in microbial response, but generally the results showed no impact or slightly enhanced colony numbers of soil bacteria, actinomycetes, and fungi. Hang et al. (2001) observed stimulated growth of soil micro-organisms at low concentrations of trifluralin application, while colony development was inhibited at higher doses. Similarly, clopyralid was found to stimulate development of actinomycetes and fungi (Vasic et al., 2009). No studies specifically assessing the impacts of quizalofop-p-ethyl and trisulfuron-methyl on microbial populations were located.

APHIS previously analyzed effects of glyphosate on soil micro-organisms in appendix N of the *Final Environmental Impact Statement for Glyphosate-Tolerant Alfalfa Events J101 and J163: Request for Nonregulated Status* (USDA-APHIS, 2010a). The results of that analysis, as well as additional research, are presented below under Alternative 2, because Alternative 2 would result in the greatest use of glyphosate. In summary, there are reports that glyphosate application might favor development of detrimental microbial species (or harm some beneficial microbes); however, to date there is no conclusive evidence linking applications of glyphosate to changes in soil microbial communities that have adverse effects on plants grown in those soils.

In conclusion, information on the effects of herbicides on soil microbes and microbial communities is limited, and research to date appears to have focused on glyphosate. However, available information suggests that applications of non-glyphosate conventional sugar beet herbicides might adversely affect soil micro-organisms. Glyphosate, which would be used less than the other herbicides under Alternative 1, also might result in shifts in soil microbial communities, but such shifts are not expected to harm plants that grow in those soils.

(3) Impacts on Micro-organisms from Crop Management Practices

Management practices used in sugar beet production can affect soil micro-organisms by altering microbial populations and activity through modification of the soil environment. The impacts from crop management practices have the potential to be beneficial to some soil biota and detrimental to others. In addition to herbicide use (which is described immediately above), tillage can influence microbial populations and their activities (Gupta and Roget, 2010). Micro-organisms are sensitive to physical soil disturbance, and their population dynamics can serve as indicators of changes in soil quality (Kennedy et al., 2004). For example, the interactions between micro-organisms and organic matter in the soil largely determine the fertility and overall quality of the soil. See section III.E.2.e for further discussion of micro-organism contribution to soil quality.

Under Alternative 1, if farmers allow the land to become fallow for a few years in the short term and continue to plow the land seasonally to inhibit colonization by weeds, the tillage would periodically disrupt the micro-organism's soil habitat. Tilling usually disturbs at least 15–25 cm of the soil surface and replaces stratified surface soil horizons with a tilled zone that is more homogeneous with respect to physical characteristics and residue distribution. The loss of a stratified soil microhabitat causes a decrease in the density of soil micro-organisms (Altieri, 1999). If farmers do not continue to plow the fallow lands, these fallow lands would revert to more natural grasslands/shrublands and soil habitat conditions would be more stable. There might be a short-term change in the abundance and species of soil micro-organisms present, with shifts toward more natural communities found in the absence of pesticides and fertilizers. This would be short term and only last until another crop is planted. Longer term impacts would depend on subsequent land use.

If farmers immediately plant conventional sugar beet (or a rotational crop) rather than allowing the land to go fallow, periodic disruption (i.e., conventional tillage) to micro-organism habitat would occur when farmers till the fields, which can result in the impacts described in the paragraph above. Also, as mentioned in section III.B.1.d, conventional tillage associated with growing conventional sugar beet involves more tillage and less crop residue retained in the field compared with conservation tillage practices employed by H7-1 sugar beet growers in regions such as the Great Plains and the Northwest. Not retaining crop residues during harvest can result in less microbial biomass and microbial activity compared to agricultural fields where crop residues are preserved on the soil surface (Kennedy et al., 2004). This in turn could lead to a decline in soil organic matter quality over time (see section IV.E.2 for a discussion of soil quality).

b. Alternative 2 – Full Deregulation

(1) Impacts on Micro-organisms from Exposure to the H7-1 Gene and Gene Product

Alternative 2 would result in the greatest adoption rate of H7-1 sugar beet. Thus, the potential for micro-organism exposure to the H7-1 gene and gene product would be greatest under Alternative 2.

After conducting an extensive literature search, APHIS is not aware of any data to date indicating that transfer of the intact *cp4 epsps* gene into microbes has occurred. Exposure to H7-1 DNA in soils, however, is unlikely to result in transfer of the intact *cp4 epsps* gene into microbes, because biodegradation of plant materials tilled into soils generally results in fragmentation of DNA strands into small pieces, none of which are likely to be long enough to represent an intact entire *cp4 epsps* gene (Lerat et al., 2007; Hart et al., 2009; Levy-Booth et al., 2009).

Although several mechanisms of gene transfer exist among micro-organisms, as discussed in section III.C.4, evidence of horizontal gene transfer (HGT) between higher plants and bacterial species, or between plants and their parasites, is extremely limited. As discussed in section III.C.4, plants growing in nature have numerous opportunities to interact directly with other organisms such as fungi and bacteria. Despite this frequent interaction, there are no reports to date of significant HGT between sexually incompatible or evolutionarily distant organisms (as reviewed in (Keese, 2008). Where data indicate HGT might have taken place, these events are believed to have occurred on an evolutionary time scale on the order of millions of years (Koonin et al., 2001; Brown, 2003). Furthermore, there has been no evidence of HGT occurring as a result of transgenes in crop species (Pontiroli et al., 2007; Demanèche et al., 2008). Therefore, HGT between H7-1 sugar beet and micro-organisms is not expected.

Exposure to the CP4 EPSPS protein in soils also is unlikely. The potential for intact CP4 EPSPS protein in a functional configuration to appear in soils is remote, because the protein degrades once it is released from cells decaying in soils (Australian Government, 2006) If some molecules did persist in soils, there is no reason to anticipate toxicity of the CP4 EPSPS protein to soil microbes. Microbes might be exposed to the protein if they incorporate an intact *cp4 epsps* gene from the environment which became functional within the bacterial genome. Although unlikely, if this occurred and glyphosate-resistant micro-organisms developed, populations of glyphosate-resistant microbes could expand with repeated glyphosate applications and displace non-glyphosate-resistant microbes. Because gene transfer between micro-organisms is common (Keese, 2008; McDaniel et al., 2010), if an intact *cp4 epsps* gene was incorporated into a micro-organism, the micro-organism might transfer the gene to other micro-organisms, resulting in a greater presence of the gene in the environment. The *cp4 epsps* gene was isolated from a naturally occurring bacteria nearly 20 years ago so it is possible that exchange of the *cp4 epsps* gene has been ongoing for decades. Given that gene transfer between plants and micro-organisms is thought to occur on an evolutionary time scale, there is not likely to be any incremental increase in gene transfer among micro-organisms under Alternative 2.

(2) Impacts on Micro-organisms from Herbicide Use

Under Alternative 2, potentially all of the approximately 1.1 million acres planted in sugar beet would receive applications of glyphosate. Also, Alternative 2 likely would result in the use of lower amounts of the numerous other non-glyphosate herbicides used to control weeds in conventional sugar beet fields as expected under Alternative 1 anddescribed in section III.B.1.f.

APHIS previously analyzed effects of glyphosate on soil micro-organisms in appendix N of the *Final Environmental Impact Statement for Glyphosate-Tolerant Alfalfa Events J101 and J163: Request for Nonregulated Status* (USDA-APHIS, 2010a). The results of that analysis are summarized here, and additional research is presented. Several types of micro-organisms produce aromatic amino acids through the shikimate pathway,[31] similar to plants. Because glyphosate inhibits this pathway, it could be expected that glyphosate would be toxic to micro-organisms. Contrary to expectations, older field studies show that glyphosate has little effect on soil micro-organisms, and, in some cases, field studies have shown an increase in microbial activity due to the presence of glyphosate, although the taxa of microbes responsible for increased respiration were not identified (USDA-FS, 2003).

[31] The shikimate pathway is the biosynthetic sequence (or pathway) by which plants and micro-organisms (e.g., bacteria) generate the aromatic amino acids. The shikimate pathway is found only in micro-organisms and plants, never in animals.

A number of studies have found that plant susceptibility to glyphosate is greater in non sterile soils than in sterile soils (Johal and Rahe, 1984; Levesque and Rahe, 1992; Schafer et al., 2009) leading these authors to conclude that soil microorganisms play a role in the mode of action of glyphosate. Several studies have observed shifts in the microbial community from glyphosate treatment particularly an increase in pathogenic microorganisms associated with plants after glyphosate treatment. Kremer and Means (2009) reported that roots of glyphosate-resistant corn and soybean treated with glyphosate were heavily colonized by *Fusarium*, compared to non-glyphosate-resistant or glyphosate-resistant cultivars not treated with glyphosate. They also reported a reduction in *Pseudomonad* spp., which are considered beneficial bacteria that produce antifungal chemicals as metabolites. However, Kremer and Means (2009) never demonstrated that the increased colonization was associated with an increase in disease. (Fernandez et al., 2009)reported that glyphosate and non tillage were associated with increased inoculum levels of *Fusarium* in barley and wheat fields but were unable to determine which factor(s) played the most important role. Similarly, Zobiole et al. (2011)reported increased root colonization by *Fusarium* spp. in response to glyphosate application to glyphosate-resistant soybeans but also did not show an increase in disease of the plants. Importantly, these studies do not provide definitive evidence that establishes increased disease susceptibility in glyphosate-resistant crops treated with glyphosate.

Powell and Swanton (2008) reviewed the studies that examined the effects of glyphosate on diseases associated with *Fusarium*, and cited greenhouse studies that have shown *Fusarium* growth to be stimulated by glyphosate. In their review of the literature, however, they found no direct evidence of glyphosate effects on either *Fusarium* abundance or *Fusarium*-related disease in field studies. EPA and others have concluded that based on chemical fate and toxicity, glyphosate is not expected to pose an acute or chronic risk to micro-organisms if label directions are followed (U.S. EPA 1993c). Long-term soil studies following repeated applications of Roundup® agricultural herbicides in the field have shown no detectable long-term adverse effects on soil microbes (Olson and Lindwall, 1991; Hart and Brookes, 1996). Investigations have shown that glyphosate is degraded by soil microbes so that even at high application rates, the soil microbial community is not affected (Haney et al., 2002) Ratcliff et al. (2006) applied glyphosate at different rates to a clay loam soil and a sandy loam forest soil in California to investigate potential changes in microbial community structure. When applied at the recommended field rate for a Ponderosa pine plantation (5 kg a.i. per hectare, or 3.65 lb a.e. per acre, which is over 3 times the rate applied to H7-1 sugar beet (1.125 lb a.e. per acre), few changes in microbial community structure were observed. The authors concluded that the commercial formulation of glyphosate has a benign effect on soil microbial community structure when applied at the recommended field rate.

As described in section III.C.3.d.(1), one study of glyphosate on disease susceptibility of the Roundup Ready® sugar beet event T-120 observed mixed results in the greenhouse (Larson et al., 2006) but was not repeatable in the field (Larson, 2010). Thus the data from sugar beet are not consistent with an adverse effect of glyphosate on promoting disease susceptibility. Furthermore, sugar beet growers only use varieties that have been tested in the field for disease resistance.

In conclusion, information on the effects of herbicides on soil microbes and microbial communities is limited, and research to date appears to have focused on glyphosate. Some studies suggest that in some soils, glyphosate application might favor development of detrimental microbial species (or harm some beneficial microbes); however, to date there is no conclusive evidence linking applications of glyphosate to changes in soil microbial communities that have adverse effects on plants grown in those soils. Sugar beet growers only use varieties that are tested in the field for disease resistance so no increased incidence of disease in sugar beet is expected from glyphosate use on H7-1 sugar beet. Available information does not indicate that glyphosate would cause substantially greater adverse effects to soil micro-organisms than the other conventional sugar beet herbicides.

(3) Impacts on Micro-organisms from Crop Management Practices

As mentioned in section III.B.1.d, after adopting H7-1 sugar beet, some growers have been using conservation tillage practices. Under conservation tillage systems, disruption or modification to the micro-organism's soil habitat from tilling would not occur as often. This reduction could lead to greater microbial activity, biomass, and diversity. Conservation tillage preserves crop residue on the soil surface, which reduces erosion and promotes microbial populations (Kennedy et al., 2004). Drijber *et al*. (2000) reported an increase in microbial biomass in a no-till system. Also, Altieri (1999) has found that no-till systems increase the ratio of fungi to bacteria and provide for a more diverse population of soil microbes than does conventional tillage.

Sugar beet farmers that implement conservation tillage practices minimize the potential impacts of tillage on micro-organisms. The percentage of farms that have been employing conservation tillage practices upon adopting H7-1 sugar beet varies between the sugar beet growing regions. As discussed in section III.B.1.c(2), conservation tillage has been widely adopted in the Great Plains and Northwest but is not practiced widely in the other three regions (Lilleboe, 2008; Lilleboe, 2010; Wilson Jr, 2012).

c. Alternative 3 – Partial Deregulation

(1) Impacts on Micro-organisms from Exposure to the H7-1 Gene and Gene Product

Under Alternative 3, exposure to the H7-1 gene and gene product would not exist for micro-organisms in California and Western Washington. For the four other regions where H7-1 sugar beet could be grown, no impacts to micro-organisms are expected because of a lack of toxicity of the gene and gene product. Similarly, no HGT between H7-1 sugar beet and micro-organisms is expected.

(2) Impacts on Micro-organisms from Herbicide Use

Under Alternative 3, glyphosate would be the predominant herbicide applied in all sugar beet growing regions with the exception of the Imperial Valley. This herbicide use would result in the same potential for impacts as described for Alternative 2 for the Northwest, Midwest, Great Plains, and Great Lakes regions and for Alternative 1 for the Imperial Valley.

(3) Impacts on Micro-organisms from Crop Management Practices

In those areas where H7-1 sugar beet is grown, the potential impacts on micro-organisms from tillage practices would be similar to Alternative 2.

In those areas where H7-1 sugar beet are not grown the potential impacts on micro-organisms from tillage would be similar to Alternative 1.

3. Plants

a. Selection for Herbicide Resistance

As discussed in section III.C.3.a, herbicide-resistant weeds result from the selective effect of herbicides on plant populations. There are many practices that can delay herbicide resistance selection in weed populations. As a result, there are impacts relating to the development of herbicide resistance from growing any crop plant that requires herbicide control, whether or not that crop is a conventional breed or genetically engineered. As of March 22, 2012, resistance has been selected in 375 unique herbicide-resistant biotypes and to 20 major categories of herbicides (Heap, 2012).

The use of H7-1 sugar beet has the potential to impact the selection of herbicide resistance in weeds due to the use of glyphosate as an herbicide, and not due to any properties of H7-1 sugar beet plants themselves.

The following sections analyze each alternative in terms of potential effects on the development of herbicide resistance in weed species as a result of growing H7-1 sugar beet seed or H7-1 sugar beet root crops. Because there are differences in herbicide usage between H7-1 sugar beet seeds and H7-1 sugar beet roots, the likelihood of developing herbicide resistance in weeds is also different. As a result, each alternative is discussed first regarding the impacts of H7-1 seed production, followed by a discussion of the impacts of H7-1 root production. The impacts of herbicide-resistant weeds in both agricultural and non-agricultural settings are discussed.

(1) Alternative 1 – No Action

H7-1 sugar beet seed production does not typically involve the use of glyphosate. As described in section IV.B.1.c, weed management in seed production fields after the adoption of H7-1 sugar beet has not appreciably changed because one of the parents in hybrid seed production lacks the H7-1 trait so it is not typically used for post-emergent weed control. Hence, glyphosate use in seed production and other weed control measures such as seed bed preparation, crop rotation, hand weeding, and in-crop cultivation would remain similar amongst all the alternatives. Development of herbicide resistance from seed production is not likely to vary under each of the alternatives.

In contrast, with regard to impacts on selection of herbicide resistance from sugar beet root production, Alternative 1 is expected to differ from the other alternatives. The potential selection of weed resistance in the four impacted regions would change under Alternative 1 compared to deregulation.

Alternative 1 would reduce weed control options for all sugar beet growing regions in the United States. Before the introduction of H7-1 sugar beet, growers had difficulty controlling weeds in their regions due to the selection of weeds with resistance to conventional herbicides such as ALS inhibitors, ACCase inhibitors, PSII inhibitors, synthetic auxins, mitosis inhibitors and fatty acid synthesis inhibitors. As reported in Table 3–9 for effectiveness of herbicides on major weeds in sugar beet, the planting of H7-1 sugar beet and the concurrent use of glyphosate as a preferred herbicide have vastly improved the control of many weed species, including weeds that have been identified as having conventional herbicide-resistant biotypes. (See section 3B.1.d.(4) for a description of why glyphosate controls weeds more effectively than non-glyphosate herbicides.)

Growers in all regions that have adopted H7-1 sugar beet would need to resume using non-glyphosate herbicides to control weeds in sugar beet. Many weeds resistant to non-glyphosate herbicides have already been selected (see Tables 3-23, 3-24, and 3-25). Under Alternative 1, selection of weeds resistant to non-glyphosate herbicides will continue to occur and existing resistant weeds will continue to grow, flower, and disperse. Such weeds, to name a few, include Kochia resistant to PSII inhibitors, ALS inhibitors, and synthetic auxins or Wild oat resistant to ACCase inhibitors, fatty acid synthesis inhibitors, ALS inhibitors, and mitosis inhibitors (Table 3-25). As described in section III.C.3.a, one of the major practices that can act to delay the development of herbicide resistance in weed species is the use of herbicides with different mechanisms of action.

Glyphosate affords growers with another herbicide mechanism of action to manage weeds that have been selected for resistance to non-glyphosate herbicides (for a list, see Table 3-24). On a pound basis, glyphosate is the third most frequently used herbicide on conventional sugar beet where it is used prior to planting and represents almost 12% of the herbicide applied (Table 3-17). On H7-1 sugar beet, it is the dominant herbicide representing 98% of the herbicide applied (Table 3-17). Under Alternative 1, growers will still be able to use glyphosate as a pre-emergent herbicide but they will have one less mechanism of action to use for post-emergent weed control and consequently, selection of herbicide-resistant weeds is expected to be greater under Alternative1 compared to Alternatives 2 and 3. With non-glyphosate herbicides, resistant biotypes of weeds are expected to be difficult to control (e.g., kochia and wild oat).

As time goes on, weed seed banks will build up, resulting in unsustainable levels of weeds in sugar beet harvests. In certain regions such as the Northwest and Great Plains, where irrigation rapidly spreads weed seed, sugar beet root production may become uneconomical and abandoned due to intense weed pressures (Sexton, 2010a). In areas where weed pressure is too high for conventional sugar beet to be economically viable, farmers could potentially lose both the use of glyphosate as a tool for combating weeds resistant to other herbicides and the use of sugar beet as a rotational crop. If the loss of sugar beet as a rotation crop results in fewer options for weed control (both mechanical and chemical) throughout the rotation, then herbicide selection for resistant biotypes could be faster than if those extra options were available.

(2) Alternative 2 – Full Deregulation

As discussed under Alternative 1, weed management in seed production fields has not substantially changed compared with methods utilized in the production of conventional sugar beet seed with the exception that glyphosate may be used for post-emergent weed control in some breeder seed fields. These fields represent a small percentage of the seed production which itself only represents less than one percent of total sugar beet production. Thus under Alternative 2, sugar beet seed production is not expected to increase the potential for glyphosate-resistant weed development.

Under Alternative 2, H7-1 sugar beet could be adopted by farmers in the Imperial Valley region. Currently, no Roundup Ready® crops are reported in rotation with sugar beet in the Imperial Valley. Sugar beet rotation crops in California include alfalfa, durum wheat, sudan grass, Bermuda grass, onions for dehdration, lettuce, carrots, sweet corn, none of which have Roundup Ready® varieties except alfalfa (see Table 3–6). However, in the Imperial Valley, growers have elected not to grow Roundup Ready®

alfalfa there according to Forage Genetics International(International, 2011).

APHIS assumes that the adoption of H7-1 sugar beet in California would result in the application of glyphosate to control weeds. As glyphosate would represent an herbicide with a different mechanism of action than is currently used, weed populations would change. Wild beet, lambsquarter, common mallow, sow thistle, canary grass, dodder, knotweed, and barnyardgrass are all problem weeds that occur in Imperial Valley sugar beet fields and that are known to be effectively controlled with glyphosate (Beet Sugar Development Foundation et al., 2011). Velvetleaf also occurs in California sugar beet fields and has some natural glyphosate tolerance and therefore may not be controlled by glyphosate applications.

Currently, *Conyza canadensis* and *C. bonariensis* are listed as glyphosate-resistant in California but are not reported as sugar beet weeds (Heap, 2011). They are both listed as weeds in roadsides and orchards, which are the type of continuous environments where selection of glyphosate-resistant weeds has been known to occur. These weeds can be controlled by cultivation and are therefore not expected to be problematic in California where conventional cultivation is also expected to be practiced should H7-1 sugar beet be adopted.

Glyphosate-resistant junglerice has been reported on two sites covering about 50 acres in California and could potentially become a problem in H7-1 sugar beet (Heap, 2011).

Glyphosate-resistant johnsongrass has been reported in soybean fields in Arkansas and Louisiana (Heap, 2011) and could become a problem in H7-1 sugar beet fields should a glyphosate-resistant biotype establish in sugar beet fields.

Wild beet, *Beta macrocarpa*, are not a problem weed in any crop except sugar beet. In the United States they are principally found in the Imperial Valley. Many herbicides control wild beet in other crops and no herbicide resistance has developed in this species. Wild beet is not controlled by conventional herbicides used in sugar beet because it is so similar to sugar beet and herbicides that can kill it would also kill sugar beet. If H7-1 sugar beet is grown in California, glyphosate resistance is not expected to evolve in *B. macrocarpa* by herbicide selection but could conceivably result from gene flow of the H7-1 trait from bolting sugar beet into flowering *B. macrocarpa*. This occurrence is unlikely as described in section III.B.5 due to an almost complete lack of flower synchrony, and extremely limited compatibility between the two species. If it did occur, however, glyphosate would lose its effectiveness in controlling wild beet and there would be a return to the current control methods of hand weeding and use of alternate herbicides in crop rotation.

In the other four regions, H7-1 sugar beet have been widely adopted and this has led to an increased use of glyphosate and decreased use of other herbicides. As discussed in section III.C.3, herbicide selection of resistant biotypes occurs most frequently when herbicides are used continuously without varying mechanisms of action. Specifically, resistance is expected to occur fastest (5 years or later) in cropping systems where the herbicide mechanism of action and crops are not rotated. As a result, selection of resistant biotypes have occurred in systems where a single herbicide is used across rotations, such as in orchards, vineyards, along roadsides, and in rotations between Roundup Ready® corn and Roundup Ready® soybeans.

Although no glyphosate-resistant weeds have been attributed to the production of H7-1 sugar beet, H7-1 sugar beet production could create an environment where glyphosate-resistant weeds may establish following dispersal from other sources. This dispersal has begun in southern Minnesota where glyphosate-resistant waterhemp, giant ragweed, and common ragweed that infested fields used for soybean are beginning to infest fields used for H7-1 sugar beet production (section III.C.3).

Furthermore, it could create a situation in certain regions such as the Midwest and Great Lakes where in a three crop rotation, all three crops would be RoundupReady®. Resistant weeds that have been selected in one crop, could then become problematic in the other crops especially if glyphosate is the only tool used for weed control. Increasingly, there have been recommendations to include either conventional crops in the rotation or to switch to LibertyLink soybean which is resistant to the herbicide glufosinate and to use alternative herbicide chemistries(CropScience, 2011). While a three crop rotation containing only glyphosate-resistant crops is more likely to result in the selection and dispersal of glyphosate-resistant weeds than a three crop rotation lacking a RoundupReady® crop, it is still preferable to a two crop rotation where both crops are RoundupReady®, because the differences in cultivation practices and crop ecology help delay resistance.

If glyphosate-resistant weeds were to become prevalent in sugar beet, combinations of herbicides with different mechanisms of action are expected to still provide effective control provided that the glyphosate-resistant weed does not already carry resistance to multiple herbicides. In that case, control could become difficult and expensive because of the need to use more chemicals and hand labor.

To estimate what possible weeds shifts could look like in H7-1 sugar beet in the future, APHIS conducted an analysis of known glyphosate-resistant weed species and their distributions in sugar beet production states. Initially, APHIS examined the distribution of glyphosate-resistant weed species in the states that produce sugar beet (Sprague and Everman, 2011);

(Table 4–18) and states that are immediately adjacent to sugar beet states. APHIS then noted if these resistant biotypes occurred in sugar beet or sugar beet rotation crops. APHIS then expanded the analysis of these glyphosate-resistant weeds by examining the distribution of additional biotypes of each species that have been noted as having biotypes that are resistant to conventional herbicides (see Table 3–26) as well as the distribution of sensitive biotypes (USDA-NRCS, 2010). Finally, APHIS examined the distribution of all remaining glyphosate-resistant species that have occurred worldwide (Heap, 2011), noting if they have been identified as sensitive biotypes in any sugar beet states. Using a tiered system to qualitatively classify the different weed species identified in each of the five sugar beet production regions, APHIS identified weed species with potential to shift into H7-1 sugar beet or other glyphosate-resistant crops in rotation with H7-1.

Table 4–18 presents a distribution of resistant weeds broken down by the five root production regions that are discussed in section III.B.1.c(1) (Imperial Valley, Northwest, Great Plains, Midwest, and Great Lakes). The table also sorts the weeds into four tiers (1, 2, 3, and 4) that denote the relative risk of the weeds becoming problems under Alternative 2. This analysis is constrained by the accuracy in reporting the identification and presence of weed species by the sources available. APHIS acknowledges that it is possible that new weed species could become problems in the future. Additionally, a weed with lower ranking could achieve a higher rank over time. Tier 1 and 2 weeds have the highest risk of shifting into H7-1 sugar beet and tier 3 and 4 weeds have a lower risk of shifting into H7-1 sugar beet. Tier rankings are not exclusive; any given weed species may have different tier rankings depending on the current weed and crop situation in each State. As a result, any given weed species can have a different tier ranking in different states. All the weeds listed in Table 4–18 have glyphosate-resistant biotypes.

The tiers in Table 4–18 were defined as follows:

Tier 1: **Weeds that currently occur in rotation crops.** The greatest risk of a problematic weed is a weed species that has been identified as having a glyphosate-resistant biotype in a crop species that has been found in sugar beet or is found in a rotated crop with sugar beet in a sugar beet producing State. These species could reproduce in rotation crops, contribute to the seed bank, and germinate in H7-1 sugar beet fields. For example, a biotype of common ragweed (*Ambrosia artemisiifolia*) has been identified as a glyphosate-resistant weed in soybean production in North Dakota. If H7-1 sugar beet were rotated into that field, it is likely that the glyphosate-resistant ragweed biotype would be selected by glyphosate-treatment in that sugar beet field. To be classified as a tier 1 risk, the weed must meet all of the following criteria: the species is a weed of sugar beet, a glyphosate-resistant biotype is present in the sugar beet producing State, and this biotype occurs in a crop that is known to be in rotation with sugar beet. These weeds are listed in Table 4–18.

In the Midwest region (Minnesota and North Dakota), APHIS identified four Tier 1 weeds including common waterhemp (*Amaranthus tuberculatus*), giant ragweed (*Ambrosia trifida*), common ragweed (*Ambrosia artemisifolia*), and kochia (*Kochia scoparia*). All four resistant biotypes were reported in crops (corn/soybean) that are rotated with sugar beet. All but kochia have been reported in sugar beet fields. As a result, growers will need to diversify their weed management strategies to control the glyphosate-resistant weeds.

In the Great Lakes region, glyphosate-resistant horseweed (*C. canadensis*) has been identified in both a rotational crop (soybean) and a stale seed bed for sugar beet. However horseweed has not been noted as a problem weed in sugar beet crops even though, in the Great Lakes, biotypes are present that are resistant to non-glyphosate herbicides used on sugar beet (Heap, 2011). Horseweed is primarily a problem in areas where no-till is used and no-till has not yet been widely adopted in Michigan sugar beet production. The occurrence of glyphosate-resistant horseweed may lead to an increase in spring cultivation in stale seed bed plantings reversing the trend away from that practice.

In the Great Plains region, glyphosate-resistant kochia is thought to be present in Nebraska and Colorado in corn and soybean. Corn is rotated with sugar beet in this region though it has not yet been reported in sugar beet fields.

Table IV-18. Glyphosate-resistant Weeds that Could Impact H7-1 Sugar Beet[1]

	Common Name	Species	Setting	Risk Tier	SB States in Region with GR weed	Nearby State
Imperial Valley	Junglerice	*Echinochloa colona*	corn, orchards, roadsides	2	CA	None
	Johnsongrass	*Sorghum halepense*	soybean	3a	None	AR, LA
Northwest	Kochia	*Kochia scoparia*	corn, cotton, cropland, soybean	3a,/b	None	KS, NE, CO, Alberta
	Common Waterhemp	*Amaranthus tuberculatus*		3a	None	IA, ND
Great Plains	Horseweed[1]	*Conyza canadensis*	soybean	1	NE	IA, MO, OK
	Kochia	*Kochia scoparia*	corn, soybean	1	NE; CO	KS
	Common Waterhemp	*Amaranthus tuberculatus*	soybean	3b	None	KS, IA, ND, MO
	Giant Ragweed	*Ambrosia trifida*	corn, soybean	1	NE	IA, KS, MN
Midwest	Kochia	*Kochia scoparia*	cropland	1	ND	KS
	Common Waterhemp	*Amaranthus tuberculatus*	Corn, soybean, sugarbeet	1	MN, ND	IA, IL,
	Giant Ragweed	*Ambrosia trifida*	soybean	1	MN	NE
	Common Ragweed	*Ambrosia artemisiifolia*	soybean	1	ND, MN	
Great Lakes	Horseweed[1]	*Conyza canadensis*	nurseries, soybean, sugarbeet	1	MI	
	Common Waterhemp	*Amaranthus tuberculatus*	soybean	3a/b	None	IN

Sources: (Heap, 2011);Stachler, 2011 #255;Nandula, 2005 #710;Cerdeira, 2006 #398;Van Deynze, 2004 #993}

[1] Glyphosate-resistant Horseweed has been identified in a sugar beet field in Michigan, but Horseweed is not considered a weed of sugar beet because it can be controlled by cultivation.

Tier 2: **Weeds that could occur following short distance dispersal**. The next greatest risk of a problematic weed is a weed species that infests sugar beet, has glyphosate-resistant biotypes in a sugar beet production State, but is currently found only in crops that are not in rotation with sugar beet. To be classified as a tier 2 risk, the weed must meet the following criteria: a glyphosate-resistant biotype is present in the sugar beet producing State in a crop that is not in rotation with sugar beet and the weed species is known to occur in sugar beet. APHIS is aware of two examples of a tier 2 risk. Glyphosate-resistant junglerice occurs in California in corn fields, orchards, and roadsides (Heap, 2011), none of which are rotated with sugar beet in the Imperial Valley, and junglerice is a weed in California sugar beet fields. Also, glyphosate-resistant horseweed occurs in soybean in Nebraska, but soybean is not rotated with sugar beet in that State. Horseweed could become a problem weed in H7-1 sugar beet that are grown with strip till and lead to a decline in that practice.

Tier 3: This tier describes two types of situations that could potentially happen. We arbitrarily label them as 3a and 3b so as not to imply one situation is more likely than the other. These scenarios depend on a number of factors such as the biology of the species, the distance between resistant biotypes and the sugar beet production area, and myriad farm practices.

- **Tier 3a: Weeds that could develop resistance elsewhere**. Here we assume that resistant biotypes could arise in a second locale if they have arisen in another. For example, Hairy Fleabane (*Conyza bonariensis*) biotypes have been selected for glyphosate resistance in South Africa, Spain, Brazil, Israel, Columbia, the United States, Australia, and Portugal (Heap, 2011). Glyphosate-resistant Hairy Fleabane is not expected to be a problem weed in sugar beet because it can be controlled by cultivation in the states where it occurs. To be classified as a tier 3a risk, the weed must meet the following criteria: demonstrated ability to develop glyphosate resistance somewhere, known weed in sugar beet, and sensitive or conventional resistance biotypes present in a sugar beet production State. These weeds are listed in Table 4–18.

- **Tier 3b: Weeds that could be dispersed over long distances.** This risk of a problematic weed is determined by the presence of a biotype of a glyphosate-resistant weed species found in a neighboring State. Because some weed species are particularly adept at dispersal, rare instances of long distance dispersal or persistent movement over several years could ultimately result in the long distance dispersal of resistant biotypes across states. A weed is classified as a tier 3b risk if it is known to be a weed in sugar beet and glyphosate-resistant biotypes are present in a neighboring State. Glyphosate-resistant waterhemp from Kansas, for example, could conceivably disperse into neighboring Nebraska.

Weeds that are naturally tolerant to glyphosate and occur as sugar beet weeds were also considered (Table 3–26). As tolerance is not tracked in the same manner as resistance, information on the presence in a single crop (or rotation crop) is not available. As discussed in Alternative 1, there is evidence that many of these tolerant weed species are currently being at least partially controlled by glyphosate applications in H7-1 sugar beet. This is not a contradiction. Tolerance can be stage dependent where older plants are much less sensitive than younger plants. Perennials, which have underground reserves, may be tolerant because they are able to regrow a shoot that has been killed by the herbicide. Alternatively, tolerance may be based on plant structures, such as a waxy cuticle or dense hairs that prevent herbicides from reaching the leaf cells. High herbicide rates, early application, and herbicide additives like surfactants can sometimes overcome tolerance. Because these naturally tolerant weeds may be controlled by glyphosate, clearly some of the formulations of glyphosate can overcome natural tolerance. Examples where glyphosate does not routinely control naturally tolerant weeds in sugar beet include Velvet leaf (*Abutilon theophrasti*), Lambsquarters (*Chenopodium album*), Nutsedge (*Cyperus* spp.), Large crabgrass (*Digitaria sanguinalis*), Filaree (*Erodium* spp.), Cheeseweed (*Malva parviflora),* Purslane (*Portulaca oleracea*), and Burning nettle (*Urtica uren*).

Alternative 2 would allow growers of H7-1 sugar beet varieties the option to control weeds resistant to non-glyphosate herbicides with post-emergent applications of glyphosate if they are present in sugar beet fields, and this in turn may reduce populations of these conventional herbicide-resistant biotypes in crops grown in rotation. If these biotypes were to develop resistance to glyphosate, alternative herbicides and continued monitoring and destruction of resistant weeds would be essential to prevent widespread dispersal of multi-herbicide-resistant weeds. Farmers are aware of the problems of glyphosate-resistant weeds and are increasingly proactive in the identification and removal of new weeds (see section III.C.3).

Under Alternative 2 growers would still have the currently available weed control methods (e.g., non-glyphosate herbicides and cultural practices described in section III.B.1.d) to manage any glyphosate-resistant weeds, whether they are present in sugar beet or other crop production fields.

In the Great Lakes, Midwest, Northwest, and Great Plains regions, H7-1 sugar beet could be used in rotation with other previously deregulated Roundup Ready® crops (e.g., corn and soybean) (see Table 3–6). As a result, these regions contain fields where glyphosate use could occur in other rotation years. Repeated use of glyphosate could lead to the selection of glyphosate-resistant weed populations in these regions. However, crop rotations themselves can effectively delay the selection of resistant biotypes by changing planting, tillage, and other management practices. If Roundup Ready® volunteers or glyphosate-resistant weed biotypes occur in these regions, it is possible that farmers could alternate to rotational crops with other herbicide resistance such as glufosinate-resistant soybeans. Additionally, incentive programs designed to encourage use of herbicide mixtures (e.g., Roundup Ready PLUS™ program, (Monsanto, 2011b)) may be used to delay resistance development by increasing the number of mechanisms of action selecting on weed populations.

Stachler et al. (2009c) recommend controlling glyphosate-resistant common ragweed in sugar beet with a mixture of glyphosate and clopyralid (Stinger). Similarly, a mixture of Stinger and glyphosate is recommended to control glyphosate-resistant giant ragweed (Stachler et al., 2009c). These herbicide combinations are expected to also control giant and common ragweed that is resistant to both glyphosate and ALS inhibitors which are known to exist in Minnesota (Stachler and Zollinger, 2009). Control of glyphosate-resistant waterhemp is much more difficult. In order to control glyphosate-resistant waterhemp, Stachler recommends several additional herbicides that include a preplant incorporation of a residual herbicide such as ethofumesate, cycloate, cycloate plus EPTC, or metolachlor and then a tank mixture of glyphosate, phenmedipham plus desmedipham (Betamix), ethofumesate, and either metolachlor or dimethenamid-P (Stachler and Luecke, 2011) and Stachler personel communication (Stachler, 2012). The additional herbicide cost is estimated to be $133/acre more than glyphosate alone (Stachler, 2012).

Changes in weed populations since the adoption of H7-1 sugar beet indicate that glyphosate has resulted in dramatic changes in the weed seed bank (Stachler et al., 2011). In farm scale experiments with sugar beet, (Heard et al., 2003a; Heard et al., 2003b) weed biomass and seed rain (seeds deposited to the soil) were lower for Roundup Ready® crops compared to conventional crops. Because of the trends observed for weed reductions and improvement in weed control in the four regions where H7-1 sugar beet has been grown, APHIS believes that weed seed banks will diminish under Alternative 2. The possibility that glyphosate-resistant weeds may appear in sugar beet fields could reverse this trend. Alternatively, the decline trend may be maintained by the use of additional herbicides with glyphosate to better manage glyphosate-resistant weeds.

Crop monitoring and follow up by academic and industry weed scientists in cases of suspected resistance are important parts of all herbicide stewardship programs. There is widespread information regarding combating glyphosate resistance available to sugar beet farmers from universities, crop commodity groups, and manufacturers. Growers have strong economic incentives to utilize properly their glyphosate-resistant sugar beet cropping systems, and their actions reflect this. Sugar beet growers and processors have established funds to support research and extension activities on weed resistance. Western Sugar Cooperative sponsors grower meetings at multiple locations in their growing regions to provide every grower the opportunity to discuss industry issues and learn about new research developments. Researchers from Colorado, Nebraska, and Wyoming, in cooperation with Monsanto, are developing region-specific technology usage guides to address weed management in cropping rotations that include sugar beet. Guides will provide regional and weed specific (kochia, common lambsquarters and pigweed) recommendations for corn, small grains, dry beans, and sugar beet, therefore enhancing the benefits of crop and herbicide rotations.

The Benchmark Study was conducted over a four-year period on 155 farms, across six states, with a minimum of 40 acres per farm. Results from this study demonstrated two important concepts in regard to glyphosate-resistant (GR) crops (Wilson et al., 2011). First, weed control is improved by rotating GR crops, compared to continuous cropping of GR cotton and soybean. Second, weed management is improved by adding a herbicide at planting with a different mode of action than glyphosate, or by combining glyphosate applied postemergence with another herbicide.

The results from the Benchmark Study clearly relate to sugar beet. Even when sugar beet is grown in rotations that include other GR crops, the rotations usually contain non-GR crops that introduce herbicides with different modes of action. In GR crops, growers are progressing from only using glyphosate and are applying conventional preemergence herbicides at planting and mixing other herbicides with glyphosate when the herbicide is applied postemergence. This all points to the conclusion that GR sugar beet is sustainable with crop rotation and utilization of herbicides with different modes of action than glyphosate. These techniques also reduce the potential for weeds becoming resistant to glyphosate (Wilson et al., 2011)

In summary, APHIS has determined that adoption of Alternative 2 would result in different impacts in different regions. In the Northwest where weeds resistant to non-glyphosate herbicides are rampant and conservation tillage is practiced, Alternative 2 will provide a big benefit to weed control. In the Imperial Valley region, APHIS has determined that gene flow between H7-1 sugar beet and wild beet (*B. macrocarpa*) is unlikely due to asynchrony in flowering time and lack of cross compatibility. Adoption of H7-1 sugar beet will likely result in greater control of weed species and potentially a reduction in the weed seed bank of *B.*

macrocarpa and weed species with resistance to non-glyphosate herbicides.

In the remaining four regions, improved weed control and changes in weed populations will continue. APHIS expects, due to crop rotation practices, use of sequential herbicides with different mechanisms of action, high awareness of farmers, and the contractual management practices outlined under the Monsanto TUG, that in the short term, selection for resistance as a result of H7-1 sugar beet is unlikely. Resistant weed populations are beginning to appear in sugar beet fields in the Midwest and these will need to be controlled by employing a diversity of weed control methods including other use of other herbicide chemistries, more cultivation, crop rotation, and other biological strategies such as use of cover crops. Otherwise these weeds will grow to maturity and disperse to neighboring crops, non-agricultural lands, and contribute to the seed bank where they would impact future rotations.

All regions are expected to see a net decline in the development and dispersal of herbicide-resistant weeds due to the introduction of an additional mechanism of action for weed management. A shift in the weed seed bank to include more glyphosate-resistant weeds is more likely under Alternative 2 compared to Alternative 1. However, management practices including the use of different herbicides with different mechanisms of action (either in mixes or sequentially), consistent crop rotation practices, and BMPs (both voluntarily adopted and contractually binding) can reduce and delay the evolution and spread of resistant weeds.

(3) Alternative 3 – Partial Deregulation

Under Alternative 3, the impacts on seed production are minimal because glyphosate is seldom used in seed production fields as described under Alternative 2.

For root production, the Great Lakes, Midwest, Great Plains, and Northwest regions would continue to experience the weed control observed since the adoption of H7-1 sugar beet and described under Alternative 2. None of the permit conditions anticipated under Alternative 3 specifically impact herbicide-resistant weed management practices. In California, where H7-1 sugar beet would not be permitted, only the conventional weed management tools would be available. Impacts in those areas would be similar to those described for Alternative 1 where weed species with resistance to conventional herbicides would continue to be a problem for sugar beet farmers in the Imperial Valley.

b. Herbicide Impacts on Non-target Plants

(1) Alternative 1 – No Action

Under Alternative 1, there would be a rapid transition to greater use of the herbicides used on conventional sugar beet and about a seven fold reduction in the use of glyphosate as H7-1 sugar beet is replaced with conventional sugar beet (Table 3-18).

Under Alternative 1, if farmers allowed the land to go fallow for a few years rather than immediately planting a conventional sugar beet variety (or a rotational crop), there would be no impacts on non-target terrestrial and aquatic plants as a result of herbicide drift, because no herbicides would be applied to the land during that time. If farmers immediately planted conventional sugar beet (or a rotational crop), there would be an increase in the use of non-glyphosate herbicides used on conventional sugar beet. The potential impacts of Alternative 1 on specific non-target terrestrial plant species depends on the herbicides that are used on conventional sugar beet and how and when they are applied. These herbicides generally target either particular groups of plants, such as broadleaf weeds (dicots) or grasses (monocots), or taxonomically related weeds within those groups. Table 3–11 in section III.B.1.d lists the general targeted weed groups or species for each of the 13 herbicides used on conventional sugar beet herbicides. Potential impacts on terrestrial and aquatic non-target plants of using those herbicides on conventional sugar beet fields under Alternative 1 are discussed below.

The toxicities of the 13 herbicides used on conventional sugar beet to non-target plants are presented in Table 4–19. The U.S. EPA's OPP generally requires toxicity data for one or more representative dicots and one or more representative monocots for herbicide registration and reregistration. EPA OPP does not categorize toxicity severity levels for plants, however. The toxicity values presented in Table 4–19 for dicots and monocots broadly correspond to the target plant groups for each herbicide noted in Tables 3–11 and 4–5, with exceptions for the selective herbicides. Trisulfuron-methyl is the most toxic herbicide to non-target plants. Sethoxydim and clethodim are much more toxic to grasses than is glyphosate.

For terrestrial plants, EPA OPP evaluates two endpoints: seedling emergence and vegetative vigor (i.e., measures of plant growth). For each type of test, EPA OPP evaluates at least one monocot (e.g., a grass) and at least one dicot (i.e., broad-leaf plant). Two toxicity metrics are identified: EC_{25} and EC_{05} or no-observed effect level (NOEL. The EC_{25} is the effective concentration for inhibiting seedling emergence or plant growth by 25 percent. The EC_{25} is used to assess the potential for adverse impacts on non-listed non-target plants in the vicinity of agricultural fields. The EC_{05} is the effective concentration for inhibiting seedling emergence or plant growth by only 5 percent. If a NOEL value was not determined, the EC_{05} can be used instead. The EC_{05}/NOEL values are used to assess the potential for adverse impacts on listed plants in the vicinity of agricultural crops.

Non-target plants may be affected by herbicides due to drift and runoff. Probably the biggest factors that influence drift are the method and frequency of application and especially if applications are not made according to label specifications. All herbicides are toxic to plants and injury from drift can happen with any herbicide. For example, (Reddy et al., 2010) reported that in 2008 in Mississippi, 56 cases of injury were reported to glyphosate sensitive crops from glyphosate application. According to (Roider et al., 2007) and the references cited therein, herbicide drift is most often the result of improper application. Wind speed and spray nozzle height above the intended target are primary contributors to herbicide drift. Herbicide application by airplane can increase the risk associated with off-target movement. Droplet size can also influence drift where finer droplets drift more. Off-target movement of herbicide during application can be somewhere between 1/10 and 1/100 of the applied rate. Rice and corn showed approximately 50% reductions in yield from 12.5% of the application rate whereas cotton and soybean were unaffected.

Aerial applications have the greatest tendency to drift, broadcast would be less, and soil incorporation would be negligible though soil applications are subject to runoff. Solubility in water promotes leaching while the degree to which the herbicide binds the soil and organic matter would prevent it from leaching (see section III.E.3 and III.E.4). Some of the parameters that influence drift and runoff are shown in Tables 3-49 and 3-50.

Herbicides that are preplant incorporated are not expected to drift. These herbicides include cycloate, EPTC, pyrazon, and ethofumesate. Eptam® (EPTC) must be disked several inches into the soil for application owing to its high volatility. Ethofumesate and pyrazon are applied both as preplant incorporated and postemergence. The remaining herbicides: clethodim, clopyralid, desmedipham, glyphosate, phenmedipham, quizalofop-p-ethyl, sethoxydim, trifluralin, and triflusulfuron-methyl are all applied by broadcast, banded, or aerially (Table 4-5).

The most common method to apply sugar beet herbicides is by broadcast application (Stachler et al., 2011). Broadcast applications typically use a ground sprayer (e.g., a boom situated near the ground). However as much as 14% of the post-emergent herbicide applications are also applied aerially (Stachler et al., 2011). Aerial application is especially common when the ground is too wet for heavy equipment to enter the field and timing is critical for weed control. With glyphosate, where timing is less critical, growers have more opportunity to let the ground dry out before spraying so aerial applications are less common (3-4%) (Stachler et al., 2011).

The risk of drift injury will also increase with the number of herbicide applications because the probability of error or uncooperative weather conditions increases. Under Alternative 1, postemergence herbicide applications are expected to be more frequent with conventional sugar beet because up to six microrate applications may be used in a season compared to 2-3 applications of glyphosate (USDA, 2011b) p.51. The timing of the microrate applications are critical whereas with glyphosate, growers have more opportunity to apply herbicide when weather conditions are less less windy and significant drift is less likely to occur. Thus there are three major reasons drift is expected to be higher under Alternative 1 than Alternative 2 or 3. Under Alternative 1,herbicides are more likely to be applied by air than broadcast on the ground and aerial applications are more subject to drift. The number of herbicide applications are expected to be higher under Alternative 1 thereby increasing the chances that drift will occur under any given application. The timing of postemergence applications is less flexible with non-glyphosate herbicides so applications are less likely to be made under optimal weather conditions.

Table IV-19. Herbicide Toxicity Values for Terrestrial Non-Target Plants

Active Ingredient	Seedling Emergence			Vegetative Vigor		
	NOEL or EC_{05} (lb a.i./A)[1]	EC_{25} (lb a.i./A)[1]	Species (Dicot, Monocot)	NOEL or EC_{05} (lb a.i./A)[1]	EC_{25} (lb a.i./A)[1]	Species (Dicot, Monocot)
Clethodim	>0.25 0.004	>0.25 0.0063	Dicot Monocot	>0.25 0.003	>0.25 0.003	Dicot Monocot
Clopyralid	ND	ND	ND	0.09 LOEL 0.09 LOEL	ND ND	Spinach Bluegrass
Cycloate[2]	ND	ND	ND	2.0 LOEL 3.0 LOEL	ND ND	Spinach Bristlegrass
Desmedipham	0.15 0.30	0.31 0.58	Tomato Onion	1.22 ND	>1.22 ND	Lettuce ND
EPTC[3]	ND 0.017	ND 0.10	ND Wild oats	0.23 NU	NU 0.22	Velvet leaf Winter wheat
Ethofumesate (43.8% a.i.)	0.031 0.16 0.08	0.40 0.17 0.15	Tomato Lettuce Wheat	0.06 0.08 0.06	0.22 1.04 0.24	Tomato Lettuce Wheat
Glyphosate TGAE	ND ND	>5 >5	Dicot Monocot	ND ND	0.074 0.16	Dicot Monocot
Phenmedipham[4]	NA	NA	NA	0.5 NOEL 0.5 LOEL	ND ND	Spinach Grasses
Pyrazon TGAI	0.008 0.022	0.035 0.117	Cabbage Rye grass	0.009 0.057	0.033 0.141	Cucumber Rye grass
Quizalofop-p-ethyl[5]	ND	ND	ND	ND	ND	ND
Sethoxydim TGAI	ND ND	ND ND	ND ND	ND 0.025	>0.47 0.029	Dicot Ryegrass

Table 4–19. (continued)

Active Ingredient	Seedling Emergence			Vegetative Vigor		
	NOEL or EC_{05} (lb a.i./A)	EC_{25} (lb a.i./A)	Species (Dicot, Monocot)	NOEL or EC_{05} (lb a.i./A)	EC_{25} (lb a.i./A)	Species (Dicot, Monocot)
Trifluralin	2 0.13	4 0.33	Cabbage Onion	0.25 0.125	0.80 1.1	Cucumber Corn
Triflusulfuron-methyl[5,6]	>0.0001 ND ND	ND 0.0096 0.0165	Sorghum Turnip Onion	0.000030	0.00052 0.00063 0.00035	Sorghum Pea Broomcorn

Sources: EPA OPP RED documents and EPA OPP Ecological Fate and Effects Division (EFED) ecological risk assessment documents available from the herbicide dockets unless noted otherwise. The lowest value from among the different dicot or monocot species tested was used to represent dicot and monocots for this table, respectively.

[1] Unless otherwise noted in row header as acid equivalent (AE or a.e.) instead of active ingredient (AI or a.i.).

[2] Data from EPA ECOTOX as NOEL/LOEL data only; no testing specifically for EPA's Office of Pesticide Programs.

[3] EPTC – Users must obtain information to identify any endangered or threatened plant species of concern that might be found in areas adjacent to crops treated with EPTC.

[4] EPA's ECOTOX database.

[5] No data for terrestrial plants available for quizalofop-p-ethyl; studies submitted to EPA were considered unacceptable and new data have been requested from the registrant.

[6] NOEL values from Health Canada (1999) and EC_{25} values from EPA's ECOTOX, with exception of sorghum, for which EC_{25} for vegetative vigor is from Health Canada (1999).

Abbreviations: A = acre; ND = no data available; NA = data might exist but are not available from EPA online; archived to disks; TGAE = technical grade acid equivalent; TGAI = technical grade active ingredient; NU = not used by EPA OPP in risk assessment because plant yielding the lowest EC_{25} did not yield the lowest EC_{05}; EC_{25} = effective concentration for 25% inhibition of seedling emergence or plant growth; EC_{05} = effective concentration for 5% inhibition of seedling emergence or plant growth; NOEL = no-observed-effect level, generally bounded by a LOEL; however, LOEL values not listed in RED or ecological risk documents.

Because conventional sugar beet plants also are sensitive to the effects of glyphosate, the herbicide is used only preplant or preemergence for conventional sugar beet, primarily to eliminate weeds present at that time (see Table 4–5). Thus, under Alternative 1, the opportunity for glyphosate drift affecting nearby terrestrial plants would be limited to the beginning of the growing season.

Table 4–20 below compares the potential of the different herbicides used on conventional sugar beet to impact non-target dicots and monocots in the vicinity of a sugar beet field if drift occurs at the time of application. The basis of the exposure comparison is the maximum single application rate allowed on sugar beet at some point in the season (e.g., preemergence for glyphosate, postemergence for clethodim). For ease of comparison, the application rates are normalized to the glyphosate maximum allowed single application rate preplant on conventional sugar beet, which is estimated to be 4.5 lb a.i. per acre. This estimate is based on the maximum total glyphosate allowed preemergence for H7-1 sugar beet, which is 3.7 a.e. per acre total preemergence or approximately 4.5 lb a.i. per acre depending on the exact salt used in the formulation (see Table 3–13). The annual limit of 7.32 lb a.i. per acre for H7-1 sugar beet does not apply to Alternative 1, because glyphosate is not applied postemergence on conventional sugar beet fields.

The bases for the toxicity comparison among herbicides are the EC_{25} values listed in Table 4–19. The lowest EC_{25} values listed in Table 4–19 for the herbicide for a dicot and for a monocot are included in Table 4–20, whether for seedling emergence or vegetative vigor. No observed effect levels (NOELs) or EC_{05} values (effective concentration for a 5 percent change in the endpoint relative to controls) are not used to compare toxicity of the herbicides because estimation of NOEL values depends on spacing of the exposure levels and because a 5 percent effect level is a more uncertain value (near the lower limit of observed data) than a 25 percent effect level, which generally falls within the observed exposure-response data for the toxicity tests. Relative risk (RR) is estimated in Table 4–20 as the product of an herbicide's maximum relative single application rate and its relative toxicity.

Table IV-20. Relative Risk to Non-target Terrestrial Plants of Herbicides Used on Conventional Sugar Beet Relative to Glyphosate Under Alternative 1[1]

Herbicide	Max[2] Single App. Rate (lb a.i./acre)	(A) Max [3] Single App. Rate Relative to Glyphosate	Lowest EC_{25} Value[4] (lb a.i./acre)		(B) Toxicity Relative to Glyphosate[5]		Relative Risk[6] RR = (A) x (B)	
			Dicot	Monocot	Dicot	Monocot	Dicot	Monocot
Clethodim	0.25	0.056	0.25	0.0030	0.36	65.07	0.020	**3.6**
Clopyralid	0.67	0.148	0.09	0.09	1.00	2.17	0.149	0.32
Cycloate	4.00	0.889	2	3	0.05	0.07	0.040	0.058
Desmedipham	1.26	0.280	0.31	0.58	0.29	0.34	0.082	0.094
EPTC	4.60	no drift[7]	ND	0.1	ND	1.95	0[7]	0[7]
Ethofumesate	3.75	no drift[7]	0.17	0.15	0.53	1.30	0[7]	0[7]
Glyphosate[8]	4.50	1.000	0.090	0.195	1.00	1.00	1.00	1.00
Phenmedipham	1.01	0.224	0.5	0.5	0.18	0.39	0.041	0.088
Pyrazon	7.30	1.622	0.033	0.12	2.7	1.67	**4.4**	**2.7**
Quizalofop-p-ethyl	0.08	0.018	ND	ND	ND	ND	ND	ND
Sethoxydim	0.47	0.104	ND	0.029	ND	6.73	ND	0.70
Trifluralin	0.75	0.167	0.80	0.33	0.11	0.59	0.019	0.10
Triflusulfuron-methyl	0.03	0.007	0.00052	0.00035	174	557.71	**1.2**	**4.0**

Sources: Listed by column header endnote.

1 Unshaded rows for herbicides used preemergence on conventional sugar beet; shaded rows for postemergence use herbicides.
2 Maximum single broadcast (near ground-level) application rate allowed from Table 4–5.
3 Application rates relative to glyphosate = maximum single application for herbicide (pre- or postemergence) divided by maximum single application for glyphosate when used post emergence.
4 Lowest EC_{25} value in Table 4–19 for the chemical and type of plant (i.e., some toxicity values are for seedling emergence, while others are for vegetative vigor).
5 Estimated as ($1/EC_{25}$) for the herbicide divided by ($1/EC_{25}$) for glyphosate.
6 Because glyphosate is the herbicide used to normalize application rates and toxicity, its relative risk value = 1.00. Values in bold indicate herbicides that pose higher risks of impacts on non-target plants adjacent to sugar beet fields than does glyphosate assuming the same application method and assuming that the chemical characteristics that might influence drift are the same among the herbicides for this comparison. Bolded values for herbicides with preemergence RR greater than glyphosate.
7 Herbicide soil-incorporated at application; assume no drift.
8 Glyphosate toxicity values based on lb a.e./acre in Table 4–19 have been converted to the equivalent toxicity values in lb a.i./acre assuming that the mass of the a.i. is on average (i.e., across the types of salts used) 1.22 times higher than the mass of the a.e. (Hartzler et al., 2006).

Abbreviations: Max = Maximum. App = Application. lb a.i. = pounds of active ingredient. ND = no data. RR = relative risk.

As indicated in Table 4–20, if drift occurs, a single maximum application of pyrazon has an RR value 4.4 times higher than glyphosate for adverse effects on non-target dicots that have already emerged or are growing at that time. Triflusulfuron-methyl has an RR value 1.2 times higher than glyphosate for non-target dicots. The remaining herbicides, if applied preemergence at the maximum allowed rate for a single application, have similar or lower RR values than the RR for glyphosate for dicots. Also as indicated in Table 4–20, of the herbicides used preemergence, a single maximum application of pyrazon has an RR value 2.7 times higher than glyphosate for adverse effects on non-target monocots that have already emerged or are growing at that time. Triflusulfuron-methyl and clethodim have RR values of 4.0 and 3.6 times higher than glyphosate, respectively for non-target monocots. The remaining herbicides used preemergence have RR values for monocots similar to or lower than the RR value for glyphosate. Of the herbicides that have higher RR values than glyphosate, trisulfuron methyl was used on 83% of sugar beet acres in 2000, pyrazon was used on 6%, and clethodim was used on 43%. Therefore,at least two of these herbicides are expected to be widely used on sugar beet under Alternative 1.

Under FIFRA, EPA carefully regulates pesticides to ensure that they do not pose unreasonable risks to human health, the environment, or non-target species when used as specified on the product label. The RR values are based on the assumption that the method of application (e.g., broadcast equipment, droplet size, and height above ground) and any chemical characteristics that might influence drift are the same across the herbicides, with the exceptions of EPTC and ethofumesate, both of which are assumed not to drift during application because they are incorporated into the soil.

Under Alternative 1, sugar beet fields also generally require conventional tillage to ensure weed control. Conventional sugar beet tillage (which can be performed in fall and spring) improves soil structure for seedling emergence and growth, eliminates early weeds, and reduces erosion risk from compacted soils (see section III.E.2.a). Conventional fall tillage is the primary tillage event (using moldboard plows or heavy disks) followed by one or more secondary tillage(s). To minimize overwinter erosion, farmers must try to retain adequate residues on the soil surface to prevent erosion or must try to use compatible cover crops for erosion control. In the spring, some tillage generally is required for early weed control, incorporating pesticides into the soils, and to improve soil texture for planting seeds (see section III.B.1). In the spring, farmers need to keep tillage to a minimum to maintain residues on top of the soil to reduce erosion and the chances of wind damage to fragile sugar beet seedlings as they emerge (Cattanach et al., 1991). Conventional tillage results in 100 percent soil disturbance (USDA-NRCS, 2008). Downgradient erosion of top soils can introduce agricultural chemicals into nearby non-target environments with various effects on terrestrial plants (e.g., excessive nutrients, exposure to fungicides, insecticides, herbicides). It is not possible to quantify such effects nationwide as each location would differ in one or more attributes that would influence the likelihood or severity of impacts on non-target terrestrial plants adjacent to conventional sugar beet fields.

The potential impacts of Alternative 1 on aquatic plant species (all are non-target) depends on the type of herbicide and on the type of aquatic plant. Table 4-21 below presents toxicity values for aquatic plants for the herbicides used on conventional sugar beet. Possible routes of aquatic plant exposure to herbicides are spray drift over nearby surface waters, inadvertent direct overspray, wind transport of soil particles loaded with adsorbed herbicide, runoff of surface waters containing the herbicide, or leaching of the herbicide into drainage systems (U.S. EPA 2006a; Borggaard and Gimsing, 2008). Each of the herbicides exhibit somewhat different chemical and physical characteristics that affect their potential mobility in the environment, as discussed in section III.E.4.d (e.g., water solubility, half-life, adsorption coefficient). For herbicides that are particularly toxic to aquatic organisms, EPA imposes specific label use restrictions, such as "Avoid direct application to any body of water." Federal law requires herbicides to be used in accordance with the label.

Table 4–21 below also compares the potential of the different herbicides used on conventional sugar beet to impact aquatic plants in the vicinity of a sugar beet field if drift and runoff occur. Estimated environmental concentrations of the herbicides were based on the assumption that a 1-acre pond, 6 feet deep receives 5 percent drift from a 1-acre field and 5 percent runoff from a 10-acre field ollowing application at the maximum rate allowed for a single application (Monsanto and KWS SAAT AG, 2010).

The toxicity of the herbicides to the most sensitive and least sensitive aquatic plant tested (one or more of five algal species and duckweed, a small floating dicot), is expressed as a water concentration of the herbicide active ingredient. Specifically, EPA OPP uses the effective concentration at which algal or duckweed growth is inhibited by 50 percent compared with controls (EC_{50}) as the endpoint by which to evaluate aquatic plant toxicity for non-listed species. Those data are presented in Table 4–21, too.

Toxicity data for the end-use formulated products generally are not readily available, thus this analysis is a comparison based solely on the active ingredients. Any label warnings and other available hazard and/or risk descriptions for non-target aquatic species are also included. A risk quotient (RQ) was determined for each active ingredient by dividing the EEC by the toxicity (EC_{50}) value. If the RQ value exceeds 1.0, the EPA considers the potential risk to pose risks of concern for non-listed aquatic plants.[32] The RQs for glyphosate are among the lower of the RQs for aquatic plants. The RQ exceeded 1.0 for desmedipham, pyrazon, and trifluralin, and those values are highlighted in bold in the table. Under Alternative 1, applications of each of these herbicides could pose risks to aquatic plants nearby sugar beet fields.

The USDA–NRCS maintains an online Pesticide Active Ingredient Rating Report (PAIRR) in which it ranks pesticide active ingredients by several characteristics, including the potential for runoff from agricultural fields either in solution or adsorbed to fine soil particles. Those rankings, and values for water solubility and K_{oc}, which are chemical-physical properties that influence environmental fate and transport, are listed in Table 3–50). Cycloate, ethofumesate, and glyphosate are ranked as having a high potential for runoff in solution. Glyphosate, quizalofop-p-ethyl, and trifluralin are ranked as having a high potential for runoff adsorbed to particles. Therefore, glyphosate is ranked as having a high potential for runoff both in solution and adsorbed to soil particles. Many other factors also influence the likelihood of significant runoff events including rain and storm frequency and intensity in a geographic region, gradient (slope), soil texture, soil cover, stage of planting, and others. On the other hand, glyphosate dissipates more rapidly in surface water than most other herbicides. (For more information on herbicide transport to surface waters, see section III.E.)

An additional impact of Alternative 1 to aquatic plants and organisms in general is use of conventional tillage, which disturbs 100 percent of the soil and generally results in more soil erosion than conservation tillage practices. Runoff of herbicides, fertilizers, other chemicals, and soil particles to nearby surface waters is higher, sometimes much higher, under conventional tillage practices than under conservation tillage practices (see section III.E.4.c). Fertilizer runoff can cause substantial algal blooms followed by death of algae and other organisms, resulting in depletion of water oxygen as the bacteria process dead tissues. Algal blooms can be followed by fish kills due to the water anoxia that follows the bloom die-off. Runoff of soil particles into surface waters generally increases water turbidity and reduces water clarity, which can alter aquatic plant community structure, sometimes substantially. It is not possible to

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[32] http://www.epa.gov/oppefed1/ecorisk_ders/toera_risk.htm#Deterministic

Table IV-21. Comparison of Potential Effects of Glyphosate and Sugar Beet Herbicides on Aquatic Plants (Algae and Duckweed)

Herbicide Active Ingredient	Max Single App Rate (lb a.i./acre)	EEC[1] (ppm)	Aquatic Plant[2] EC_{50} (mg a.i./L) (low/high)	Aquatic Plant Risk Quotient (RQ)[3] (worst/best)	Classification / Label Warnings
Clethodim	0.25	0.003	1.34; >11.4	0.0023; <0.0003	May pose a hazard to federally designated endangered species of Solano Grass and Wild Rice
Clopyralid	0.67	0.008	6.9; ND	0.001; ND	
Cycloate	4.0	0.135	ND; ND	ND; ND	
Desmedipham	1.26	0.040	0.044; >0.33;	0.909; 0.123	
Glyphosate Pre **Glyphosate Post**	3.0 1.37	0.10 0.038	14.5; 14.8 0.8; 38.6	0.007; 0.007 0.047; 0.001	
EPTC	4.6	0.141	1.36; 41	0.104; 0.003	
Ethofumesate	3.75	0.121	>2.76; >39	<0.003; <0.044	
Phenmedipham	1.01	0.020	0.19; >0.32;	0.106; <0.064	Toxic to fish and aquatic organisms
Pyrazon	7.3	0.246	0.17; >4.6;	**1.441;** <0.053	
Quizalofop-p-ethyl	0.0825	0.006	>0.082; >1.77	<0.069; <0.004	Toxic to fish and aquatic organisms
Sethoxydim	0.47	0.016	>0.27: >5.6	0.059; <0.003	Toxic to aquatic organisms
Trifluralin	0.75	0.024	0.015; 5.0	0.005; **1.6**	Extremely toxic to freshwater, marine, and estuarine fish and aquatic invertebrates, including shrimp and oyster
Triflusulfuron-methyl[4]	0.03	0.0027	0.0028; 0.123	0.96; 0.022	

Sources: Identified by endnote for column header.

[1] EEC values as reported by Monsanto 2010, Table 4-3. Assumes that a 1-acre pond, 6 feet deep receives 5 percent drift from a 1-acre field and 5 percent runoff from a 10-acre field.

[2] Aquatic EC50 values obtained from the 2010 EPA Ecotoxicology One-Line Database except for the values of phenmedipham which are from the Reregistration Eligibility Decision (RED) for phenmedipham (U.S. EPA 2005g).

[3] Risk Quotient (RQ) = EEC/EC_{50}; RQ **bolded** if >1.0 = Level of Concern for non-listed aquatic plants for EPA's Office of Pesticide Programs (http://www.epa.gov/oppefed1/ecorisk_ders/toera_risk.htm#Deterministic).

[4] Toxicity values are from the Regulatory Note REG99-03 from the Pest Management Regulatory Agency of Canada

Abbreviations: EEC = Estimated Environmental Concentration; ND = no data; EC_{50} = concentration resulting in 50% growth inhibition as measured by cell count for algae and dry biomass or fronds for duckweed.

quantify such effects nationwide, because each location would differ in one or more attributes that would influence the likelihood or severity of impacts on nearby non-target aquatic plants.

In summary, under Alternative 1, there would be a rapid transition to greater use of the non-glyphosate herbicides used on conventional sugar beet and much less use of glyphosate. There are several reasons to expect the potential risk to non-target plants to be greater under Alternative 1 compared to Alternative 2. First, non-glyphosate herbicides are expected to be sprayed more frequently than is glyphosate under Alternative 2. Second, application of non-glyphosate herbicides is more time critical than is glyphosate thereby increasing the chances that applications will be made under poor weather conditions. Third, aerial applications are expected to be more frequent under Alternative 1 than under Alternative 2. The increased frequency of spraying and the greater use of aerial spraying is expected to increase the likelihood of drift thereby increasing exposure of non-target plants to herbicide. Fourth, under Alternative 1, tillage is expected to be greater than under Alternative 2. Tillage is expected to increase runoff and erosion of soil that also can increase the exposure of herbicides into nearby non-target environments. Fourth, at least three of the post-emergent herbicides used under Alternative 1, clethodim, trisulfuron-methyl, and pyrazon, are expected to pose greater risk to non-target terrestrial plants than is glyphosate. For aquatic plants, desmedipham, pyrazon, and trifluralin are expected to pose greater risk to aquatic plants than is glyphosate. Phenmedipham, desmedipham, clethodim, and trisulfuron-methyl are expected to be widely used in all sugar beet fields under Alternative 1. Therefore,the risk to non-target plants is expected to be greater under Alternative 1 because both the hazard and the exposure are greater than under Alternative 2.

(2) Alternative 2 – Full Deregulation

Expected herbicide use under Alternatives 2-3 is shown in Table 3-17 which based on data from year 2011. Use of non-glyphosate herbicides would still occur, but at greatly reduced rates compared to Alternative 1. Under Alternative 2, the maximum application rate of glyphosate postemergence on H7-1 sugar beet is more than three fold less than pre emergence or 1.37 lb a.i. per acre (1.125 a.e. per acre) compared to 4.5 lb. a.i.per acre for pre-emergent applications. This change in application rate will change the relative risk of the herbicides normalized to glyphosate. Values are recalculated in Table 4-22. The result is qualitatively similar to that reported in Table 4-20, but the differences between glyphosate and the herbicides that pose greater potential risk to non-target plants are greater because glyphosate is being used at a lower relative concentration. Pyrazon (14.6) and trisulfuron-methyl (4.1) are expected to pose greater risk to dicots than is glyphosate. Clethodim (12), pyrazon (8.9), and trisulfuron-methyl (13) are expected to pose greater risks to monocots.

One additional herbicide, sethoxydim (2.3), is expected to pose greater risks to monocots. Under Alternative 2, the use of these non-glyphosate herbicides are expected to be reduced over 15 fold. Thus fewer impacts from the non-glyphosate herbicides are expected under Alternative 2 compared to Alternative 1.

The RR values are based on the assumption that the method of application (e.g., broadcast equipment, droplet size, and height above ground) and any chemical characteristics that might influence drift are the same across the herbicides. (For the preemergence herbicides EPTC and ethofumesate, the potential for drift is considered negligible because they are soil-incorporated at application.) Under FIFRA, EPA carefully regulates pesticides to ensure that they do not pose unreasonable risks to non-target plants when used as specified on the product label.

A survey of sugar beet growers in Minnesota, North Dakota, and Montana in 2009 showed that glyphosate applied to glyphosate-tolerant sugar beet is almost always broadcast with a ground sprayer (Stachler et al., 2012a). Stachler et al. (Stachler et al., 2012a) reported that, for those sugar beet acres represented in their survey, glyphosate was broadcast-applied by air on only 4 percent of the acreage in Minnesota and eastern North Dakota. The potential for spray to drift outside of the boundaries of the sugar beet field is lower when applying glyphosate with a ground sprayer than by air. Non-target plants immediately adjacent to sugar beet fields would have the greatest risk of receiving spray drift. To mitigate potential adverse effects due to glyphosate drift during applications, EPA has imposed specific label use restrictions for its use, including “the product should only be applied when the potential for drift to adjacent sensitive areas (e.g., residential areas, bodies of water, known habitat for threatened or endangered species, non-target crops) is minimal (e.g., when wind is blowing away from the sensitive areas).” Under Alternative 2, any surface waters in the vicinity of H7-1 sugar beet fields might on occasion receive glyphosate from drift during application or surface runoff during rain or storm events. Table 3-50 indicates that USDA–NRCS rates glyphosate as having a high potential for runoff

Table IV-22. Relative Risk to Non-target Terrestrial Plants of Herbicides Used on H7-1 Sugar Beet During Growing Season (i.e., postemergence) Under Alternative 2[1]

Herbicide	Max[2] Single App. (lb a.i./acre)	(A) Max [3] Single App. Relative to Glyphosate	Lowest EC_{25}[4] Value (lb a.i./Aacre)		(B) Toxicity Relative to Glyphosate[5]		Relative Risk[6] RR = (A) x (B)	
			Dicot	Monocot	Dicot	Monocot	Dicot	Monocot
Clethodim	0.25	0.182	0.250	0.003	0.36	65.07	0.066	**12**
Clopyralid	0.67	0.487	0.090	0.090	1.00	2.17	0.49	**1.1**
Cycloate	4.00	2.92	2.0	3.0	0.05	0.07	0.13	0.19
Desmedipham	1.26	0.92	0.31	0.58	0.29	0.34	0.27	0.31
EPTC	4.60	no drift[7]	ND	0.10	ND	1.95	0[7]	0[7]
Ethofumesate	3.75	no drift[7]	0.17	0.15	0.53	1.30	0[7]	0[7]
Glyphosate post	1.37	1.00	0.090	0.195	1.00	1.00	1.00	1.00
Phenmedipham	1.01	0.737	0.50	0.500	0.18	0.39	0.13	0.29
Pyrazon	7.3	5.33	0.033	0.117	2.7	1.67	**14.6**	**8.9**
Quizalofop-p- ethyl	0.08	0.060	ND	ND	ND	ND	ND	ND
Sethoxydim	0.47	0.343	ND	0.029	ND	6.7	ND	**2.3**
Trifluralin	0.75	0.547	0.80	0.330	0.11	0.59	0.062	0.32
Triflusulfuron-methyl	0.03	0.023	0.00052	0.000035	174	557	**4.1**	**13**

Sources: As in Table 4–20 with the exception noted above under endnote c.

1 Shaded rows are for herbicides applied after sugar beet emergence (postemergence); unshaded rows are for preemergence herbicide application.

2 Maximum single broadcast (near ground-level) application rate allowed for glyphosate, the maximum allowed per post-emergent application to H7-1 sugar beet

3 Application rates relative to glyphosate = maximum single application for herbicide (pre- or postemergence) divided by maximum single application for glyphosate when used postemergence.

4 Lowest EC_{25} value whether for seedling emergence or vegetative vigor.

5 Estimated as ($1/EC_{25}$) for the herbicide divided by ($1/EC_{25}$) for glyphosate.

6 Because glyphosate is used to normalize the application rates and toxicity, its relative risk value = 1.00. Values in bold indicate herbicides that pose higher risks of impacts to on non-target plants adjacent to sugar beet fields than does glyphosate assuming the same application method and that the chemical characteristics that might influence drift are the same among the herbicides for this comparison.

7 Herbicide soil-incorporated at application – preemergence only; assume no drift occurs.

Acronyms: A = acre. Max = Maximum. App. = Application. lb a.i. = pounds of active ingredient. ND = no data.

in solution and adsorbed to soil particles, and it is the only herbicide of the 13 with high rating for both types of runoff. Because glyphosate binds strongly to soil particles, however, conservation tillage practices (e.g., no-till, row tillage) that can be practiced in some locations under Alternative 2 have the potential to reduce runoff compared with conventional tillage practices generally required for conventional sugar beet. As discussed previously, adoption of H7-1 sugar beet has reduced the amount of tillage needed to produce a sugar beet crop. However, glyphosate still may reach aquatic environments in runoff and by erosion of soils during storm events. Borggaard and Gimsing (2008) reviewed the state of knowledge on sorption, degradation, and leachability of glyphosate in soils. The results of their review showed that sorption, degradation, and leaching of glyphosate vary from soil to soil ((Borggaard and Gimsing, 2008) citing Gimsing et al., 2004, Landry et al., 2005, Mamy et al., 2005). This variability and uncertainty make it difficult to predict glyphosate's fate in the soil. Borggaard and Gimsing (2008) concluded that although sorption and degradation are affected by many factors (e.g., the physical and chemical properties of the soil) which might affect the mobility of glyphosate in the soil, leaching of glyphosate is mainly determined by soil structure and rainfall. Limited leaching has been reported in non-structured sandy soils, as well as structured soils, but only when large amounts of rainfall followed glyphosate application (Borggaard and Gimsing, 2008). The potential for glyphosate transport from terrestrial to aquatic environments can be mitigated by conservation tillage practices, and glyphosate is not expected to reach groundwater or to travel downgradient in aquifers that recharge surface waters due to sorption and degradation in the soil (Borggaard and Gimsing, 2008). The extent to which use of conservation tillage would mitigate glyphosate runoff to surface waters cannot be estimated nationally given available data and would depend on local conditions.

Use of conservation tillage practices under Alternative 2 can benefit aquatic plants and animals by reducing runoff of fertilizers, other chemicals, and soil particles to nearby surface waters compared with conventional tillage (see section III.E.4.d). Potential impacts from agricultural runoff to surface waters were discussed under Alternative 1. Use of conservation tillage can potentially reduce the frequency and magnitude of algal blooms, anoxic waters, fish kills, and sedimentation. It is not possible to quantify such effects nationwide at this time.

Aminomethyl phosphonic acid (AMPA), the primary degradation product of glyphosate, seems to be equally or less toxic than glyphosate (USDA-FS, 2003). Also, EPA determined that, based on toxicological considerations, AMPA need not be regulated (U.S. EPA 2006c); (U.S. EPA 1993c). Therefore, AMPA is believed to pose less risk than glyphosate itself.

In summary, Alternative 2 would result in the application of glyphosate-based herbicide formulations on most sugar beet acreage resulting in a seven fold increase in glyphosate use compared to Alternative 1. Use of non-glyphosate herbicides would still occur, but in much lower annual pounds. Under Alternative 2, there would be less frequent spraying of post-emergent herbicides, less aerial spraying, spraying would be more likely to be conducted under better weather conditions because application timing is less critical, and more conservation tillage which all would reduce the exposure of non-target plants to herbicides from drift and runoff. Under Alternative 2, the amount of glyphosate used relative to clethodim, pyrazon, trisulfuron-methyl , sethoxydim, and desmedipham, would increase relative to Alternative 1. As all these non-glyphosate herbicides pose greater risk to non-target plants than does glyphosate, the risk to non-target plants is expected to be less under Alternative 2 than Alternative 1.

(3) Alternative 3 – Partial Deregulation

Under Alternative 3, the risk to non-target plants in the northern sugar beet regions would be the same as under Alternative 2 and the risk to non-target plants in California and Western Washington would be the same as under Alternative 1.

c. Sugar Beet Weediness Potential

This section describes impacts of H7-1 sugar beet on weeds in nonagricultural settings. Weed abundance and weed seed banks and the impacts of H7-1 sugar beet plants and gene product on weeds (such as sugar beet volunteers) in agricultural settings are discussed in section IV.B.1.c.

(1) Alternative 1- No Action

Under Alternative 1, glyphosate could be used to control sugar beet volunteers in seed production fields. As sugar beet have never established feral populations in the United States, it is unlikely that glyphosate would be needed to control sugar beet in non-agricultural settings.

(2) Alternative 2 – Full Deregulation

APHIS considered whether the new phenotype imparted to H7-1 sugar beet might allow the plant to be grown or employed in new habitats and especially if it could naturalize in the environment. In performing the plant pest risk assessment (PPRA), APHIS assessed whether H7-1 sugar beet is any more likely to become a weed than the non-transgenic recipient sugar beet line or other currently cultivated sugar beet. Weediness potentially could affect plant species if H7-1 sugar beet were to become naturalized in the environment. The PPRA considers the basic biology of sugar beet and an evaluation of unique characteristics of H7-1 sugar beet. The parent plant, *Beta vulgaris* L. spp. *vulgaris*, is not listed as a weed by the Weed Science Society of America (2010) nor is it listed as a noxious weed species by the U.S. Federal government (7 CFR part 360). The characteristics of plants that are notable of successful weeds are not possessed by sugar beet (Baker, 1965; Keeler, 1989). In trials conducted in the United States under permits issued by APHIS, no differences were observed between H7-1lines and conventional lines with respect to the plants ability to persist or compete as a weed (Monsanto and KWS SAAT AG, 2004). APHIS considered data relating to plant vigor, bolting, seedling emergence, seed germination, seed dormancy, and other characteristics that might relate to increased weediness. No unusual characteristics were noted that would suggest increased weediness of H7-1 sugar beet plants. Additionally, results were variable over different trial locations and indicated that there were no consistent characteristics relating to disease or insect resistance that might affect weediness. H7-1 sugar beet is still susceptible to the typical insect and disease pests of conventional sugar beet.

APHIS considered the potential for H7-1 sugar beet to extend the range of sugar beet into new nonagricultural areas. The genetic transformation does not impart any phenotypic characteristic that would allow for the establishment of H7-1 sugar beet in areas unsuitable to other sugar beet varieties. Nonagricultural sugar beet growth patterns and distributions would be the same for H7-1 sugar beet as for other sugar beet varieties. Sugar beet plants do not have naturalized or feral populations except in California, as discussed in section III.B.5.

Under Alternative 2, H7-1 sugar beet will likely be grown in California. California is currently the only State where escaped *B. vulgaris* occurs and these populations have persisted for many years, indicating that conditions for *B. vulgaris* to establish feral populations exist in California. The origin of these populations is unclear but researchers have suggested that they represent escaped varieties of Swiss chard and not sugar beet (see section III.B.5). Wild *B. vulgaris* is unlikely to be growing in the Imperial Valley where all the sugar beet production is located. At one time sugar beet was produced in the Central Valley but these operations have been abandoned and all five sugar beet processing plants have closed in this area indicating sugar beet production will not resume in the Central valley. The only wild beet species confirmed to exist in the Imperial Valley is *Beta macrocarpa* and it only occurs in sugar beet fields. As no feral populations of sugar beet exist in the current sugar beet growing area, and none of the feral populations of wild beet in California were derived from sugar beet despite the fact that they have been grown for nearly 100 years in California, it is not reasonably foreseeable that feral populations of sugar beet will establish in California.

(3) Alternative 3 – Partial Deregulation

Under Alternative 3 the weediness potential of H7-1 sugar beet is negligible as it is under Alternatives 1 and 2.

D. Socioeconomic Impacts

This section assesses potential socioeconomic impacts under each of the three alternatives analyzed in this EIS. There are three ways in which the choice of alternative might have socioeconomic impacts. First, because costs of producing H7-1 sugar beet differ from those of conventional (non-GE) sugar beet and because yields may differ between H7-1 varieties and conventional varieties, this section assesses the economic implications of the alternatives analyzed for sugar beet producers, processors, and consumers. Second, because over 95 percent of sugar beet seed produced in recent years is estimated to be of H7-1 varieties (Colacicco, 2010b), conventional seed and some herbicides might no longer be available at the scale needed to supply the entire sugar beet root market with conventional seed and associated herbicides. Because sugar beet seed production has a multiyear cycle, where seed production fields are planted 2 years before planting root production fields, and because increases in herbicide production might require considerable advanced planning, this section discusses the implications for sugar beet root and seed growers and for the sugar market, under two scenarios: a) one in which conventional sugar beet seed and associated herbicides are available to supply the entire U.S. sugar beet root market in 2013; and b) one in which conventional sugar beet seed and/or associated herbicides are not available to supply the entire U.S. sugar beet root market in 2013. Third, to the extent that there is gene transmission from H7-1 sugar beet root or seed production to conventional or organic sugar beet root or seed fields or to vegetable beet, this section addresses whether adverse socioeconomic impacts could occur to producers or consumers of conventional or organic sugar beet and sugar and to producers and consumers of vegetable beet. The implications of these three potential sources of impacts for producers, processors, and consumers of sugar, sugar beet, vegetable beet, and beet seed, under each of the three alternatives are assessed below.

This section is organized as follows. Section IV.D.1 addresses impacts on the U.S. sugar and sugar beet markets derived from differences in costs and returns to H7-1. Two different scenarios are discussed. In IV.D.1.a APHIS assumes conventional sugar beet seed and associated herbicides are available to supply the entire U.S. sugar beet root market in 2013. In IV.D.1.b, APHIS assumes conventional sugar beet seed and/or associated herbicides are not available to supply the entire U.S. sugar beet root market in 2013. Section IV.D.2 analyzes impacts of each of the three alternatives to sugar beet seed markets. Here too, impacts under each of the two scenarios are discussed. Section IV.D.3 addresses impacts of each alternative on organic and conventional sugar beet root and seed markets. Section IV.D.4 addresses impacts on vegetable beet root and seed markets.

1. The U.S. Sugar and Sugar Beet Markets

a. Impacts Assuming No Shortages of Conventional Seed and/or Herbicide

(1) Alternative 1 – No Action

Under Alternative 1, H7-1 sugar beet would be fully regulated and the entire root crop from 2013 onward would need to be planted with conventional seed. Under Alternative 1, the current trend of a decline in the number of farms producing sugar beet and of the number of processing plants could continue. As discussed in sections III.D.1.b and III.D.1.c, declines in the number of farms and of processing plants in the past two decades were part of a consolidation process in the sugar beet industry. This consolidation process avoided declines in beet sugar production by increasing yields in the field and efficiency in the plants. Between 1992 and 2007, the number of farms growing sugar beet decreased from 8,810 to 4,022 (USDA-NASS, Various Years), and 13 sugar beet processing plants have shut down since 1996 (ASA, 2011). Under Alternative 1, this process could continue, resulting in further decreases in the number of sugar beet farmers and number of plants. In a survey of sugar beet processing plant chief executive officers (CEOs) conducted in 2010, one processor stated that it would no longer be profitable to operate with conventional seed and would likely cease operations if only conventional sugar beet seed were available (Sexton, 2010a). Sugar beet growers could incur losses related to the purchase of equipment for production of H7-1 sugar beet (e.g. for strip tillage).

(2) Alternative 2 – Full Deregulation

Under Alternative 2, over 95 percent of the 2013 root crop would be expected to be H7-1 sugar beet varieties, similar to the adoption rate of H7-1 in the 2009 sugar beet crop. As H7-1 varieties adapted to conditions in California are developed, it is expected that the share of root crop production that is of H7-1 varieties would approach 100 percent. Section III.D.1.d reviewed the existing evidence on differences in costs and returns between H7-1 and conventional varieties of sugar beet. There is evidence that production of H7-1 sugar beet has the potential to reduce production costs with labor, fuel, fertilizer, and water. There is also evidence of potential reductions in herbicide costs and increased yields, although costs with herbicides might increase over time due to weed resistance and weed shifts. On the other hand, H7-1 sugar beet root growers would have to pay the technology fee for H7-1 seed. Section III.D.1 shows that the existing studies indicate an increase in the overall economic returns to sugar beet root production with H7-1 adoption, although with considerable regional differences. In particular, root growers in the largest production area, the Midwest, might not benefit from H7-1 adoption as much as those of other areas.

Under Alternative 2, because of the cost savings and potential for increased yields associated with H7-1 sugar beet root varieties when compared to conventional sugar beet varieties, sugar beet grower incomes would be expected to be higher than if only conventional sugar beet varieties were available. As discussed in section III.D.1.d, Kniss (Kniss, 2010b) estimated the net economic benefit to farmers of H7-1 sugar beet adoption to be 233 U.S. dollars (USD) per acre (and a 15 percent increase in yields) in Wyoming in 2007. Sexton (2010a) estimated the average expected gross profits for growing H7-1 sugar beet to be 276 USD per acre more than the average expected gross profits for conventional sugar beet seed, among a sample of sugar beet farmers, and Sexton (2010b), based on a processor survey, weighted by the acreage planted in each region, estimated that the total reduction in grower profits from planting conventional as opposed to H7-1 sugar beet amounted to approximately 120 USD per acre.

In addition to increased profitability per acre, growers obtain benefits from the convenience and flexibility of using H7-1 sugar beet. As described in section III.B.1. weed control is much easier to manage with glyphosate because fewer herbicides are needed and the application timing is less critical. Weed control is more effective than using nonglyphosate herbicides so fewer tractor trips across the field are made and less hand labor is needed for weeding. Glyphosate is less toxic to the applicator than many of the non-glyphosate herbicides. By simplifying the management of growing sugar beet and saving the grower time, these factors improve the quality of life for the grower. At the public meeting in Fargo, ND, numerous growers described how H7-1 sugar beet improved their quality of life (USDA, 2011b) eg, p24, 36. Reasons mentioned include:

1) reducing the time spent on weed control that allows them to spend more time managing other farm responsibilities, more time with their families, and more time on recreation

2) increasing the simplicity of weed control and therefore alleviating stress to farm personnel by reducing pesticide applications, reducing number of pesticides applied, reducing exposure to toxic chemicals, providing a wider window of application thereby making the farming practice less susceptible to vagaries of weather and allowing farmers to chose better weather conditions to apply herbicide, and making it easier to grow rotation crops

3) reducing overall labor costs and labor management issues.

Increased incomes would mean that sugar beet growers would be less likely to leave sugar beet production in favor of production of other crops, particularly in regions where returns to sugar beet production compete closely with returns to other crops.[33] Because processing costs tend to decrease with volume of production, maintenance of sugar beet production volumes is important to maintain the feasibility of processing plants and sugar beet plants would be less likely to close. As there is indication that H7-1 varieties are at least currently more suitable to some producing areas than others, not all producing areas would benefit equally. Sugar beet growers in the Midwest seem to not benefit as much as other sugar beet producing areas from the adoption of H7-1 sugar beet varieties. The Midwest, however, was already the region with the lowest operating and total economic costs in 2000, according to Ali (2004) (Table 3–35). None of the 13 plants that closed since 1996 was in the Midwest (section III.D.1.b).

Despite the increased income that adoption of H7-1 sugar beet has likely provided sugar beet growers and processors, seasonal agricultural workers might find less opportunities for work in hand weeding of H7-1 sugar beet fields, compared to those of conventional sugar beet fields. As discussed in section III.D.1.d, for the Midwest data was available to estimate the lost wages to seasonal agricultural workers from the adoption of H7-1 sugar beet. For this region, APHIS estimates that about $8 million dollars is no longer spent on farm labor for hand weeding since the adoption of H7-1 (Table 3-37). On the other hand, many commenters noted the difficulty they were having in finding anyone to do handweeding (public comments 4055, 4088, 4258, 3551, 3943,3988, 3720). For example, according to (Marshall)

“Through the years, laborers to weed beet have been getting fewer and fewer until now I do not believe you could get a crew. My last beet howing crew was my high school daughters and their friends. I could not find anyone else. For 455 acres of beet that was't enough.”

If laborers are not available, then obviously they will not be impacted by a shortage of field labor work.

(3) Alternative 3 – Partial Deregulation

Under Alternative 3, H7-1 sugar beet seed would be produced under permits and sugar beet roots under compliance agreements. The permits

[33] For example, see Patterson P Patterson, "The Economics of Growing Sugarbeets in Southern Idaho: A Short Run Gross Margin Analysis," (University of Idaho. Department of Agricultural Economics and Rural Sociology, 2009), vol. for a discussion of relative returns of sugar beet and other crops in Idaho.

and compliance agreements would allow APHIS to control individual seed field locations and enforce stewardship practices. Sugar beet growers adopting H7-1 varieties would continue to experience potential savings in labor, fuel, fertilizer, water and possibly herbicide costs, and potential increased yields and incomes. However, Alternative 3 would impose mandatory conditions on production, processing and transport of sugar beet that would constitute additional regulatory requirements on sugar beet growers, even if minor, similar to that experienced during the partial deregulation conditions currently in place.

Many measures generally required of H7-1 sugar beet seed growers during production would be similar to those measures taken through industry stewardship agreement adhered to by H7-1 sugar beet seed growers under the full deregulation (Alternative 2). However, stewardship controlled by APHIS has the potential to improve compliance through additional oversight and enforcement mechanisms. In addition, Alternative 3 does impose some added requirements such as the need to obtain a permit for seed production activities and compliance agreements for root production activities. In addition, the location of H7-1 sugar beet seed production would be restricted to areas outside California and western Washington, although these areas do not currently produce H7-1 sugar beet seed. To the extent that improved compliance, added requirements and geographical restrictions add costs to H7-1 sugar beet seed growers through greater regulatory requirements, these added costs would likely be at least partially transferred to sugar beet root producers in the form of increased sugar beet seed prices. Because APHIS was unable to identify an estimate for the price elasticity of demand for sugar beet seed, the extent to which increased seed production costs would be transferred to sugar beet root producers cannot be estimated. However, increased seed costs would impact no more than 7 percent to 14 percent of total sugar beet production costs (Table 3–36).

Sugar beet root growers of H7-1 would be impacted by the mandatory conditions of Alternative 3. In addition to any increase in sugar beet seed prices, H7-1 sugar beet root growers would need to enter into compliance agreements with APHIS establishing specific mandatory conditions for root growth. Compliance agreements would typically be signed by sugar beet cooperatives or processors on behalf of their members/farmers and much of the financial and time burden of Alternative 3 would be absorbed by such cooperatives/processors. These include the financial and time costs of applying for and obtaining a compliance agreement with APHIS, collecting information on acreage and global positioning system (GPS) coordinates of growers, arranging and paying for third-party inspectors and third-party audits, record generation and maintenance and training of crop growers and field personnel.[34] An indicator of the burden imposed by these financial and time costs on growers can be obtained by dividing estimated costs by the acreage of H7-1 produced to obtain an indicator per acre. The largest of these costs is likely to be the third-party inspectors and audits. Based on APHIS' current experience, one field inspection costs about 500 USD, including travel. Enough H7-1 sugar beet fields would have to be visited to guarantee compliance at a 95 percent level of confidence. Based on APHIS' experience, if over 95 percent of sugar beet producers adopted H7-1 sugar beet varieties, some 3,000 inspections could be required. At 500 USD each, this would amount to a total of 1.5 million USD for one round of inspections. If these costs are divided by all farmers based on their sugar beet acreage, and assuming a total sugar beet acreage of roughly 1,000,000, the cost per acre of one inspection would be 1,500,000 USD /1,000,000 acres = 1.5 USD per acre. If more than one field could be visited on a single trip, this cost would be less. In addition to inspections, sugar beet growers would be requested to pay for audits. Based on APHIS experience, 100 audits could be conducted. At a cost of 1,000 USD per audit, this would amount to another 100,000 USD, or 0.10 USD per acre. If miscellaneous other regulatory costs are added (say, hiring personnel or recordkeeping), an additional 400,000 USD of costs would be needed for the total regulatory requirements on H7-1 sugar beet grower cooperative/processors to reach 2 USD per acre.

In addition to financial and time costs for sugar beet root grower cooperative/processors, Alternative 3 also requires that individual growers incur added financial and time costs directly from production management operations. These costs related to surveying fields for bolters every 3 to 4 weeks, accompanying inspectors and auditors on field visits, generating and maintaining records, monitoring for volunteers, and any losses incurred by the restrictions imposed on crop rotation and use of equipment for Swiss chard/table beet. Some of these costs may not be new to growers. For example, rotation crops are often visually distinct from sugar beet, producers do not commercially grow Swiss chard or table beet, and some degree of field monitoring and recordkeeping is likely already done by most growers. In addition, some of these costs, such as those with recordkeeping and time spent with inspectors and in training, would be diluted by the average size of sugar beet fields (300 acres per farm, according to the 2007 Agricultural Census).

Based on the above discussion, the overall burden of Alternative 3 on sugar beet root growers is likely to be no more than a few dollars per acre. The burden is likely not enough to discourage the adoption of H7-1 sugar beet varieties by growers. As discussed in section III.D.1.d, H7-1 sugar beet production often offers returns of over 100-200 USD per acre above

[34] Additional inspections, training, and recordkeeping would be required from APHIS.

the returns for conventional sugar beet. To the extent that the mandatory conditions of Alternative 3 do discourage some growers from planting H7-1 in favor of conventional varieties, this impact would be expected to affect growers in the Midwest region, where differential returns of H7-1 appear to be less than in other growing regions. In 2011, about 92% of the sugar beet crop was planted to H7-1, down from 95% the previous two years (Schwartz, 2012). It is not known to what extent the decrease was due to the uncertain regulatory status of H7-1 sugar beet or due to the additional regulatory requirements.

Alternative 3 does not allow production of H7-1 sugar beet roots in California and western Washington. Although H7-1 sugar beet roots are currently not produced in these areas, conventional sugar beet root production does occur in California and amounts to approximately 2.2 and 3.1 percent of total U.S. sugar beet acreage and production, respectively (Table 3–33). Sugar beet producers in California would not be able to adopt H7-1 in the future and would not realize any potential increased income derived from adoption of H7-1 sugar beet varieties. California growers would be expected to benefit considerably from the use of glyphosate to manage wild beet because they are very costly to manage in conventional sugar beet for three reasons. First, because selective herbicides are not available, wild beet requires extensive hand labor. Second, wild beet physically interferes with the harvest increasing the labor needed for the harvest and decreasing the grower's return per acre. Third, fields with heavy infestations of wild beet must be kept out of sugar beet production for as much as ten years to reduce the wild beet seed bank. As sugar beet is the most lucrative crop in the rotation, the wild beet infestation represents a significant lost opportunity cost (2011). There is currently one remaining sugar beet plant in California, in Imperial County. Of the 13 sugar beet plants that closed since 1996, 5 were in California.

b. Impacts Assuming Shortages of Conventional Seed and/or Herbicide

(1) Alternative 1 – No Action

Under Alternative 1, H7-1 is fully regulated and the entire root crop from 2013 onwards would need to be planted with conventional seed.

Information regarding the availability of domestically produced conventional seed is not publicly available, given that sugar beet seed companies treat this information as business confidential. In 2010, upon request from the Intervenor-Defendants (representatives of sugar beet growers and processors) in the litigation *Center for Food Safety, et al., v. Tom Vilsack, et al.*, Civil Action No. 3:08-cv-00484, Dr. Susan H. Manning, a private consultant, obtained information from four sugar beet seed providers and eight beet sugar processing companies and estimated the availability of conventional seed for the 2011 crop by matching existing supply with demand from each growing region, taking into consideration the suitability in terms of disease and pest resistance and any possible deterioration due to age (Manning, 2010). Although the exact numbers are not publicly available, a declaration to the court stating the identification of a shortfall in the availability of conventional seed for the 2011 crop production is available. This declaration stated that: (1) seed breeders had not engaged in conventional variety seed development since 2006/2007; (2) the estimated shortfall in conventional seed availability for the 2011 crop production would not be the same for each producing region but would be substantial even under highly conservative assumptions; and (3) basic seed stock for production of seed for the 2012 crop production was not available for all varieties, so availability of conventional seed for sugar beet growers in 2012 would depend on the varieties demanded (Manning, 2010). Based on contacts with manufacturers of herbicides, Manning also stated that production of two herbicides used with conventional sugar beet production (BetaMix® and BetaNex®) was discontinued, and the production of two others (Nortron® and Upbeat®) was severely reduced with the adoption of H7-1 varieties. To restart or ramp up production of these herbicides, manufacturers indicated they would need a lead time of approximately one year and decisions would depend on demand expectations.

Manning's estimates were made for the 2011 crop, before the current partial deregulation of H7-1 was in place. The current regulatory uncertainty regarding the possibility of growing H7-1 sugar beet root in 2013 and beyond could have led seed providers to produce seed of conventional varieties, starting in 2011 for use in 2013, in the event that H7-1 sugar beet could no longer be commercialized from 2013 onwards. APHIS currently has no information on the extent to which this has occurred. Given the potential losses to the industry of disruptions to sugar beet production (see discussion further below), APHIS expects that any shortages of conventional seed or herbicide for conventional production would be less severe than those predicted for 2011 in Manning (2010).

To the extent that a shortage of domestic conventional seed did occur under Alternative 1, it would likely not be fully addressed through increased seed imports. European sugar beet seed varieties would be relatively unadapted and expected to yield less than varieties developed for the U.S. market. Due to the possibility of importing Europe's weed beet problem along with the seed, this option could potentially have long-term adverse consequences on the U.S. beet sugar industry. Canada is a net importer of beet seed (United Nations, 2011). Chile, although historically a net exporter, exported less than 4,000 kg of sugar beet seed in 2009, when it was actually a net importer as well (United Nations, 2011). It is unlikely that either of these countries or others would be able to meet a U.S. demand that was estimated in 2010 to have been between 575 tons and 5,750 tons of sugar beet seed (section III.D.2.a).

Figure 4–4 below shows that the sugar beet seed production cycle started in 2011 would have concluded and the sugar beet seed production cycle to be started in 2012 would not yet have started, if Alternative 1 were chosen in May of 2012. However, H7-1 seed production from the 2011 production cycle would not be allowed to be sold in the domestic market and would need to be channeled to export markets. The main sugar beet seed importer that has currently approved H7-1 sugar beet seed for planting is Canada. Canada's imports of sugar beet seed from the United States typically amount to less than 700 tons per year (Table 3–41), far less than U.S. seed production of about 3,500 tons in 2007, and would not be able to absorb all U.S. H7-1 seed. Sugar beet seed producers would likely lose most of the H7-1 sugar beet seed production from the 2011/2012 cycle.

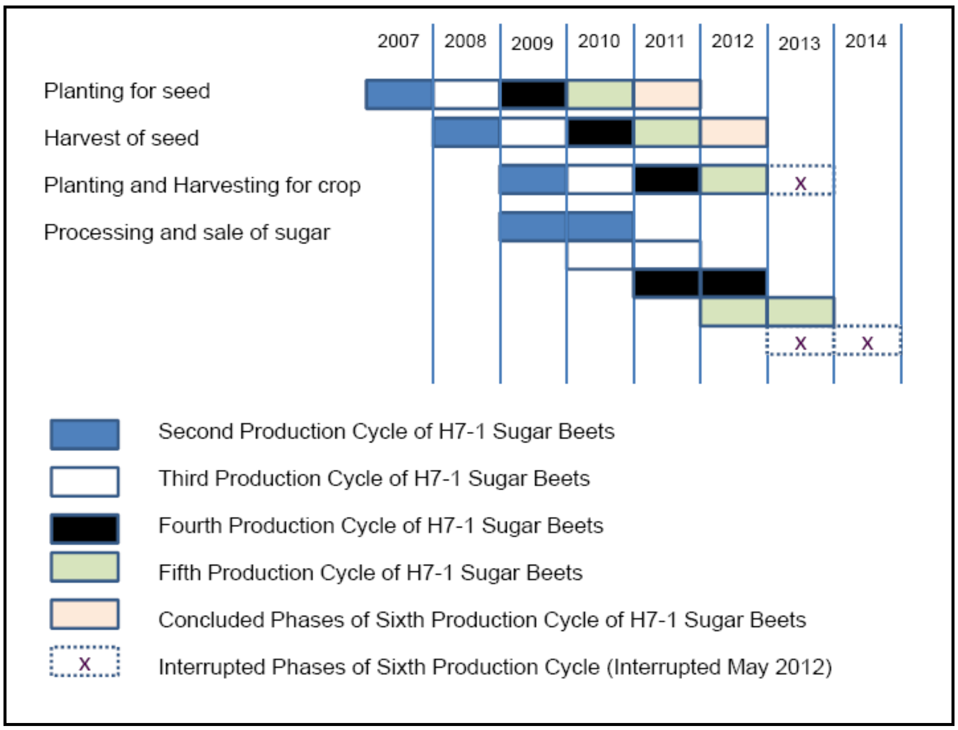


Figure 4- 4. Interrupted production cycles of sugar from H7-1 sugar beet under Alternative 1

Figure 4–4 assumes the 2012 root crop would be allowed to be harvested and commercialized. Sugar beet root production during 2013 and sugar production during 2013 and 2014 would be affected by a shortage of seed. A shortage of conventional seed would imply reduced sugar beet acreage and reduced domestic production with potential consequences for sugar beet grower income and for sugar prices, but the potential consequences would depend on the extent of the seed shortage.

In the event that a shortage of seed of the magnitude estimated for 2011 by Manning did occur, some estimates of the consequences provide a reference for understanding their severity. Based on Manning's study, for example, the Director of the Dairy and Sweetener Analysis Group (DSA) at USDA's Farm Service Agency estimated that availability of conventional seed in 2011, would have allowed sugar beet production in only 63 percent of the total acreage, and would have led to a reduction in beet sugar production by an estimated 1.6 million tons, an increase in the price of refined sugar from 33 cents per pound to 41 cents per pound, an additional 1.6 billion USD paid by consumers for sugar and a loss of 700 USD million to growers and processors (Colacicco, 2010b). Based on the same estimates, Dr. Richard Sexton, a professor of agricultural economics at the University of California, Davis, estimated that a limitation in the availability of seed in production years 2011 and 2012 would have led to reduced income for sugar beet growers and salaried employees between 300 million and 400 million USD in both 2011 and 2012.

Estimates were done by both Colacicco (2010b) (USDA's sugar expert) and Sexton (2010b) (an economist hired by the Intervenor-Defendents, representatives of sugar beet growers and processors) in the litigation *Center for Food Safety, et al., v. Tom Vilsack, et al.,* Civil Action No. 3:08-cv-00484.

As previously discussed, APHIS considers unlikely that any shortages of seed in 2013, under Alternative 1, would be as severe as those estimated for 2011 because seed and herbicide providers have had more time to build up supplies of conventional seeds and the associated herbicides. A severe shortage, even if only during one or two planting seasons, could have long term consequences for the sugar beet industry. Sexton (Sexton, 2010b), for example, predicted that the unavailability of H7-1 seed for 2 years, 2011 and 2012, would lead to the permanent closure of eight beet processing plants: six in the West region and two in the East region.[35] Plant closures would have immediate impacts on local communities, with loss of permanent and seasonal jobs and loss of income for sugar beet growers, and would impact the communities around the sugar beet plants as a whole, through their economic interactions with sugar beet growers and processing plants.[36] If the shortage is less severe, some or all of these plant closures would be less likely to follow, however, as would the labor and income impacts for the grower and processing plant communities.

To the extent that a shortage of conventional sugar beet seed or of herbicide for conventional sugar beet production would occur, sugar beet growers and processors would be adversely impacted. However, the possibility of deterring these adverse impacts from also occurring in the

[35] Producer regions have been combined for this discussion into two regions due to disclosure issues. The West Region includes the Northwest and Great Plains regions. The East Region includes the Upper Midwest and Great Lakes regions. The Imperial Valley is excluded from this section on economic impacts because only conventional seed is used there; hence, the unavailability of H7-1 beet seed would have no impact.

[36] Producers in Ontario, Canada, producing for the Michigan Sugar Company would also be affected. These include over 90 producers and almost 10,000 acres of sugar beet (Better Farming, 2010; Better Farming, 2011).

sugar market would depend on the extent to which cane sugar is available to replenish the market. Increased use of cane sugar to supply the domestic sugar market faces two obstacles: (1) U.S. sugar cane refining capacity, and (2) world supply of refined sugar. Domestic sugar shortages are typically alleviated by USDA through increases in the raw sugar tariff rate quota. This solution depends on the domestic capacity to refine imported raw cane sugar, recently estimated to be operating at nearly full capacity (Colacicco, 2010b). The U.S. sugar policy does not allow reassignment of the U.S. sugar marketing allotments between domestic cane and beet sugar processors, but program actions could be taken to increase imports. However, use of domestically produced sugar from cane would also face the limitations in the domestic capacity to refine sugar.

The possibility of importing refined sugar instead depends on the availability of refined sugar in world markets to address increased U.S. imports. This would be challenging due to the limited world sugar processing capacity and the uncertain capability of foreign producers to supply refined sugar of the quality and packaging needed by U.S. sugar users. It would also tax the current refined sugar distribution system (Colacicco, 2010b). If sugar could be acquired from the world market, the temporary loss of cane refineries in 2005 and 2008[37] showed that many U.S. food manufacturers have difficulty using imported refined sugar due to the difference in product quality or packaging (Colacicco, 2010b). This suggests a domestic shortage of sugar and increases in the domestic sugar price would likely follow any potential shortages in conventional sugar beet seed.

(2) Alternative 2 – Full Deregulation

Under Alternative 2, no shortage of seed for production of sugar beet would be expected and current trends for sugar beet and sugar production would be expected to continue without interruption. Figure 4–5 shows the production cycles of sugar from H7-1 sugar beet under Alternative 2.

Because there would be no shortage of sugar beet seed under this alternative, the potential losses in grower income and processor jobs discussed under Alternative 1 for 2011 and 2012 would not occur. Nor would processing plants be forced to close because of limited availability of sugar beet. There would be no reason to expect a spike in domestic sugar prices or for consumers to pay higher prices due to domestic sugar production shortages.

(3) Alternative 3 – Partial Deregulation

Under Alternative 3, H7-1 sugar beet seed would be produced under permits and sugar beet roots under compliance agreements. The permits and compliance agreements would allow APHIS to control individual plot locations and enforce stewardship practices. Alternative 3 would also not allow seed or root production of H7-1 sugar beet varieties in California or western Washington. Conditions would be similar to those currently in place. Based on the discussion in IV.D.1.a.(3) of the regulatory requirements of this alternative, APHIS does not expect production of H7-1 sugar beet seed to suffer interruptions under this alternative and no shortage of sugar beet seed would be expected. There would be no losses

[37] The refined sugar market was disrupted in 2005 by the closing of two New Orleans sugar refineries after Hurricane Katrina, and the failure of the early sugar beet product in the Red River Valley, North Dakota, and Minnesota, which resulted in a loss of 160,000 to 210,000 tons of refined sugar. The market was disrupted again in 2008 by an explosion at an Imperial Sugar plant in Savannah, Georgia which reduced U.S. refining capacity by 900,000 tons D Colacicco, "Second Declaration of Daniel Colacicco, Regarding Center for Food Safety, Et Al., Plaintiffs, V. Thomas J. Vilsack, Et Al., Defendants. United States District Court for the Northern District of California, San Francisco Division. Case No. 3:08-Cv-00484 Jsw," (2010b), vol..

in grower income and processor salaries, plant closures or increased sugar prices due to an acute domestic sugar shortage.

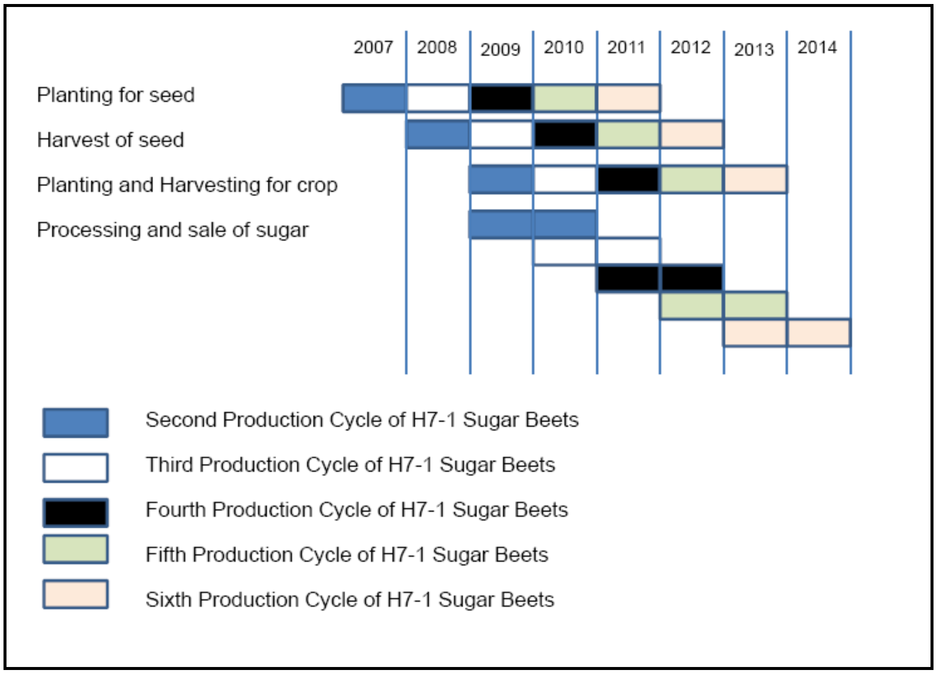


Figure 4-5. Production cycles of sugar from H7-1 sugar beet under Alternative 2

2. The Sugar Beet Seed Market

a. Alternative 1 – No Action

Under Alternative 1, H7-1 sugar beet would be fully regulated and the entire root crop from 2013 onward would need to be planted with conventional seed. Sugar beet seed production from 2012 onward would consist only of conventional sugar beet seed varieties, with the exception of research and development activities in small plots, allowed under permit or notification. These research and development activities would be expected to dwindle with time.

Because sugar beet seed production has a multi-year cycle, H7-1 seed grown in 2011 for the 2013 crop production would need to be mostly discarded, as discussed in IV.D.1.b. Sugar beet seed companies would lose past investments in the development of H7-1 varieties and any past investments in stewardship programs incorporating H7-1 varieties. As the biotechnology developers, Monsanto and KWS SAAT AG would lose investments in research and development and in regulatory approvals abroad, to the extent that returns on those investments depend on production in the U.S. To the extent that there is a shortage of domestic conventional seed in 2013, sugar beet seed providers would temporarily experience decreased seed sales. These sales would be expected to gradually recover. Because U.S. sugar beet seed exports are destined mostly to Canada, where H7-1 varieties are approved, it is possible that U.S. sugar beet seed exports to that country would temporarily decrease.

The main impact of Alternative 1 for the sugar beet seed industry would be the large financial losses resulting from research and development costs for the production of varieties that could not be used, lost time to develop new varieties, and lost inventory from seed that would need to be discarded. APHIS does not know the financial impact for the lost R and D costs that result from not being able to use hundreds of lines that took from 5-10 years to develop. Just the seed inventory for the 2013 planting year that would need to be discarded represents a loss in excess of $110 million U.S.D. (Enright, 2010; Fritz, 2010; Meier, 2010). Potentially, there might be the disincentive to future investments in genetically engineered varieties of sugar beet, if the expected likelihood of obtaining regulatory approval is diminished.

b. Alternative 2 – Full Deregulation

Under Alternative 2, over 95 percent of the 2013 root crop would be expected to be of H7-1 sugar beet varieties, similar to the adoption rate of H7-1 in the 2009 sugar beet crop. As H7-1 varieties adapted to conditions in California are developed, it is possible that the H7-1 share of root crop production would approach 100 percent. In addition, no shortage of seeds for sugar beet production would be expected.

There is no publicly available information on differences in costs and returns for production of sugar beet seed of H7-1 varieties compared to conventional varieties. The difference in returns to individual seed growers of producing H7-1 or conventional sugar beet seed varieties would depend not only on production costs, but on the contractual arrangements made with each sugar beet seed company. As described in section III.D.2.b, U.S. sugar beet seed production is concentrated in few farms and seed companies. In 2007 there were 93 farms producing sugar beet for seed and in 2002 there were 130, occupying less than 4,500 acres (USDA-NASS, 2009c). These farms produce under contract for five sugar beet seed companies who develop and market sugar beet seed varieties, both conventional and containing the H7-1 trait.

The main impact on sugar beet seed producers of differential costs and returns of sugar beet production under Alternative 2 is the resulting demand for specific varieties of seed. This resulting demand has implications on past and future research and development of sugar beet seed varieties. Under Alternative 2, conventional seed produced in case H7-1 is no longer allowed for planting in 2013 would likely be discarded, although some might be exported to Canada, depending on the varieties. Any recent investments in development of those conventional seed varieties would also likely be lost. Past investments in varieties with the H7-1 trait and in research and development leading to H7-1 sugar beet would be preserved. Incentives for future development of GE sugar beet varieites for the United States would be maintained as would current trends in seed exports.

c. Alternative 3 – Partial Deregulation

Under Alternative 3, H7-1 sugar beet seed would be produced under permits and sugar beet roots under compliance agreements. The permits and compliance agreements would allow APHIS to control individual field locations and enforce stewardship practices. Conditions would be similar to those currently in place. Based on the discussion of the regulatory requirements of this alternative, H7-1 adoption rates would be expected to be over 95 percent, although not 100 percent, given that sugar beet root producers would not be allowed to produce H7-1 sugar beet varieties in California or western Washington. Producers in California would continue to demand conventional sugar beet seed. Under this alternative, past investments in H7-1 sugar beet seed varieties and in conventional sugar beet seed varieties suited to California would be preserved, while any current investment in development of H7-1 sugar beet seed varieties for California would be lost. Incentives for future development of GE sugar beet the United States would be maintained.

Sugar beet seed growers of H7-1 varieties would be bound to comply with measures imposed to limit gene flow from H7-1 sugar beet seed fields. Many measures required from H7-1 sugar beet seed growers during production under permit would be similar to those H7-1 sugar beet seed growers would be required to adopt under full deregulation (Alternative 2) by industry stewardship agreements. However, co-existence stewardship controlled by APHIS has the potential to improve compliance. In addition, Alternative 3 imposes the added requirements needing to obtain a permit and packaging specifications for the transport of seed. Improved compliance, added requirements, and geographical restrictions could add costs to H7-1 sugar beet seed production. However, because of the extent to which co-existence stewardship practices already prevail in the seed industry, these costs would not be expected to substantially influence the supply or price of seed.

3. Organic and Conventional Sugar Beet and Sugar Markets

As discussed in section III.D.3, the demand for organic sugar has been steadily increasing though it still remains just 1 percent of the sugar market. Organic sugar is primarily imported and derived from cane. There currently is a small amount of organic cane sugar production in the U.S. but no commercial organic beet sugar production. At least a segment of the domestic and export sugar market is likely sensitive to the presence of GE material. The impacts of each of the alternatives on these markets are discussed below.

a. Organic and Conventional Sugar Beet Root and Sugar Markets

For each alternative, the sections below summarize the information obtained on the likelihood of gene flow to organic and non-GE sugar beet root fields and the potential socioeconomic impacts on growers and consumers if gene flow does occur.

(1) Alternative 1 – No Action

Under Alternative 1, H7-1 is fully regulated and the entire root crop from 2013 onward would need to be planted with conventional seed. No H7-1 sugar beet could be planted other than for research and development. No sugar derived from these beet would be available.

Under Alternative 1, all sugar sold in the domestic market would be conventional or organic (approximately 1 percent). Sales of organic sugar would be expected to increase to keep pace with the expanding organic market, with the main source of supply being imported organic sugar from cane. Domestic organic sugar production, while currently insubstantial, could develop if the domestic demand for organic sugar grows, domestic production can effectively compete with imported organic cane sugar, and a solution is devised to economically process organic sugar from either cane or sugar beet.

Consumers would have the option of choosing between conventional and organic sugar. Sugar beet growers and processors would not have the option of growing and processing H7-1 varieties of sugar beet.

(2) Alternative 2 – Full Deregulation

Under Alternative 2, adoption of H7-1 sugar beet varieties by root growers would be expected to remain above 95 percent of the root crop, increasing to 100 percent as H7-1 varieties become available in California. Even with such widespread adoption of H7-1 varieties, no adverse socioeconomic impact due to gene flow is expected to conventional and organic sugar beet producers.

LLP in conventional sugar beet is not expected to lead to any economic losses for several reasons. First, by mutual agreement among growers, cooperatives, processors, and marketers, H7-1 sugar beet and conventional sugar beet are currently harvested, transported, stockpiled, processed, and marketed without distinction in all producing regions with the exception of California, where H7-1 sugar beet has not been grown to date. This indicates that current domestic demand for conventional sugar beet is not sensitive to the presence of GE material. Second, Canada and Mexico, the main importers of U.S. sugar, allow the import of GE sugar beet products without restriction, as does Japan, the main importer of sugar beet pulp from the United States (section III.D.1.b). This suggests that the main foreign buyers of U.S. sugar would not impose restrictions to conventional sugar exports from the United States for fear of presence of GE material. In addition, refined sugar from sugar cane or from sugar beet is typically 99.95 percent sucrose, and sucrose is identical irrespective of its cane or beet origin (The Sugar Association, Undated). During the processing of sugar beet into refined sugar, the DNA and protein is removed so molecular tests cannot distinguish between H7-1 and conventional beet sugar.

Currently there is no organic beet sugar market to be impacted by H7-1. If an organic beet sugar market were to develop, it would require segregation from the rest of the beet sugar produced from H7-1 and would be sensitive to LLP, Seed lacking LLP could be obtained from a number of sources. It could be produced in areas outside of eastern Washington and the Willamette Valley where no H7-1 sugar beet seed is produced. It could be produced in Eastern Washington and the Willamette Valley taking care to observe isolation distances and testing the seed for LLP[38]. It could be obtained from Europe where some organic sugar beet are produced.

The organic sugar beet root crop can be produced in proximity to H7-1 sugar beet root crop without concern of LLP because no gene flow is possible from one root crop to the next. Thus, if seed is verified to lack LLP, the root crop produced from that seed will also lack LLP. Testing of the sugar beet root crop would be very cumbersome given the size of the root (several pounds) and the labor intensiveness to collect a representative sample from thousands of roots for analysis. Testing the refined sugar would be pointless because measureable quantities of protein and DNA are absent (see section III.F.1.a.(5)).

Because beet seed production already is established with isolation distances that minimize cross pollination between various beta seed crops and the organic and H7-1 root crops can be produced in proximity without adverse impacts to the organic crop, APHIS does not believe that widescale adoption of H7-1 will interfere with the emergence of an organic beet sugar industry. The greatest challenges for establishing an organic beet sugar industry will come from the costs of establishing and maintaining dedicated storage and processing facilities for organically grown sugar beet, the high cost of growing sugar beet without chemical weed control, and competition from imported organic sugar which can be produced at lower cost due to lower labor costs needed for weed control.

Manufacturers of sugar containing products destined for GE sensitive markets, currently have the option of using conventional or organic cane

[38] Conventional lines lacking LLP are still successfully produced in the Willamette Valley as are vegetable beet. Conventional sugar beet seed is routinely tested for the H7-1 trait M. Anfinrud, " Deposition of Mark Anfinrud, Center for Food Safety Et Al. Vs. Thomas Vilsack Et Al. File No. 3:08-Cv-00484-Jsw," ed. The United States District Court for the Northern District of California San Francisco Division (2010), vol.

sugar. For example, European markets require labeling of ingredients obtained from GE crops and exporters of sugar containing products destined to Europe would need to opt for cane sugar or other sweeteners if the label were not desired. Because sugar from sugarcane is processed and can be marketed separately from sugar from sugar beet, manufacturers and consumers wishing to avoid sugar from GE sugar beet would be able to do so.

Sugar beet processing generates pulp and molasses as co-products that is mainly used as feed for livestock. Sugar beet tops may also be fed to livestock. To the extent that livestock farmers are sensitive to the presence of GE material in feed, Alternative 2 would make sugar beet co-products unavailable to those livestock farmers. Sensitivity to GE material in feed is likely restricted to a small share of livestock farmers, if any. As an example, Putnam (2005) notes that GEcrops such as corn and soybeans have been used as animal feed for years with no perceptible impact on the marketing of beef. Also, sugar beet products represent a very small share of the feed products available to farmers. As an example, if all the sugar beet co-products from 2010 (approximately 32 million tons) were sold as pulp pellets for livestock feed, the amount sold would be approximately 1.76 million tons of pellets (at 110 lb of pellets per 1 ton of sugar beet (Western Sugar Cooperative, 2006). This would correspond to just over 1 percent of the 140 to 180 million tons of four major feed grains (corn, sorghum, barley and oats) consumed for feed each year (USDA-ERS, 2011b). In addition, livestock is often highly dependent on forage. As an example, only 16 million out of 96 million cattle were on feed as of December 2007 (USDA-NASS, 2007b). Organic livestock farms would typically not be affected because 100 percent organic feed is required by the National Organic Program (see 7 CFR § 205.37(a)) and there are currently no commercialized organic sugar beet.

Under Alternative 2, consumers of sugar would still have the option of obtaining conventional or organic sugar. Sugar beet growers and processors would have the option of producing and processing conventional or H7-1 varieties of sugar beet. Widescale H7-1 sugar beet production under Alternative 2 would prevent little incremental barrier for the development of an organic beet sugar industry.

(3) Alternative 3 – Partial Deregulation

Under Alternative 3, H7-1 sugar beet seed would be produced under permits and sugar beet roots under compliance agreements. The permits and compliance agreements would allow APHIS to control individual field locations and enforce stewardship practices. Conditions would be similar to those currently in place. Based on the discussion of the regulatory requirements of this alternative, H7-1 adoption rates would be expected to be over 95 percent, although not 100 percent, given that sugar beet root producers would not be allowed to grow H7-1 sugar beet varieties in California or western Washington. As explained in section IV.D.3.a (2), even under full deregulation (Alternative 2), no economic losses to conventional sugar beet root growers would be expected, even under the unlikely presence of GE material in their fields. Nor would APHIS expect impacts on sugar containing products sold in GE sensitive markets l, because of the availability of conventional and organic cane sugar, as well as other sweeteners. The controls imposed by Alternative 3 on sugar beet production and transport would reduce further the likelihood of gene flow.

Under Alternative 3, consumers of sugar would still have the option of obtaining conventional or organic sugar. Sugar beet growers and processors would have the option of producing and processing conventional or H7-1 varieties of sugar beet.

b. Organic and Conventional Sugar Beet Seed Markets

For each alternative, the sections below summarize the information obtained on the likelihood of gene flow to organic and non-GE sugar beet seed fields and the potential socioeconomic impacts on growers if gene flow does occur.

(1) Alternative 1 – No Action

Under Alternative 1, H7-1 is fully regulated and the entire sugar beet root crop from 2013 onward would be planted with conventional seed. Sugar beet seed production from 2012 onward would consist only of conventional varieties, with the exception of research and development activities in small plots, allowed under permit or notification. These research and development activities would be expected to dwindle with time.

Under Alternative 1, all sugar beet seed available in the domestic market would likely be conventional. Because the demand for seed is a derived demand from the demand for sugar beet roots and no organic sugar beet roots are expected to be grown, no demand for organic sugar beet seed is expected to develop. Although there may be some demand for organic sugar beet seed in Europe, this market would likely be supplied by locally produced varieties of seed (see III.D.2.a for a discussion).

(2) Alternative 2 – Full Deregulation

Under Alternative 2, adoption of H7-1 sugar beet varieties by root growers would be expected to remain above 95 percent of the root crop, increasing to 100 percent as H7-1 varieties become available in California. This means that the domestic market for sugar beet seed would increasingly demand H7-1 sugar beet varieties. However, conventional sugar beet seed could still be produced in the short run or for foreign markets that do not plant GE sugar beet seed.

As noted in section III.D.2.b, almost all domestic sugar beet seed is produced by five seed companies. Because production of sugar beet seed is concentrated in these companies, and because gene flow can be minimized by isolation distances and other production management practices, availability of conventional sugar beet seed to satisfy any existing demand would depend largely on a business decision made by these seed companies. Section III.B.1 reviews the sugar beet seed industry current stewardship practices. These include mapping of seed fields, tracking systems, isolation distances, and seed processing procedures that minimize gene flow between sugar beet seed fields of different varieties. In addition testing can be done for GE sensitive seed markets (export markets) with cost estimates varying from a few dollars to 300 dollars per test (see section IV.D.3.b for more details).

Based on the existing data on sugar beet seed production and international trade before and after the authorization for planting of H7-1 varieties of sugar beet seed in 2005, no impacts on total sales or U.S. international trade of sugar beet seed can be detected from the availability of H7-1 varieties in the U.S. market. Exports have fluctuated around 700 tons since 2000 with 65 to 86 percent of exports destined to Canada (Table 3–40).

(3) Alternative 3 – Partial Deregulation

Under Alternative 3, H7-1 sugar beet seed would be produced under permits and sugar beet roots under compliance agreements. The permits and compliance agreements would allow APHIS to control individual field locations and enforce stewardship practices. Conditions would be similar to those currently in place. Based on the discussion of the regulatory requirements of this alternative, H7-1 adoption rates would be expected to be over 95 percent, although not 100 percent, given that sugar beet root producers would not be allowed to produce H7-1 sugar beet varieties in California or western Washington. As explained in section IV.D.3.b (2), even under full deregulation (Alternative 2), no economic losses to conventional sugar beet seed growers would be expected. The controls imposed by Alternative 3 on sugar beet seed production would reduce further the likelihood of gene flow. No impacts on sugar beet seed markets would be expected.

4. Vegetable Beet Markets

a. Vegetable Beet Markets (Leaf and Root)

For each alternative, the sections below summarize the information obtained on the likelihood of gene flow to chard and table beet vegetable fields and the potential socioeconomic impacts on growers and consumers if gene flow does occur.

(1) Alternative 1 – No Action

Under Alternative 1, H7-1 is fully regulated and the entire sugar beet root crop from 2013 onward would be planted with conventional seed. No H7-1 seed could be planted other than for research and development. Under Alternative 1, U.S. production and consumption of vegetable beet would likely continue to be between 100,000 tons and 150,000 tons a year, with a tendency to decline. Acreage might also decline, although the number of farms might not, given the recent declining trend in vegetable beet acres per farm. Exports would likely remain few and mostly destined to Canada (section III.D.4.a).

(2) Alternative 2 – Full Deregulation

Under Alternative 2, adoption of H7-1 sugar beet varieties by root growers would be expected to remain above 95 percent of the root crop, increasing to 100 percent as H7-1 varieties adapted to sugar beet production in California become available. As described in section III.D.4.a, vegetable beet root production for processing is highly concentrated in New York and Wisconsin, two states that do not produce sugar beet for root or seed. Vegetable beet root production for the fresh market is more dispersed and includes states such as Michigan – a producer of sugar beet root crop, and Oregon – a producer of sugar beet seed.

Section III.B.5.c describes the potential for gene flow from H7-1 sugar beet varieties to conventional and organic vegetable beet. Because commercial vegetable beet is harvested before flowering, no pollen-mediated gene flow would occur. If any bolting occurred, the bolting inflorescence would be removed, given that the flowering stock is undesirable to vegetable beet crop farmers, precluding any possibility of gene flow. No impacts would be expected to vegetable beet root growers or consumers.

(3) Alternative 3 – Partial Deregulation

Under Alternative 3, H7-1 sugar beet seed would be produced under permits and sugar beet roots under compliance agreements. The permits and compliance agreements would allow APHIS to control individual field locations and enforce stewardship practices. Conditions would be similar to those currently in place. Based on the discussion of the regulatory requirements of this alternative, H7-1 adoption rates would be expected to be over 95 percent, although not 100 percent, given that sugar beet root producers would not be allowed to produce H7-1 sugar beet varieties in California. As explained in section IV.D.4.a (2), even under full deregulation (Alternative 2), no economic losses to conventional sugar beet root growers would be expected. The controls imposed by

Alternative 3 on sugar beet root production and transport would reduce further the likelihood of gene flow. No impacts would be expected to vegetable beet root growers or consumers.

b. Vegetable Beet Seed Markets

For each alternative, the sections below summarize the information obtained on the likelihood of gene flow to vegetable beet seed fields and the potential socioeconomic impacts on growers if gene flow does occur.

(1) Alternative 1 – No Action

Under Alternative 1, H7-1 is fully regulated and the entire root crop from 2013 onward would be planted with conventional seed. Sugar beet seed production from 2012 onward would consist only of conventional sugar beet seed varieties, with the exception of research and development activities in small plots, allowed under permit or notification. These research and development activities would be expected to dwindle with time.

Under Alternative 1, because demand for vegetable beet seed is derived from the demand for vegetable beet roots and leafy greens and this demand is declining, domestic demand for vegetable beet seed would tend to decline. Foreign demand might remain stable at around 700 to 800 tons a year (Table 3–46). Vegetable beet seed production would likely continue to be concentrated in the western States of Washington, Oregon and California, with a strong concentration in western Washington (section III.D.4.b).

(2) Alternative 2 – Full Deregulation

Under Alternative 2, adoption of H7-1 sugar beet varieties by sugar beet root growers would be expected to remain above 95 percent of the root crop, increasing to 100 percent as H7-1 varieties become available in California.

Under Alternative 2, gene flow to vegetable seed production from sugar beet seed fields would be possible. Current industry practices, including mapping of seed fields, tracking systems, isolation distances and seed processing procedures would tend to minimize gene flow, but would not eliminate the possibility (see section III.B.1 for a review of sugar beet seed industry current stewardship practices).

Seed could need to be tested, if required by the market,[39] or to avoid the unintentional sale of seed with adventitious presence of genetically

[39] Morton F. Morton, "Declaration of Frank Morton in Support of Plaintiffs' Motion for Temporary Restraining Order and Preliminary Injunction, Regarding Center for Food Safety, Et Al., Plaintiffs, V. Thomas J. Vilsack, Et Al., Defendants. United States District Court for the Northern District of California, San Francisco Division. Case No. 3:08-Cv-00484 Jsw," (2010), vol.claims that he must

engineered material. Seed could be tested by protein or DNA based tests (see Section III.B.1.b.19). According to Morton (2010), testing costs for DNA by Polymerase Chain Reaction (PCR) would cost 300 USD per seed lot. Protein based testing using Lateral Flow Strips cost about $2-4/test, do not require special equipment, but are about ten fold less sensitive and are not quantitative. If LLP were to be found, it could result in lower value of the seed crop for the seed grower if he caters to a GE sensitive market. If the market for the vegetable seed is not GE sensitive, such as the beet canning industry, there is not likely to be any new impacts. Nor would there necessarily be impacts to the organic producer. The National Organic Program excludes the use of genetically engineered products but is process based (as opposed to product based) and LLP would not automatically imply the loss of organic certification. APHIS is not aware of any organic grower who has lost organic certification due to LLP. However, individual customers and foreign markets might still have zero tolerance for LLP even though the product has an organic certification. This could result in a loss of customers for vegetable beet seed producers in the Willamette Valley.

For the grower of vegetable beet seed for a GE sensitive market who discovers LLP in his seed, it is possible that the intended purchaser of the seed may reject the lot (for example, many foreign markets forbid the planting of GE seed) and the grower will need to find an alternative buyer who would likely pay less for the seed. Seed tested and found to lack LLP might still contain LLP at a frequency below the limit of detection for the assay. Assuming the limit of detection is 1 seed in 10,000 seed for a DNA based test, a vegetable beet grower who purchased such seed might expect to find 5-10 off-type vegetables/acre. Detection methods of less sensitivity could result in higher levels of off-types in the resulting crop. As discussed in section III.B.5.e(1), the GE trait will be limited to either sugar beet plants or hybrid off-types and such plants usually are visibly distinct from vegetable beet and can be rogued (Figs 3-15 and 4-3). When identified they could be removed and not reach the consumer but could represent a minor loss to the vegetable producer. The loss from roguing the hybrid, is no different whether the hybrid off-types result from any combination of vegetable beet and sugar beet including conventional. If the vegetable beet seed is being used to grow microgreens or sprouts, off-types would not be detectable and could reach the consumer at the frequency hybrid off-types are present in the seed for planting. Vegetable beet seed growers have expressed concern that the reputation of seed growing regions in western Oregon, such as the Willamette Valley or the Rogue River Valley, will be harmed, in the view of organic and GE sensitive markets, by the potential for LLP (Morton, 2008; Morton, 2010;

test his seed if GE varieties of his contracted species are being grown within 10 miles of his seed but his tests have so far been done willingly (not in response to a request from a client).

Tipping, 2010; Morton, 2011). If the market has zero tolerance for any level of LLP, vegetable beet producers who cater to this market may insist in purchasing their seeds from regions outside of Oregon.

If harm to seed grower's reputations, including loss of clients, were in fact inflicted by the detection of LLP in conventional or organic seed, or by the perception that the geographic origin of the seed alone poses the risk of presence of LLP in vegetable beet seed, the potential impact in the Willamette Valley could affect an estimated 300 acres of chard and table beet seed with an annual gross value of 1.75–2.25 million USD produced by a "dozen family seed farms," according to the Director of Advocacy of the Organic Seed Alliance (Dillon, 2010). Some vegetable beet seed growers could cease production of vegetable beet seed and contracts with seed companies to produce this seed may shift elsewhere.

The extent of the impact of Alternative 2 on U.S. vegetable beet seed production as a whole would depend on the extent to which the market for U.S. vegetable beet seed is sensitive to the perceived risk of presence of LLP in vegetable beet seed, even if no LLP is present in testing or has ever been detected. Several literature reviews suggest that there is a portion of food markets that is sensitive to GE food ingredients . Fernandez-Cornejo (2006), for example, notes that consumers often do have concerns with food containing GE ingredients. Many contingent valuation studies exist for Europe, United States, Japan, and Australia reporting that consumers are typically willing to pay a higher price for GE-free foods, and various articles review this literature (Lusk et al., 2004; Rigby et al., 2004). However, studies suggest consumer sensitivity is usually only a portion of the market and often has less impact on sales than expected. Hallman et al. (2003) report that only one quarter of the U.S. residents they surveyed approved of use of genetic engineering in animal farming, but one half approved of plant-based engineering, suggesting consumer sensitivity levels also depend on the kind of product being sold. Noussair et al. (2004) found that the level of content of GE material seems to influence consumer preference. In their survey, 89 percent of consumers were willing to purchase a product with up to 1 percent GE content and 96 percent with up to 0.1 percent GE content. (Fernandez-Cornejo and Caswell, 2006) noted that while opinion surveys provide some insight into consumer opinion, they often do not reflect how consumers will behave in a real market situation when purchasing goods and services. In the United States, many products contain GE ingredients, and the demands for these products apparently have been unaffected by negative opinions about biotechnology expressed in surveys.

As reported in section III.D.3., Kalaitzandonakes (2005) conducted a study in the Netherlands that found that even when products are labeled as containing GE ingredients, a majority of consumers did not shift away from the purchase of processed foods containing GE ingredients in the presence of alternatives in stark contrast to findings based on opinion surveys. Despite the trend in the stated preferences of the population to avoid GE foods, consumers continued to purchase these foods at the same rate before labeling was instituted or after GE ingredients were no longer used. In other words, at a time when consumers overwhelmingly said they would not purchase GE foods, consumers continued to purchase labeled GE products to the same degree as before they were labeled and when people expressed more of a willingness to purchase them. This data further supports the idea that the link between the elicited attitudes expressed in surveys and product demand is weak.

Under Alternative 2, at least a share of vegetable beet consumers would continue to demand GE free vegetable beet and there would continue to be a derived demand for GE-free vegetable beet seed. How big of an impact on the Willamette Valley seed producers would depend on the size of that demand relative to the total vegetable beet market. Consumers would still have the choice to consume conventional or organic vegetable beet as vegetable growers who cater to a GE sensitive market could obtain seed from a tested source in the Willamette Valley or a producer in an area where H7-1 seeds are not grown. Sugar beet growers and processors would have the option of producing and processing conventional or H7-1 varieties of sugar beet.

(3) Alternative 3 – Partial Deregulation

Under Alternative 3, H7-1 sugar beet seed would be produced under permits and sugar beet roots under compliance agreements. The permits and compliance agreements would allow APHIS to control individual field locations and enforce stewardship practices. Conditions would be similar to those currently in place. H7-1 sugar beet seed production would be prohibited in the Western Washington where much of the vegetable beet seed is produced. Based on the discussion of the regulatory requirements of this alternative, H7-1 adoption rates would be expected to be over 95 percent, although not 100 percent, given that sugar beet root producers would not be allowed to produce H7-1 sugar beet varieties in California. Under Alternative 3, the enforcement of stewardship practices and the added conditions imposed on sugar beet seed production of H7-1 varieties would reduce the likelihood of LLP in vegetable beet seed fields, even further than under full deregulation (Alternative 2). To the extent that seed producers still engage in testing of vegetable beet seed lots for LLP, whether required by the market or not, Alternative 3 would result in added costs to vegetable seed producers.

As in the case of Alternative 2, however, under Alternative 3, at least a share of vegetable beet consumers would continue to demand GE-free vegetable beet root and there would continue to be a derived demand for GE-free vegetable beet seed. Consumers would still have the choice to consume conventional or organic vegetable beet. Sugar beet growers and processors would have the option of producing and processing conventional or H7-1 varieties of sugar beet.

E. Physical Environment

The potential environmental impacts of implementing the three alternatives on the physical environment are discussed in sections IV.E.1 through IV.E.4. The discussion of land use addresses potential impacts on the acreage and location of land used for sugar beet production. The discussion of soil quality addresses potential impacts on the structure and physical make-up of soil due to sugar beet production. The discussion of air quality and climate change addresses potential impacts on air and global climate change due to sugar beet production. The discussion of water quality addresses potential impacts on surface water and groundwater quality due to sugar beet production.

In this section, the assessment of potential impacts on land use, soil quality, air quality and climate change, and surface water and groundwater quality is based on the following assumptions:

- H7-1 sugar beet production results in increased conservation tillage practices.
- H7-1 sugar beet has the same fertilizer requirements as conventional sugar beet because the genetic alteration does not affect the nutrient needs of the plant.
- H7-1 sugar beet has the same water requirements and efficiency levels as conventional sugar beet because the genetic alteration does not affect the water needs and efficiency of the plant.
- H7-1 sugar beet has the same processing requirements as conventional sugar beet.

1. Land

Genetically engineered crops are largely replacing conventional crops rather than becoming an additional market or causing the conventional crop to become a separate market (USDA-ERS, 2009a) . The average yearly acreage of principal crops from 1983 to 1995, was 328 million (USDA-NASS, 2010b) and after the introduction of biotechnology-derived crops in 1996, including several principal crops such as soybeans, corn, and cotton, in 2009, 319 million acres of principal crops were planted, which is less than a 3-percent change (USDA-NASS, 2010b). Sugar beet acreage has remained relatively constant over the last 50 years with 1.13 million acres planted in 1961 increased to 1.18 million acres in 2010 and 1.24 million acres in 2011. Considering the agricultural use of the land for sugar beet production has remained relatively consistent over the last five decades, and the alternatives under consideration analyze continued conventional sugar beet or H7-1 sugar beet crop production, it is generally expected that the agricultural use of land currently under sugar beet production would not substantially change under any of the alternatives.

a. Alternative 1 – No Action

In spring 2011, H7-1 sugar beet was planted subject to partial deregulation, and assuming that H7-1 sugar beet would again be planted under partial deregulation in 2012, Alternative 1, if implemented, would first apply to the root crop that would be planted in the spring of 2013 and the seed crop planted in the fall of 2013. Thus in 2013, no H7-1 sugar beet root crop or seed crop would be produced. In addition, on those agricultural lands that would no longer be allowed to grow H7-1 sugar beet, growers could allow the land to go fallow, or could plant other Roundup Ready® crops, other agricultural crops, or use the land for other purposes. That most growers would choose to do something with the land other than grow sugar beet is not expected because of the contractual relationship between sugar beet growers and sugar beet processing facilities (for a detailed discussion of the U.S. sugar market and its regulatory framework, see section III.D.1.a; see section III.D.1.b for a discussion of the demand for sugar beet). There may be some growers who would not go back to planting conventional sugar beet if H7-1 sugar beet is no longer available. However, considering the high value of sugar beet and the potential penalties for not producing a grower's allotment of sugar beet, it is possible though that most growers would continue to produce conventional sugar beet if H7-1 sugar beet is not available and that it is economical to do so.

Growers may choose to grow other Roundup Ready® crops like Roundup Ready® corn or Roundup Ready® soybean if they cannot grow H7-1 sugar beet. However, the decision to do this could be influenced by several factors including, availability of desirable varieties, availability and cost of any specialty cultivating equipment (e.g., for conservation or reduced tillage methods), value of these glyphosate-resistant crops compared to other alternative crops, and the potential penalty or lost ownership shares in the cooperative for not growing conventional sugar beet. Similar factors would also influence the potential decision to plant other agricultural crops. Alternative 1 could result in a decrease in sugar beet production over the short term due to a potential shortage of conventional sugar beet seed as discussed in section IV.D. If there is a shortage of conventional sugar beet seed in the short term, it would reduce sugar beet acreage and harvest, reduce domestic production, and increase the cost of sugar.

Another possible scenario to consider under Alternative 1 could be that conventional sugar beet seed would be available, and growers choose to plant conventional sugar beet instead of other glyphosate-resistant crops and acreage would be expected to be similar to 2010 sugar beet planted acreage at 1,171,400 acres. As discussed in section IV.D.1.b, the current regulatory uncertainty regarding the possibility of growing H7-1 sugar beet roots in 2013 and beyond, could have led seed producers to develop conventional varieties, starting in 2011 and for use in 2013, in the event that H7-1 sugar beet could no longer be commercialized starting in 2013. In this case, several factors could influence the decision to begin growing conventional sugar beet, including availability of herbicides, availability and cost of specialty cultivating equipment, availability of desirable varieties of sugar beet, the cost of hand labor for weeding under conventional production, and the value of sugar beet compared to alternative crops.

At least in certain regions such as the Great Plains, where weed control is very difficult, it appears that it is no longer economical for some growers to grow conventional sugar beet. For example, at the Fargo public meeting the General Manager of Sidney Sugars (covering Montana and Western North Dakota) reported that prior to the introduction of H7-1 sugar beet, acreage contracted to sugar beet declined by 63%. In the past three-years now that growers are using H7-1 sugar beet, acres contracted to sugar beet more than doubled. To quote:

> “declines in weed control effectiveness and resulting poor yields received in some areas cause the growers to look for more economical and profitable avenues to pursue on their farm. In 2003, growers contracted 41,500 acres. By 2008, this total had dropped to 15,300 acres. In 2009, growers started using a Roundup Ready® sugar beet variety extensively and the crop contracted rose to 24,900 acres. And it rose again in 2010 to 31,100 and the acres contracted in 2011 were 33,200.” (USDA, 2011b) p. 13-14.”

b. Alternative 2 – Full Deregulation

Under Alternative 2, H7-1 sugar beet and progeny derived from them would no longer be regulated articles under the regulations at 7 CFR part 340, would not require permits or notifications for the introduction of H7-1 into the environment, and growers would be able to freely move H7-1 sugar beet seed, stecklings, and any harvested seeds and roots without any APHIS oversight. Given growers' established preference for H7-1 sugar beet made evident by the 95 percent adoption rate of H7-1 sugar beet in 2009–2010 (USDA-ERS, 2009a) , H7-1 sugar beet would be expected to almost entirely replace conventional varieties with adoption continuing at 95 percent in the short term and expected to reach 100 percent in the long term, including planting of H7-1 sugar beet crops in California when suitable varieties of H7-1 sugar beet become available. Thus, Alternative 2 is expected to result in an increase in the prevalence of H7-1 sugar beet. Even after wide-scale planting of H7-1 sugar beet varieties occurred in 2008, the total U.S. sugar beet acreage after 2005 remained similar to the total sugar beet acreage of 1961 and successive years (USDA-NASS, 2010b). Therefore, implementation of Alternative 2 is not expected to change current land use patterns and no impact on land use compared to current conditions is expected.

Under Alternative 2, it is possible that Swiss chard and table beet seed production could relocate from the Willamette Valley to California, western Washington, and Arizona to counter market perceptions of potential LLP of the H7-1 trait (see section IV.D.4 for a detailed discussion of potential impacts on vegetable beet markets). As a result, the land used to grow approximately 300 acres of Swiss chard and table beet seed in the Willamette Valley may be used to produce a non-*Beta* seed crop.

As discussed in section III.D.1, existing studies indicate a potential increase in the overall economic returns to sugar beet root production with H7-1 adoption, although with considerable regional differences. Considering the potential for increased economic returns, it is possible that sugar beet growers may increase sugar beet acreage in some regions, however, increased returns are unlikely to lead to increased acreage of sugar beet root production as a whole. As discussed in section III.D.1.a, the domestic sugar market is closely managed by USDA's Sugar Program and maximum amounts of sugar allowed to be sold domestically are set each year for sugar beet processors (see section III.D.1.a for a detailed discussion of the U.S. Sugar Market's regulatory framework). Further, sugar beet processing plants have a certain processing capacity and no new plants are expected to open (see section III.D.1.b for a discussion of sugar beet processing plants). Thus, sugar beet growers might be unable to increase acreage in response to H7-1 sugar beet increased returns because of the limit to the amount of sugar that can be domestically sold and the limited processing capacity of the existing plants with no new processing plants being expected to open.

Section III.D.1.d, discusses a study (Kniss, 2010a) that compared 22 sugar beet fields (11 H7-1 and 11 conventional) in Wyoming in 2007 and reported that yields of H7-1 sugar beet were 15 percent higher than those of conventional varieties. Thus, there could even be an incentive for sugar beet growers to decrease acreage, if the increased yields obtained with H7-1 sugar beet production allow the production of the maximum amounts of sugar with less acreage. However it is important to consider that there are notable differences in growing conditions across sugar beet production regions in the United States and the results from this study in Wyoming do not provide sufficient data to generalize yield potential with H7-1 sugar beet adoption in all sugar beet growing regions across the country. The potential for decreased acreage across sugar beet growing regions cannot be substantiated at this time.

c. Alternative 3 – Partial Deregulation

Under Alternative 3, partial deregulation would not allow planting of sugar beet root and seed crops in California and Western Washington. The acreage of H7-1 sugar beet would not be as widespread under Alternative 3 compared to Alternative 2 due to the mandatory exclusion of California, which produces about 3 percent of the root crop on about 2 percent of the acreage, from potential H7-1 sugar beet crop plantings. Adoption of H7-1 sugar beet would be expected to range from 95 to 97 percent in the long term. It should also be noted that APHIS may deny individual field locations, which could also affect adoption rates.

As discussed under Alternative 2, the overall acreage under sugar beet production would not be expected to change notably with the adoption of H7-1 sugar beet even though the potential for increased returns with H7-1 sugar beet is realized. This stasis is expected because U.S. sugar market is regulated and beet processing capacity is limited.

As discussed in section IV.D.1.a(3), with the implementation of Alternative 3, H7-1 sugar beet root growers could be impacted by the regulatory requirements of Alternative 3 which is expected to be a few dollars per acre (see section IV.D.1.a(3) for a detailed discussion). This modest burden is generally not expected to diminish overall H7-1 sugar beet adoption behavior across sugar beet growing regions in the United States considering the variable costs involved in sugar beet production in different regions. In 2011, there was only a slight decrease nationwide in the acreage planted to the H7-1 sugar beet root crop where it declined from 95% to 92% (Schwartz, 2012). In 2011, the Midwest planted about 89.5% of the sugar beet root crop with H7-1 (Bernhardson et al., 2012). It is not known whether the decline in H7-1 production was due to regulatory uncertainty or the additional regulatory requirements .

2. Soil Quality

Different production systems used to grow sugar beet (root crops and seed crops) cause different impacts on soil quality. Cultivated soils are prone to degradation because certain farming practices, such as tilling, disturb and expose the top layer of the soil surface. Soil tillage may result in degradation of soil quality because of the varying impacts of erosion on soil nutrient composition and in the loss of top soil which, once lost, could take centuries to replace (Lal and Bruce, 1999; Cerdeira and Duke, 2006). Such erosion out of the fields would result in more chemical nutrient support being required for continued plantings on land. Tillage could also cause soil carbon stores to release into the atmosphere, contributing to global climate change (Lal and Bruce, 1999).

a. Soil Quality and Tillage

The different types of tillage methods used in sugar beet production, conventional tillage, conservation tillage, reduced tillage, and strip tillage have been described in section III.E.2.a(2). Implementation of any of the three alternatives is expected to result in changes to the extent to which these tillage methods would be applied to sugar beet production in the future. Potential impacts from these tillage methods on soil are briefly summarized below.

Research has shown that land management techniques involving tillage, crop type, or a pest management regime have notably greater effects on the biology of the soil than the type of crop grown (Griffiths et al., 2007). Specifically, the changes in soil micro-organisms associated with growing currently deregulated GE crops are relatively variable and transient compared to the effects from crop rotation, tillage, herbicide usage, and irrigation (Pontiroli et al., 2007). For more information on micro-organisms in soil and sugar beet production, see section III.E.2.e.

(1) Alternative 1 – No Action

Alternative 1 could potentially result in a decrease in sugar beet production over the short term due to a potential shortage in the availability of domestic conventional sugar beet seed as discussed in section IV.D. If there is a shortage of conventional sugar beet seed in the short term, it would imply reduced sugar beet acreage and harvest, and reduced domestic production. Farmers may allow the field to go fallow or replace the sugar beet crop with another Roundup Ready® crop.

If the land is tilled and allowed to go fallow, the amount of organic matter within the soil would be expected to decrease (USDA-ARS, 2005) resulting in the loss of potentially good bacteria and los of soil fertility (USDA-NRCS, 2011b). Further, leaving the field fallow would also increase the likelihood of erosion.

If farmers plant other Roundup Ready® crops, such as Roundup Ready® corn or Roundup Ready® soybean, it is expected that more conservation or reduced tillage would be used as the use of conservation tillage with these crops is currently more extensive than it is with sugar beet. However, the extent of increase in the use of conservation or reduced tillage and the consequent impacts as described in section IV.E.2.a as a result of planting Roundup Ready® crops under Alternative 1 would vary and depend on the individual crop's (corn or soybean for example) needs for optimal yield, (for example, specific fertilizer, herbicide, pesticide, irrigation, and plowing needs),the regional soil characteristics, topography, and climate such as timing and quantity of rainfall, and weed management strategies (Cheesman, 2004).

Another scenario to consider would be if conventional sugar beet seed is available for planting and growers choose to plant conventional sugar beet instead of other Roundup Ready® crops. As discussed in section IV.D.1.b, the current regulatory uncertainty regarding the possibility of growing H7-1 sugar beet roots in 2013 and beyond, could have led seed producers to develop conventional varieties, starting in 2011 and for use in 2013, in the event that H7-1 sugar beet could no longer be commercialized starting in 2013. In that case with the availability of domestic conventional sugar beet seed, farmers would plant conventional sugar beet in the place of H7-1 and thus would likely employ more intensive tillage practices compared to H7-1 sugar beet or other GE crops. In summary, if conventional sugar beet is planted, more tillage is expected than if H7-1 sugar beet or other glyphosate-resistant crops are planted. Adoption of conventional tillage with the planting of conventional sugar beet crops would be expected to result in greater erosion risks, loss of organic matter, and soil compaction, and reduced moisture holding capacity as discussed in section IV.E.2.a as compared to conservation or reduced tillage methods (see section IV.E.2.a for details on how conventional tillage can impact soil).

(2) Alternative 2 – Full Deregulation

Under Alternative 2, growers who have been producing H7-1 sugar beet seed and root would be expected to continue those plantings, and H7-1 seed and root production could expand to areas that currently produce conventional sugar beet seed and root since it has been observed that GE crops are largely replacing conventional crops rather than becoming an additional market or causing the conventional crop to become a separate market (USDA-ERS, 2009a).

With the high level of adoption of H7-1 sugar beet across the country, it is expected that the use of less intensive tillage methods such as conservation tillage, reduced tillage, and strip tillage would be greater relative to Alternative 1 (see section IV.E.2.a for more details). Increased adoption of less intensive tillage methods would vary between the production regions and is expected to result in varying impacts on soils in sugar beet production regions depending on the site specific soil characteristics, topography, climate, and related factors. For example, conventional tillage would continue in California because it is needed for furrow irrigation that is practiced there (2011).

Per a national survey in 2000, some sugar beet root production regions already employed conservation or reduced tillage to some degree. For example, in the Midwest, 36 percent of conventional sugar beet farms used reduced or mulch tillage (see section III.E.2.a for a detailed discussion and 75-80% of sugar beet farms in Nebraska use strip till (Wilson Jr, 2012). H7-1 sugar beet have largely replaced conventional sugar beet varieties in all regions except the Imperial Valley, and tillage and or cultivation use in all these regions decreased and positively impacted the soil quality and structure. As discussed in section III.E.2. Some benefits of conservation, reduced, and strip tillage methods include reduced water and wind erosion, improved soil structure and increased organic matter, enhanced infiltration, increased soil moisture, reduced soil compaction, reduced carbon emissions into the air, and lower machinery, fuel, and labor costs.

It is expected that the adoption of H7-1 sugar beet and the associated increase in less intensive tillage methods such as conservation, reduced, and strip tillage has resulted and will continue to result in beneficial impacts on soil quality and structure in sugar beet producing regions as discussed above. It is generally expected that if H7-1 sugar beet is adopted in California where only conventional varieties were grown in the past, conservation tillage would not be adopted because it is not compatible with furrow irrigation. Therefore,this region would not experience the benefits from the increased use of conservation or reduced tillage methods. There are expected to be a reduction in cultivations under Alternative 2 due to improved weed control with glyphosate. Therefore, the soil quality under Alternative 2 might be improved compared to Alternative 1 even though conventional tillage is practiced under both Alternatives.

(3) Alternative 3 – Partial Deregulation

To the extent that H7-1 sugar beet root crop production is adopted in sugar beet producing states, (except in California), an associated increase in less intensive tillage methods would be generally expected just like under Alternative 2. In California, under Alternative 3, tillage is expected to be equivalent to that described under Alternative 1.

b. Micro-organism Contribution to Soil Quality.

As described in section III.E.2.e. interactions between micro-organisms and organic matter in the soil largely determine the fertility and overall quality of the soil. Agricultural management practices used in crop production affect soil micro-organisms either through direct effects on populations and activity or indirectly through the modification of the soil environment (Kennedy et al., 2004). Both can be either beneficial or detrimental to the soil biota. Agricultural practices that favor build-up of soil organic matter can lead to higher micro-organism diversity, whereas practices that involve high disturbance and reliance on chemical additives can result in limited micro-organism diversity or elimination of some biological groups (Kennedy et al., 2004). Severe disturbances, such as those caused by heavy tillage, can reduce plant diversity and growth, which leads to decreased micro-organism growth and functioning (Kennedy et. al., 2004 citing Christensen, 1989 and Zak, 1992). Impacts of herbicides on micro-organism activity is discussed in section IV.C.2.a.(2).

(1) Alternative 1 – No Action

Under the No Action Alternative, sugar beet growers are expected to: 1) increase conventional tilling and cultivation and 2) revert to the use of herbicides used prior to nonregulated status of H7-1 sugar beet. This might result in a reduction in organic matter build-upand increased soil disturbances. This might lead to a limited micro-organism diversity or elimination of some micro-organisms, which could alter soil quality. Under Alternative 1, shifting to non-glyphosate herbicides could lead to shifts in microbial communities. As described in section IV. C.2., information on these effects are limited.

(2) Alternative 2 – Full Deregulation

Alternative 2 would be expected to result in more conservation tillage practices and less cultivation relative to Alternative 1 which could increase organic matter build-upand reduce soil disturbances. These agricultural practices favor higher micro-organism diversity (Kennedy et al., 2004). Alternative 2 could result in higher amounts of glyphosate-based herbicide used on sugar beet and a decrease in non-glyphosate herbicides. Under Alternative 2, the increased use of glyphosate herbicides may create shifts in micro-organism communities that have uncertain effects on crops.

(3) Alternative 3 – Partial Deregulation

Micro-organism impacts from the increased use of conservation, reduced, and strip-tillage methods would be similar to those described under Alternative 2 but would not occur in as many sugar beet growing locations (owing to H7-1 exclusion from California and a potentially lower adoption rate under Alternative 3 because of the mandatory conditions for production of H7-1 sugar beet).

c. Manganese in Soil

There is uncertainty associated with these potential impacts as discussed below. Manganese solubility is strongly influenced by soil pH, which can be affected by micro-organisms, other nutrients, organic matter, water availability, and herbicides. The availability of manganese in soils would depend on many of these factors and on site-specific conditions.

A shift from glyphosate-based herbicide use to a wider array of herbicides may or may not affect the availability of manganese depending on site-specific conditions. There are reports that glyphosate-resistant soybean varieties require supplemental manganese to reach their yield potential compared to conventional varieties (Gordon, 2007) and that by extension, other glyphosate-resistant crops would suffer micronutrient deficiencies. Huber (2007) found that glyphosate-resistant crops required the application of almost 50 percent more manganese to meet their physiological sufficiency than conventional soybean varieties. Zobiole et al., (2010) reported in greenhouse studies that glyphosate applications decreased manganese and other nutrient concentrations in glyphosate-resistant soybean varieties. They also reported significant reductions in shoot and root biomass due to glyphosate applications which, according to Hartzler (2010), is not normally observed on glyphosate treated soybeans. Importantly`, results of greenhouse studies may not reflect actual field situations. Indeed`, two separate field studies have found no reduction in manganese levels after glyphosate-tolerant soybeans were treated with glyphosate at standard label rates (Ebelhar et al., 2007; Vyn et al., 2010)Finding similar inconsistencies from applying manganese to glyphosate-tolerant soybean, Diedrick et al., (2010) cautioned against any presumption of possible manganese deficits, since unnecessary application can cause yield losses. Manganese deficiency can occur in sugar beet, but the condition is related to soils with high organic matter, pHs of 6.5 and higher, and planting in old lake beds (Warncke, 2008). Growers would be able to supplement manganese-deficient soils with foliar applications of manganese to their sugar beet crops should the need arise.

No known studies have evaluated the effect of glyphosate, or the glyphosate-resistance gene, on manganese deficiency in sugar beet. Differences in manganese absorption, accumulation, and availability between glyphosate-resistant and non-treated glyphosate-resistant soybean have been observed in only a limited number of conditions (Bott et al., 2008) or not at all (Nelson, 2009; Rosolem et al., 2009). Monsanto/KWS SAAT AG conducted studies in 2008 and 2009 that tested manganese-glyphosate effects on soybean (Murdock, 2010). The research was carried out with 3 soybean varieties planted at 17 locations in multiple states. The studies had various treatment regimes (including timing and application rates) of glyphosate and manganese foliar treatments and untreated controls. The findings of those studies showed the following:

- that no significant differences occurred in post-application leaf concentration of manganese for glyphosate applications within a manganese foliar treatment regime for either variety;

- that yield did not differ significantly among varieties, manganese treatment rates or glyphosate applications;

- that the manganese concentration in seed likewise exhibited no significant difference in manganese concentrations for glyphosate applications within a manganese foliar treatment regime (Murdock, 2010).

Diedrick et al., (2010) found that manganese-glyphosate interactions did not result in yield losses due to the glyphosate application on glyphosate-tolerant soybeans compared to the same variety with no glyphosate application. Thus the evidence in support of a negative interaction effect between manganese and glyphosate or the glyphosate-resistance gene is weak and conflicting for soybean and absent for sugar beet

(1) Alternative 1 – No Action

Under Alternative 1, increased tillage and use of non-glyphosate and/or glyphosate herbicides might alter the micro-organism profile and managanese solubility in the soil. If manganese became limiting for sugar beet production, growers could ensure that the correct amount of manganese would be available for growth through foliar manganese applications.

(2) Alternative 2 – Full Deregulation

Under Alternative 2, decreased tillage and use of glyphosate herbicides might alter the micro-organism profile and managanese solubility in the soil. If manganese became limiting for sugar beet production, growers could ensure that the correct amount of manganese would be available for growth through foliar manganese applications.

(3) Alternative 3 – Partial Deregulation

Under Alternative 3, the impacts are expected to be the same as under Alternative 2. If manganese became limiting for sugar beet production, growers could ensure that the correct amount of manganese would be available for growth through foliar manganese applications.

d. Nitrogen Availability in Soil

Possible impacts to soil nitrogen or its availability may be related to exposure to glyphosate, and in the case of soybean, rhizobacteria involved in nodulation and nitrifying activity demonstrate sensitivity to glyphosate with reports of reduced nodulation from glyphosate treatment (Zablotowicz and Reddy, 2004). However more recent studies in both the greenhouse and the field have found no or only minor reductions in nodulation or nitrogen accumulation in glyphosate-tolerant soybeans treated with glyphosate (Reddy and Zablotowicz, 2003; Zablotowicz and Reddy, 2007; Bellaloui et al., 2009; Bohm et al., 2009; Powell et al., 2009). When minor reductions in nitrogen content did occur after treatment with typical label rates of glyphosate, there was no negative effect on yield. Furthermore, unlike soybean, *rhizobacteria* do not colonize sugar beet. Other transient effects of glyphosate exposure to soil can be demonstrated on specific soil populations, such as decreases in fluorescent pseudomonads, and IAA-producing rhizobacteria (Zobiole et al., 2010). No persistent effects of glyphosate on soil microbial communities have been reported. Direct exposure of soil bacteria to glyphosate or the exudation of glyphosate from roots into the soil may be the pathway for impacts on *rhizobacteria* (Kremer and Means, 2009). However, other herbicides may also impact soil bacteria with nitrogen cycle functions. Bromoxynil causes reductions in populations of nitrifying species, such as proteobacteria and Acidobacteria, but 84 days following treatment, most populations had returned to values typical of control values (Baxter and Cummings, 2008).

Similarly in corn, both glyphosate and a mixture of acetochlor and terbuthylazine impact rhizobacterial species active in nitrifying activities, with "glyphosate being less aggressive than [the herbicide mixture] under the experimental conditions used" (Barriuso et al., 2010). Other potential effects following herbicide application have been noted by Damin et al. (Damin et al., 2010b), and these results suggest that applied herbicides can affect the content and availability of nitrogen in soil. However, these studies reflect the use of herbicides on cover crops (*Brachiaria decumbens and Pennicetum glaucum*) chosen to control erosion (from wind or water), and these grasses when dessicated may possibly release nitrogen into atmosphere, or into soil. The grassy crops studied may have quite different physiological responses to herbicide compared to the predominantly broadleaf weeds controlled in sugar beet fields by glyphosate. Cover crops for sugar beet in Minnesota or North Dakota Red River Valley may include barley and rye (Sporcic and Kuenstler, 2007). Notable also is that additional herbicides (glufosinate) can impact the plant nitrogen disposition of herbicide-killed plants just as does glyphosate (Damin et al., 2010a). Removal of cover crops by herbicide treatment can leave soil nitrogen with higher levels than by mechanical harvest (Jewett and Thelen, 2007).

Nitrogen is the most limiting nutrient in sugar beet production, and proper nitrogen management is critical (Davis and Westfall, 2009). Growers necessarily determine the needed soil nitrogen to ensure maximum yield and sucrose content of beet. However, consequences of the type and amount of herbicides selected and used are not usually a matter of concern, since the impacts have not been consistently shown. More likely to preserve soil nitrogen are maintenance of conservation tillage practices (Locke et al., 2008) or by use of cover crops to reduce erosion and leaching of soil nitrogen. As the relationship between herbicide use and soil nitrogen is tenuous at best, no conclusions can be drawn as to the impacts of herbicides on soil nitrogen under the three Alternatives. Because nitrogen is a critical limiting nutrient for sugar beet production, growers would be expected to ensure that the correct amount of nitrogen would be available in the soil through fertilization under all the alternatives.

(1) Alternative 1 – No Action

Under Alternative 1, partial deregulation of H7-1 sugar beet would be phased out over time. Growers who are now growing H7-1 sugar beet, might grow conventional sugar beet or alternative glyphosate-resistant crops. The former would likely lead to increased tillage, the latter less. Under Alternative 1 more nitrogen is expected to be lost with the increased use of conventional tillage and that would depend on the extent growers decide to grow conventional sugar beet versus alternative glyphosate-resistant crops. It would also depend on the extent growers use cover crops and other measures that reduce soil erosion.

(2) Alternative 2 – Full Deregulation

Soil nitrogen is likely to be most influenced by the degree of tillage that is practiced. Under Alternative 2, less tillage and cultivation is likely to be performed on H7-1 sugar beet relative to conventional sugar beet that may have a beneficial impact. However, if Alternative 1 encourages growers to plant another glyphosate-resistant crop instead of conventional sugar beet, and that crop uses more conservation tillage than sugar beet, there may be an improvement in soil nitrogen under Alternative 1.

(3) Alternative 3 – Partial Deregulation

Nitrogen availability in the soil from the increased use of glyphosate would be similar to that described under Alternative 2.

3. Air Quality and Climate Change

As discussed in section III.E.3, there is evidence of changes in tillage practices and equipment usage accompanying H7-1 sugar beet farming as compared to conventional sugar beet farming. A study has suggested that H7-1 sugar beet require fewer cultivation passes (which may result in less tillage, less soil compaction, and less erosion) and fewer herbicide applications with a less toxic herbicide (glyphosate) than conventional sugar beet varieties (Hirnyck, 2007). The result of less machinery usage would be decreased emissions of air pollutants and greenhouse gas emissions (GHGs). Emissions related to climate change, ozone depletion, summer smog, and carcinogenicity were found to be lower in glyphosate-tolerant crop systems compared to conventional crop systems (Bennett et al., 2004).

To the extent that (1) reductions in tillage and machinery usage have occurred with planting of H7-1 sugar beet, and (2) reduced tillage does in fact reduce fugitive particulate emissions from soil erosion and GHGs from soil (see section 3.E.3.c.), then reductions in emissions of criteria pollutants and GHGs from sugar beet farming might have resulted under from the widespread adoption of H7-1 sugar beetHowever, the available evidence is insufficient to demonstrate that such emission reductions occurred.

With adoption of H7-1 sugar beet, weed control practices could include substitution of glyphosate for herbicides that are more volatile than glyphosate and more likely to be applied aerially, as discussed in section III.B.1. As a result of these decreases in the volatility of herbicides applied and the method of application, there might be reductions in the amount of herbicide drift onto adjacent lands, and reductions in the amount of herbicide that volatilizes to the atmosphere and is dispersed, as discussed further in section III.E.3.

a. Alternative 1 – No Action

If growers choose to plant crops other than sugar beet or leave the land fallow, then the effects on air quality and climate could vary depending on the specific land use. Growers may allow land to go fallow for a growing season and may not till or apply any herbicide unless weeds became an issue on the fallow land or the grower had intentions of planting a crop in the near future. Equipment emissions, soil disturbance, fugitive particulate emissions from soil erosion, and herbicide drift would be reduced under this scenario. It is expected that plowed lands would eventually be planted with conventional sugar beet or other crops, limiting these potential short-term impacts. If farmers do not plow the fallow lands or choose not to plant any crop, the fallow lands could revert to more natural grasslands/shrublands, which would result in no machinery usage or herbicide applications. If growers choose to plant other crops, then the differences in the amount of machinery used and herbicide applied would depend on the specific crop chosen. Similarly, if growers' choice of crops involves changes to crop rotation schedules, then the resulting differences in the amount of machinery used and herbicide applied also would depend on the specific crops chosen and whether they have the glyphosate-resistant trait.

In the long term, under Alternative 1, partial deregulation of H7-1 sugar beet would be phased out over time and the presence of H7-1 sugar beet would eventually return to the pre-deregulation levels of nearly no H7-1 sugar beet. Under this alternative, growers who grew H7-1 sugar beet in 2009–2010, and who most likely would choose to grow conventional sugar beet, would need to use other practices for weed management. These sugar beet growers would be expected to (in some combination): 1) increase conventional tilling (relative to use of conservation tillage), and 2) revert to the use of non-glyphosate herbicides, which would increase tillage activities and machinery usage, and increase soil disturbances. Returning to non-glyphosate herbicides could lead to applying larger quantities of herbicides that are more volatile than glyphosate, which could increase machinery usage and the potential for herbicide drift. The consequences of Alternative 1 on air quality and climate for seed production are the same as for root production, because H7-1 sugar beet seed and root production acreage would be expected to eventually decline to zero.

Therefore, Alternative 1 might be expected to result in higher emissions of criteria pollutants, GHGs, and airborne herbicides, with associated potential impacts on air quality and climate, compared to Alternative 2. The likelihood of these air quality and climate impacts is uncertain, because the available evidence is insufficient to demonstrate that such emission reductions occurred.

b. Alternative 2 – Full Deregulation

Under Alternative 2, the increase in acreage devoted to H7-1 sugar beet is expected to lead to increased use of conservation tillage practices and decreased soil disturbance, as well as increased use of glyphosate herbicide, compared to Alternative 1, as discussed in section III.E.2.

Alternative 2 would result in more conservation tillage practices which would decrease machinery usage and reduce soil disturbances. Alternative 2 would result in higher amounts of glyphosate-based herbicide used on sugar beet and a reduction in the use of non-glyphosate herbicides. Sugar beet tillage practices, soil disturbance levels, machinery usage, herbicides used, and levels of herbicide application associated with H7-1 sugar beet farming would also be expected to be similar to 2009–2010 conditions. Therefore, Alternative 2 might be expected to have lower emissions of criteria pollutants, GHGs, and airborne herbicides, with associated reductions in potential impacts on air quality and climate, compared to Alternative 1. As discussed above, the likelihood of these air quality and climate impacts is uncertain.

The proportion of this impact attributable to H7-1 seed production would be less than for root production because, in contrast to H7-1 sugar beet root production, glyphosate is not used as a post-emergent herbicide in hybrid seed production fields, and because the amount of acreage planted to seed and stecklings is comparatively inconsequential. For further discussion of steckling, seed, and root production methods see section III.B.1.

c. Alternative 3 – Partial Deregulation

Under Alternative 3, the impacts of tillage and herbicide use are expected to have the same beneficial impacts to air quality as described under Alternative 2. In California, there are not expected to be any differences in tillage under Alternatives 2 and 3. Herbicide use is expected to differ under Alternative 3 because in some areas producers would not use glyphosate and consequently decreases in air quality may be anticipated. Therefore, Alternative 3 might be expected to exhibit levels of emissions of criteria pollutants, GHGs, and airborne herbicides, with associated potential impacts on air quality and climate, that are similar to or slightly higher than under Alternative 2.

4. Surface Water and Groundwater Quality

As with other agricultural crops, the effects of sugar beet on surface water and groundwater (e.g., lakes, streams, aquifers) depend on multiple factors or activities related to crop production, which can include soil preparation, planting and harvesting; tillage practices; tractor and other equipment use; the use of herbicides and fertilizers; and the frequency of irrigation necessary to produce a viable crop. Table 4–23 lists some common activities that are part of crop production and how they might affect water quality.

Table IV-23. Common Crop Production Activities and their Potential Effect on Water Quality

Crop Production Activities	Potential Effect on Water Quality
Soil Preparation Planting Harvesting	Soil disturbance from tillage practices and soil compaction from heavy equipment use could leave soils susceptible to increased wind and water erosion, leading to potential sedimentation and turbidity impacts in surface waters from increased runoff.
Nutrient Management	Use of fertilizers could lead to leaching of nitrates into groundwater and movement of nitrates and phosphorous into surface waters, potentially causing eutrophication.
Pest Management	Leaching of herbicides into groundwater and movement of herbicides to surface waters through soil erosion or runoff, spray drift, or inadvertent direct overspray.
Irrigation	Irrigation induced runoff could potentially increase movement of nutrients and herbicides into groundwater and surface waters

a. Tillage and Water Infiltration and Runoff

(1) Alternative 1 – No Action

Under Alternative 1, growers who are now growing H7-1 sugar beet, and who most likely would choose to grow conventional sugar beet, would need to use other practices for weed management, which could affect water quality. For weed control, under the No Action Alternative, sugar beet growers (in some combination) could: 1) increase conventional tilling (while reducing conservation tillage), and 2) revert to herbicide practices used for conventional sugar beet production.

Growers might allow land to go fallow for a year and then continue to plow the land, which could increase the erosion of topsoil via wind or rainfall. It is likely that plowed lands would eventually be planted with conventional sugar beet or other crops, limiting these potential short-term impacts. If farmers do not plow the fallow lands or choose to not plant any crop, the fallow lands could revert to more natural grasslands/shrublands, which could result in more vegetative cover and more root stabilization in the soil, which could lead to less soil erosion and less potential sedimentation impacts on surface waters when compared to land that is planted with sugar beet or is fallow and then plowed.

Little H7-1 sugar beet would be planted; all would be under permit or notification and would likely be quickly phased out over time and be replaced by conventional sugar beet. This could result in a return to conventional tillage practices which would increase soil disturbance and expose more soil to the erosive forces of wind and water when compared to the conservation tillage practices used for H7-1 sugar beet. An increase in soil disturbance could lead to increased soil erosion potential, and an increase in potential sedimentation and turbidity in nearby surface waters during rain and irrigation events ((Sandretto and Payne, 2006)citing Edwards, 1995 and USDA, 1997). In 2009, based on states' water quality reports, the EPA identified sedimentation and turbidity as 2 of the top 10 causes of impairment to surface water in 44 states, 2 territories, and the District of Columbia, with the exception of coastal waters (U.S. EPA 2009d); in 2007, the EPA had identified sedimentation as the leading cause of impairment to rivers and streams in reporting jurisdictions. Regionally, the greatest potential for soil erosion would be expected to occur in the Upper Midwest sugar beet production area as illustrated in Fig. 3–22.

(2) Alternative 2 – Full Deregulation

Under Alternative 2, the increase in acreage devoted to H7-1 sugar beet is expected to lead to increased use of conservation tillage practices, as well as increased use of glyphosate herbicide compared to Alternative 1.

Growers could continue to implement conservation tillage practices which would continue to decrease the erosion potential of topsoil via wind or rainfall, compared to typical tillage practices for conventional sugar beet. A decrease in soil disturbance could lead to decreased soil erosion potential, and a subsequent decrease in potential sedimentation and turbidity in nearby surface waters. The role of conservation tillage (including no till, ridge till, and mulch till) in controlling soil erosion and soil degradation is well documented (Sandretto and Payne, 2006). By leaving substantial residues of plant and organic matter on the soil surface, conservation tillage (1) reduces soil erosion by wind; (2) reduces soil erosion by water; (3) increases water infiltration and moisture retention; (4) reduces surface sediment and water runoff; and (5) reduces chemical runoff (Sandretto and Payne, 2006)citing Edwards, 1995 and USDA, 1997). In addition, the filtering action of increased organic matter in the top layer of soil could result in cleaner runoff (by reducing contaminants such as sediment and adsorbed or dissolved herbicide chemicals), and thus also benefit water quality in surface waters (Anderson and Magleby, 1997) citing Onstad and Voorhees, 1987 and CTIC, 1996). The EPA has projected conservation tillage to be “the major soil protection method and candidate best management practice for improving surface water quality” (U.S. EPA 2002b) though a comprehensive data set has not yet been developed to verify EPA’s projection. The EPA identifies conservation tillage as the first of its core agricultural management practices for water quality protection (U.S. EPA 2008a)

Regionally, the greatest potential for soil erosion occurs in the Midwest sugar beet production area (see Fig 3–22) which means this area may benefit the most in reduced erosion, sedimentation, and potential water quality impacts that result from use of conservation tillage practices on H7-1 sugar beet. Other sugar beet regions have potential for soil erosion, but not to the same extent as the Midwest sugar beet region.

In drier areas where irrigation is used, the adoption of H7-1 sugar beet under Alternatives 2 and 3 may help to conserve water. APHIS received a comment from a water district manager in Eastern Wyoming and Western Nebraska, where he noted that

> “from my own personal observations, I have seen the use of Roundup Ready® Sugarbeet seed and other crops like Roundup Ready® Corn make a huge difference in the water demand by these crops. Much of the reduction is due to better control of weeds using glysophate weed control products, reduction in the weed population reduces their competition with crops for water and nutrients”(Strauch, 2011).

During the public meeting in Fargo, two growers from the Midwest noted that they save a considerable amount of water on the farm from a reduction in the number of sprays needed. In one case the grower indicated H7-1 sugar beet saves 20,000 gallons of water per year on his farm (USDA, 2011b) p.51. Another grower noted he uses 5 gallons of acre for spraying H7-1 and 20 gal/acre for spraying conventional sugar beet (USDA, 2011b) p.53. It should be noted that conventional tillage would continue in California because it is needed for furrow irrigation that is practiced there. In this area, constituting approximately 2 percent of the sugar beet growing area, there would be the same amounts of soil erosion and runoff as found under Alternative 1

(3) Alternative 3 – Partial Deregulation

The beneficial impacts under Alternative 3 are expected to resemble those noted above under Alternative 2 except would be slightly reduced based on a lower adoption rate of H7-1 sugar beet due to those discouraged from planting because of the additional regulatory requirements.

b. Herbicides and Water Infiltration and Runoff

(1) Alternative 1 – No Action

Under Alternative 1, growers may allow land to go fallow for a year and would not likely apply any herbicide unless weeds became an issue on the fallow land and the grower had intentions of planting a crop in the near future. Herbicide impacts on surface and groundwater would be reduced under this scenario. It is likely that plowed lands would eventually be planted with conventional sugar beet or other crops, limiting these potential short-term impacts. If farmers do not continue to plow the fallow lands or choose to not plant any crop, the fallow lands would revert to more natural grasslands/shrublands, which would result in no herbicide applications and no impacts on water resources.

Over the long term, H7-1 sugar beet would be phased out over time and would eventually be replaced by conventional sugar beet. This could result in a shift from glyphosate dominated herbicide use to a combination of herbicides used prior to de-regulation . Prior to adoption of H7-1 sugar beet, growers regularly used multiple chemical herbicides to control weeds (Cole, 2010; Kniss, 2010b; Wilson, 2010) The use of glyphosate on sugar beet crops would likely return to the level of use similar to that used on conventional sugar beet Tables 3-17 and 3-18. Growers would likely resume the use of a larger array of other herbicides, consisting of the twelve other common sugar beet herbicides listed in Table 3–11. The types and amounts of herbicide would depend on weed pressures, weed management, and production practices of a particular sugar beet production region, as well as site-specific farm conditions. See tables G1 through G11 discussed in section IV.B.1.e and provided in appendix G, which list the types and amounts of herbicides used on conventional sugar beet in 2000 for each sugar beet production region.

As described in section III.E.4.d, each herbicide's fate and transport in the environment depends on several factors, such as the physical characteristics of the herbicide, the characteristics of the soil that the herbicide is sprayed on, tillage practices, the slope of the land, rain, and irrigation volumes. In the absence of information on site specific sugar beet field conditions, an herbicide's adsorption, water solubility, and persistence characteristics can allow for comparisons between various herbicide products. Under Alternative 1, there would be an increase in conventional tillage and soil disturbance compared to that used on H7-1 sugar beet, which would increase the potential for herbicides to move with soil to surface waters during erosion events. Under Alternative 1, a shift from a glyphosate dominated herbicide use to a wider array of other herbicides would increase the risk of chemical leaching into groundwater because all other sugar beet herbicides have higher potentials to leach based on their lower adsorptive properties (K_{oc}) when compared to glyphosate (which has the highest K_{oc} compared to the other herbicides) (see Table 3–50). The use of non-glyphosate herbicides that would increase under Alternative 1 do not bind as tightly to soil particles as glyphosate, which would increase their potential downward mobility in soil. During erosion events, most non-glyphosate herbicides would have a lower potential than glyphosate to move in surface water runoff in solution and when attached to soil particles (see Table 3–50), which could lead to a reduced potential for herbicides reaching surface waters when compared to glyphosate. Only four other non-glyphosate sugar beet herbicides have the same high potential as glyphosate to move in solution runoff (cycloate and ethofumesate) and adsorbed runoff (quizalofop-p-ethyl and trifluralin) (see Table 3–50). All remaining herbicides have a lower potential than glyphosate to move in surface water runoff in solution or attached to soil particles during an erosion event (see Table 3–50). Once an herbicide reaches surface water, the water quality effects of the herbicide on the environment would depend on the ecology of the aquatic system. These impacts are discussed further in section IV.C Biological Resources. However, in general, and as supported by the EPA designation of reduced risk for application of glyphosate to H7-1 sugar beet, glyphosate is a more environmentally preferred herbicide compared to other herbicides currently used in sugar beet production since glyphosate is generally less toxic and has more favorable degradation properties.

Once in surface water, glyphosate dissipates more rapidly than most other herbicides, and various studies have shown that glyphosate appears in surface water less than several alternative herbicides (Cerdeira and Duke, 2006) and (Carpenter et al., 2002). (See section IV.C for a more thorough discussion of the effects of herbicides on the aquatic biological environment.) In summary, under Alternative 1, there would be a greater potential for leaching herbicide chemicals into groundwater, but a decreased potential for herbicides to move in surface runoff and reach surface waters during erosion events. However, non-glyphosate herbicides are considered more toxic and have less favorable degradation properties than glyphosate (see section IV.C Biological Resources).

Regional herbicide use data (from 2000) presented in section III.B.1.e indicate that the Northwest sugar beet production region applied the most pounds of herbicide per acre planted (1.55 lb). The remaining four regions have relatively similar pounds of herbicide application per acre: Great Lakes (0.73 lb per acre), Midwest (0.66 lb per acre), Great Plains (0.60 lb per acre), and Imperial Valley (0.67 lb per acre). Based on this information and assuming the herbicide use would return to H7-1 sugar beet levels, the Northwest region would have the greatest potential for herbicides reaching surface water.

(2) Alternative 2 – Full Deregulation

Under Alternative 2, herbicide impacts on surface and groundwater are expected to be be similar to those that prevailed in 2009–2010, and impacts could be less intense than those occurring before introduction of H7-1 sugar beet.

As described in section III.E.4.d, each herbicide's fate and transport in the environment depends on several factors, such as the physical characteristics of the herbicide, the characteristics of the soil that the herbicide is applied to, tillage practices, the slope of the land, rain, and irrigation volumes. Under Alternative 2, there could be a continued increase in conservation tillage, resulting in a reduction in soil disturbance compared to 2009–2010 conditions. This could decrease the potential for herbicides to move with soil to surface waters during erosion events. Under Alternative 2, an increase in use of glyphosate herbicide could decrease the risk of chemical leaching into groundwater because the other twelve sugar beet herbicides have higher potentials to leach based on their lower adsorptive properties (K_{oc} coefficient) when compared to glyphosate (which has the lowest adsorptive coefficient (K_{oc})) (see Table 3–50). Glyphosate has rarely been reported in groundwater (Borggaard and Gimsing, 2008) but can be present especially after rains that immediately follow after application (Coupe et al., 2011).

Once absorbed to soil particles glyphosate has a high potential to move into surface water from runoff when erosion conditions lead to the surface transport of soil particles (see Table 3–50). However, H7-1 sugar beet would lead to an increase in conservation tillage systems compared to conventional sugar beet, which would result in less mechanical disturbance of the soil during sugar beet cultivation, decreasing the loss of surface soil. Because of this, and the fact that glyphosate binds strongly to soil particles (see Table 3–50) conservation tillage of H7-1 sugar beet fields is expected to reduce the presence of glyphosate in surface water runoff. In addition, the filtering action of increased organic matter in the top layer of soil from conservation tillage could result in cleaner runoff (by reducing contaminants such as adsorbed or dissolved herbicide chemicals), and thus also benefit water quality in surface waters ((Anderson and Magleby, 1997) citing Onstad and Voorhees, 1987 and Conservation Technology Information Center or CTIC, 1996). This could lead to a reduction in the potential for all herbicides (glyphosate and non-glyphosate) used on H7-1 sugar beet to move in surface runoff. Once in surface water, glyphosate dissipates more rapidly than most other herbicides, and various studies have shown that glyphosate appears in surface water less frequently than several alternative herbicides (Cerdeira and Duke, 2006) and (Carpenter et al., 2002). (See section IV.C for a more thorough discussion of the effects of herbicides on the aquatic biological environment.). In summary, under Alternative 2, there would be a lesser potential for leaching of herbicide chemicals into groundwater, a lesser potential for all herbicides to move in surface runoff and reach surface waters during erosion events due to conservation tillage, decreased use of non-glyphosate herbicides, and an increase in the amount of glyphosate used on sugar beet. As previously mentioned in section IV.C., each of the twelve non-glyphosate herbicides used on sugar beet is considered more toxic and has less favorable degradation properties than glyphosate.

Under Alternative 2, it is expected that total applied glyphosate would increase while non-glyphosate herbicides would decrease compared to Alternative 1. The greatest potential for soil erosion (and subsequent herbicide movement) occurs in the Upper Midwest sugar beet production area (see Fig. 3–22), which means this area may benefit the most from the reduced erosion, sedimentation, and herbicide movement that could result from conservation tillage practices used with H7-1 sugar beet. In addition, California growers would produce H7-1 sugar beet for the first time, which would mean higher amounts of glyphosate would be expected to be introduced into the environment.

(3) Alternative 3 – Partial Deregulation

The effect of herbicides on surface and groundwater related to the increased use of glyphosate (and reduced use of non-glyphosate herbicides) and increase of conservation, reduced, and strip-tillage methods could be less than or similar to those described under Alternative 2 but might not be chosen in as many sugar beet growing locations (owing to H7-1 exclusion from California and a potentially lower adoption rate under Alternative 3 because of the mandatory conditions for production of H7-1 sugar beet).

F. Human Health and Safety

This section assesses the human health and safety impacts of the three alternative APHIS actions regarding H7-1 sugar beet. This section parallels that of section III.F by first discussing public health and safety and then worker health and safety. Impacts from sugar beet and related products and impacts from pesticides used during production are each addressed within these sections for the three alternatives.

1. Public Health and Safety

As discussed in section III.F.1, sugar beet is used for food, feed, and various other products to which people are exposed. Areas of potential environmental consequences related to public health and safety include the direct human exposure to sugar beet pollen on or near farms, the consumption of products derived from sugar beet, and exposure to pesticides used on sugar beet.

a. Sugar Beet and Related Products

Human health and safety impacts of Alternatives 1 through 3 are addressed below within the context of the public's exposure to sugar beet and related products. As discussed in detail in section III.F.1.a, people are exposed to a variety of these products. The average American consumes the equivalent of about four to five teaspoons of beet sugar daily. Trace impurities in the sugar, such as inorganics, plant proteins and other sugars (besides sucrose, the primary sugar), are a natural consequence of sugar production (Lew, 1972; Potter et al., 1990; Potter and Mansell, 1992). Other sugar beet products available on the market, including food and livestock feed additives, baker's yeast, and pharmaceuticals, also may contain impurities such as these. While some of these other products make their way into human foods only indirectly (e.g., the use of molasses as a growth medium for baker's yeast and other fermentation products, other products are ingested directly (e.g., betaine) or added directly to the human diet (e.g., fiber from beet pulp).

Another potential route of exposure to sugar beet constituents is by inhalation of pollen. This exposure is limited primarily to the fewer than 5,000 seed production acres in Oregon, Washington, Idaho, and Colorado because generally only sugar beet for seed production reach the stage of pollen release (see section III.B.1.b for additional detail on seed production). Another potential exposure route is gene flow from sugar beet to the other *Beta* species of Swiss chard, table beet, and fodder beet, with subsequent direct or indirect consumption of these other crops or associated products. These related plants are discussed further in section III.B.2 through III.B.4, and the potential for gene flow in *Beta* species is discussed in section IV.B.5. The amount of consumption of hybrids between sugar beet and vegetable beet is expected to be negligible because isolation distances used in seed production usually keep the hybrid frequency to below 1 in 10,000 and hybrids usually look different and can be rogued.

APHIS assessed these potential human exposures for the three alternatives by first examining the compositional nature of sugar beet and related products. APHIS then assessed whether any of these compositional factors could result in any direct adverse health effects, including adverse effects caused by the toxicity and allergenicity of sugar beet pollen and the CP4 EPSPS protein. APHIS also examined whether these factors represent other unintended consequences resulting from the action, such as a change in the nutritional makeup of the product resulting from the incorporation of the *cp4 epsps* gene in H7-1 sugar beet. Finally, APHIS examined the human health consequences from gene flow from sugar beet to related crops, such as Swiss chard, table beet, and fodder beet.

(1) Alternative 1 – No Action

Under Alternative 1, sugar, pulp, and other products derived from sugar beet would be from conventional sugar beet.

No direct consumption of or exposure to the H7-1 gene or gene product during public use is expected to occur under this alternative. Sugar from sugar beet would continue to be produced at roughly the same amount per capita. Sugar beet pulp would be used for direct food consumption via nonsugar food items such as fiber. Sugar beet molasses would continue to be used for the production of betaine (a nutritional supplement), citric acid, monosodium glutamate (MSG), baker's yeast, and other products, chemicals, and pharmaceuticals. Humans would continue to consume meat and dairy from livestock that consume feed derived from sugar beet molasses, sugar beet pulp, or sugar beet leaves and petioles.

One area of potential differences between the current situation (2010-2011 growing season) and this alternative would be the shift from products almost exclusively derived from H7-1 sugar beet to those exclusively from conventional sugar beet. As discussed in section III.F.1.a(4), no meaningful differences in characteristics were found between H7-1 and conventional sugar beet. In particular, analyses included basic qualities (crude ash, crude fiber, crude fat, crude protein, and dry matter), carbohydrates, quality parameters (sucrose, invert sugar, sodium, potassium, alpha-amino nitrogen), saponins (naturally-occurring "anti-nutrients"), and 18 amino acids (see section III.F.1.a(4) for additional detail and literature citations). In summary, as part of its consultation regarding H7-1 sugar beet FDA concluded that the Agency had no questions about the developer's determination that H7-1 sugar beet is not materially different in composition, food and feed safety, or other relevant parameters from conventional sugar beet (U.S. FDA, 2004).

Similar to the public's exposure to sugar beet products, a small number of people near sugar beet seed farms could be exposed to sugar beet pollen almost exclusively from conventional sugar beet instead of H7-1 sugar beet under Alternative 1. As noted above, this exposure would be limited primarily to the less than about 5,000 seed production acres (less than 0.4 percent of total sugar beet acres), which are in Oregon, Washington, Idaho, and Colorado. Under this alternative, APHIS expects that existing adverse health effects related to allergenicity to sugar beet pollen from conventional sugar beet will continue. APHIS is not aware of any reports of differences between the allergenicity of pollen from conventional versus H7-1 sugar beet so these effects would be the same under all the alternatives.

The amount of tillage used to grow sugar beet under Alternative 1 is expected to be more than is used in the recent growing seasons (e.g., 2010-2011), as described in section IV.E.3. Thus, engine exhaust emissions and fugitive soil particulates from tractor use during cultivation would be greater under this alternative compared to the recent growing seasons. These emissions and particulates, which are an expected consequence of farming in general, can result in adverse human health effects. Soil particulates can be associated with adsorbed pesticides and other chemicals, which people then inhale. See section IV.F.1.b for more on pesticide effects on human health.

In summary, APHIS concludes that the compositional characteristics of the predominantly conventional sugar beet and products under Alternative 1 pose no greater risks to human health than from H7-1 sugar beet currently used. In either case, there are equivalent health risks associated from over-consumption of sugar and the potential allergies from pollen inhalation under all the alternatives. Under Alternative 1, there is a greater potential for adverse health effects from inhalation of engine exhaust and soil particulates resulting from the greater amount of cultivation compared to recent tillage practices with H7-1 sugar beet.

(2) Alternative 2 – Full Deregulation

FDA concluded that the Agency had no questions about the developer's determination that H7-1 sugar beet is not materially different in composition, food and feed safety, or other relevant parameters from conventional sugar beet (U.S. FDA, 2004). As such, Alternative 2 is not likely to cause any unique adverse health effects compared to those effects caused by conventional sugar beet.

The potential for allergenicity and toxicity of the CP4 EPSPS protein in H7-1 sugar beet CP4 EPSPS protein has been evaluated and it has been concluded that CP4 EPSPS is unlikely to pose allergenicity or toxicity concerns. This finding is based on research described in section III.F.1.a(5). For example, no treatment-related adverse effects were observed in an acute toxicity test in which mice were gavaged (orally dosed) with up to 572 mg of CP4 EPSPS per kg of body weight (designed to reflect a 1,000-fold factor of safety on the highest possible human exposure to CP4 EPSPS, assuming multiple sources in the diet). The CP4 EPSPS protein also does not have biologically relevant structural similarities to protein toxins known to cause adverse health effects in humans or animals (based on a comparison of the amino acid sequence to protein sequences in the ALLPEPTIDES database). Additionally, CP4 EPSPS does not share immunologically relevant amino acid sequence homology with known allergens, as determined by comparison of the amino acid sequence of the CP4 EPSPS protein to sequences in the ALLERGEN3 database. Furthermore, many variants of the *epsps* gene and EPSPS protein are ubiquitous in nature, are normally present in food and feeds derived from these plant and microbial sources, and when used to impart tolerance to glyphosate in corn, cotton, and soybean plants, have not resulted in any known adverse human health effects despite being grown on hundreds of millions of acres across the United States over the past decade.

Based on these and other research findings described in section III.F, APHIS concludes that the compositional characteristics of H7-1 sugar beet grown under Alternative 2, when used as food or feed, poses no risks to human health different from those of conventional sugar beet.

In terms of gene flow, section IV.B.5 concludes that the potential for gene flow to Swiss chard and related products is too low for any meaningful transfer of traits. Furthermore, if transfer were to occur, the resulting seeds would consist of hybrid off-types that had undesirable and intermediate characteristics that would deter harvest and consumption by humans (see section 3.B.5.e). Moreover, the research cited and summarized in section III.F.1.a(4) finds that even if such traits were to transfer, no harmful changes in characteristics would occur. For these reasons, APHIS believes that gene flow from H7-1 sugar beet to vegetable beet under Alternative 2 would not pose any health risks beyond those of Alternative 1.

The amount of tillage used to grow sugar beet under Alternative 2 is expected to be similar to what is used in the recent growing seasons (e.g., 2010-2011), which declined from that used prior to the commercial cultivation of H7-1 sugar beet. With this decline are possible reductions in adverse human health effects otherwise associated with the inhalation of engine exhaust emissions and fugitive soil particulates, including from pesticides adsorbed to the soil. See section IV.F.1.b for more on pesticide effects on human health.

In summary, the health effects associated with Alternative 2 are expected to be similar to Alternative 1.

(3) Alternative 3 – Partial Deregulation

Alternative 3 is expected to result in human consumption of H7-1 sugar beet products, similar to, though lower in magnitude than, the consumption described above for Alternative 2 (Full Deregulation). Human health impacts for Alternative 3 are expected to be similar to those presented above for Alternative 2.

b. Pesticides

A variety of pesticides – insecticides, herbicides, and fungicides – are used in growing sugar beet. As discussed in detail in section III.F.1.b, pesticides are composed of both active and "inert" ingredients. People can be directly exposed to pesticides via inhalation, oral, and dermal routes if they live on or near farms that use them. The broader public can be exposed to pesticides as residues on the products from crops that are sprayed directly. People also can be exposed indirectly, such as through ingestion of livestock products (e.g., milk) derived from livestock fed the sprayed crops. Consumption of adjacent crops affected by spray drift is also a possible route of exposure, as is inhalation and dermal exposure from spray drift to residents near those spraying operations. Movement of pesticides to surface water or groundwater used for drinking water also is a potential pathway for exposure. Various interacting factors affect exposure, including a pesticide's chemical characteristics (e.g., volatility, solubility, organic-carbon partitioning), a farm's environmental characteristics (e.g., soil, climate, weediness), a farm's pesticide management practices, a pesticide's use profile (e.g., conservative use, overuse, mixing with other pesticides), and the surrounding population's characteristics (e.g., proximity, behavior, physiology).

By their nature, pesticides are bioactive and may convey some risk to human health. Pesticides are carefully evaluated by EPA prior to registration to ensure that they can be used with a reasonable certainty of no harm (U.S. EPA 2011a). The risks associated with the application of these herbicides are controlled by a number of factors, including the use restrictions established by EPA and states and specified on the product labels. However, that does not mean that the correct application of these herbicides is without risk or that the risks of each herbicide are equivalent. Some herbicides pose greater risks because they are more toxic than others. Some herbicides pose greater risks because they are applied at higher concentrations and or more frequently thereby increasing the risk due to exposure.

APHIS focused on the health consequences of herbicides for this assessment and did not address insecticides and fungicides in any detail because the latter are used similarly across alternatives in terms of type, quantity, and hence would have the same potential environmental impact. Herbicides, however, are expected to be used differently among the alternatives, especially between Alternative 1 versus Alternatives 2 and 3. Alternative 3 is expected to have herbicide usage very similar to Alternative 2 and hence the only comparison for herbicide use is made between Alternatives 1 and 2. Also, while there are differences in herbicide use between seed production and root production, the amounts of herbicides used in seed production are relatively minor compared to the amounts used in root production (less than 0.4 percent of total sugar beet use, based on acreage planted). Therefore, seed production is not analyzed in detail in this assessment.

A number of tools are available to compare the relative risks of the herbicides used to produce the sugar beet root crop. These include:

- **Oral Reference Dose (RfD)**. The RfD is EPA's maximum acceptable oral dose of a toxic substance. The RfD is a value chosen by EPA, from relevant toxicity data, and adjusted for a number of factors, including human toxicity data, population variability, and inadequacies in the studies. The Oral RfD is an "…estimate, with uncertainty spanning perhaps an order of magnitude, of a daily oral exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime" (U.S. EPA 1993b).

- **Dietary Risk Assessment for Food**. Dietary risk assessment incorporates both exposure and toxicity of a given pesticide. (U.S. EPA 2004) The risk is expressed as a percentage of a maximum acceptable dose (i.e., the dose which is not expected to result in unreasonable adverse health effects (U.S. EPA 2004). This dose is referred to as the Population Adjusted Dose (PAD). Dietary risk is characterized in terms of the PAD, which reflects the Reference Dose (RfD), either acute (aRfD) or chronic (cRfD), that has been adjusted to account for the Food Quality Protection Act (FQPA) Safety Factors and is therefore considered the PAD. Estimated dietary exposure less than 100% of the PAD is not expected to be of concern to the Agency. The values of the cPAD for all 13 herbicides do not pose risks of concern (Table 4-24).

- **Aggregate Risk**. The aggregate risk integrates the assessments conducted for food, water, and residential uses when appropriate. All uses of the herbicide are considered, not just uses for sugar beet. Some herbicides (cycloate, desmedipham, ethofumesate, phenmedipham, pyrazon and triflusulfuron-methyl), are used almost exclusively on sugar beet. For the remainder, use on sugar beet is often a small fraction of the total use. All of the thirteen herbicides do not pose risks of concern indicating that no unreasonable adverse effects on human health by the herbicides are expected regardless of the registered use of the herbicide.

- **APHIS Relative Risk Score (RRS).** The APHIS RRS is a metric used by APHIS to provide an estimate of the risk of various herbicides, relative to a given herbicide (in this case glyphosate). For public health, the RRS is based on the maximum application rates per season (a surrogate for exposure), divided by the chronic oral RfD (a surrogate for toxicity). For this analysis, APHIS indexed the RRS on glyphosate, given the importance of this herbicide to this determination. Thus, the ratios for exposure (a given herbicide's maximum application rate divided by glyphosate's maximum application rate) and toxicity (a given herbicide's RfD divided by glyphosate's RfD) are divided, producing the RRS. This indexing allows a comparison of the inherent risks of the herbicides to glyphosate. Thus, the overall risk score for glyphosate is 1. This approach is similar to risk-based scoring approaches that USDA has conducted for other actions (see WIN-PST).

- **Windows Pesticide Screening Tool** (**WIN-PST) Exposure Adjusted Toxicity Category.** WIN-PST was developed by the USDA–NRCS as a risk screening tool for pesticides. WIN-PST is used to evaluate the potential for pesticides to move with water and eroded soil/organic matter and affect non-target organisms. WIN-PST considers the impact of soil characteristics, irrigation/rainfall probability, and pesticide application area, method, and rate on the potential for pesticides to move off-site following application (UC-Davis, 2008). For assessing human health impacts in this EIS, APHIS used only the exposure adjusted toxicity rating from WIN-PST, which represents the soluble pesticide long-term toxicity level for humans. This metric is used to determine relative risk and is based on the drinking water maximum contaminant level (MCL, determined by EPA), health advisory (HA, determined by EPA), or chronic human carcinogen level (CHCL, calculated using an EPA algorithm) for the given pesticide. The exposure adjusted toxicity categories are "Very Low," "Low," "Intermediate," "High," and "Extra High."

- **Consumer Environmental Impact Quotient (EIQ)**. The EIQ, developed by Kovach et al. ((1992)and updated annually integrates information on different types of environmental and human health impacts of individual pesticides into a single indicator value of impact. The EIQ is a method of determining the environmental impact of different pesticides and pest management programs (Cornell University, 2011a). The EIQ is an average of the impact values for three components: farm workers, consumers, and ecosystems. APHIS used the consumer component of the EIQ for this analysis. It is the sum of consumer exposure potential and potential groundwater effects. Consumer exposure is calculated as chronic toxicity multiplied by the average residue potential in soil and plant surfaces multiplied by the systemic potential rating of the pesticide (the pesticide's ability to be absorbed by plants). Generally, a lower EIQ indicates that an herbicide poses less risk.

Each of these metrics has underlying assumptions and limitations, which are addressed in detail in the indicated references. One of these metrics, the RfD, is toxicity-based only and thus must be considered along with some measure of exposure, such as application rate, to obtain a reasonably complete understanding of health risks. This is the basis for the APHIS RRS. The other metrics used here are relative risk-based approaches that do incorporate some measures of individual exposure. When used either alone or together for purposes such as comparing pesticides for regulatory actions, as with H7-1 sugar beet, these metrics provide a reasonable understanding of the relative health risks that were used to form impact conclusions for each alternative.

One approach used by EPA for protection of human health, but not otherwise addressed in this analysis, is the tolerance (maximum residue). As described in section III.F.1.b and shown in Table 3–51, tolerances exist for the 13 most common herbicides applied to sugar beet (or, in the case of trifluralin, to other root crops or to sugar cane). Tolerances are enforceable maximum residue limits for pesticides on food products and are based on the requirement for a "reasonable certainty" that no harm will result from exposure to active ingredients at levels below the tolerance. Tolerances are derived assuming application of the pesticide is according to label directions; therefore, unless tolerances are exceeded due to mixing or application errors, APHIS anticipates that there will be no unreasonable human health impacts of herbicides from public exposure. Table 3-51 ilustrates that refined sugar, the principal sugar beet product to which the population is exposed, generally does not have a tolerance level for any herbicide, except for ethofumesate, because pesticide residues are simply not detected in the product.

Note that the metrics considered in this analysis address the active ingredient of these herbicides only, and not the inert ingredients. While these inert ingredients are known to contribute their own risks or modify the risks of the active ingredients, in most cases they are confidential and so cannot be individually analyzed. Furthermore, they may be similar across the herbicides and thus would not affect the relative risk. Food-use inerts such as those used on sugar beet also must be approved by EPA, as noted in section III.F.1.b.

(1) Alternative 1 – No Action

Under Alternative 1, APHIS expects that the herbicide use would consist mainly of the 13 herbicides shown in Table 4-24. Under Alternative 1, and compared to the recent (2010-11) growing seasons, the use of conventional sugar beet would lead to an increase in exposure to all of the listed herbicides with the exception of glyphosate. Exposure could occur during application of the herbicide, transportation and processing of harvested crops, and in the consumption of livestock that have been fed sugar beet pulp and beet molasses. However, most of the population is not expected to have contact with sugar beet fields or the unprocessed beet. Most of the population will be exposed to beet sugar which has no detectable herbicide residue except in the case of ethofumesate.

For that subset of the population that might be exposed to beet products other than refined sugar, Table 4-24 compares various risk metrics for each of the thirteen herbicides. These include an APHIS relative risk score, windows pesticide screening tool, consumer environmental impact quotient, and chronic oral reference dose.

The following observations can be made about the risk-based metrics shown in Table 4–24:

- The **APHIS RRS** is lowest for clopyralid (0.5), triflusulfuron-methyl (0.8), and glyphosate (1.0). Clopyralid and trisulfuron-methyl are two of the most widely used herbicides on sugar beet. The remaining 10 herbicides rank higher than glyphosate in terms of this RRS and could pose greater risks to human health. The highest RRS score is for cycloate (192) followed by EPTC (59). These two herbicides are not expected to be that widely used in sugar beet production. In 2000 they were used on about 5% of sugar beet acres (Table 3-14). However clethodim, desmedipham, and phenmedipham are all expected to be widely used on sugar beet under Alternative 1 (Tables 3-14 and 3-15) and all have higher RSS values than glyphosate.

- The range of values for the **WIN-PST** exposure adjusted toxicity category is from Very Low to Intermediate for the 13 herbicides evaluated. Glyphosate is in the category of very low risk as a most of the herbicides used on sugar beet. Three of the herbicides in this analysis – cycloate, trifluralin, and triflusulfuron-methyl – had rankings of Intermediate risk. Of these herbicides, triflusulfuron-methyl is expected to be heavily used under Alternative 1 (Tables 3-14 and 3-15). Clethodim and quizalofop-p-ethyl had rankings of Low risk and clethodim is expected to be widely used under Alternative 1. Thus the WIN-PST ratings indicate that at least 5 herbicides expected to be used on sugar beet have higher toxicity ratings than glyphosate and two of those herbicides are expected to be widely used on conventional sugar beet.

- The Consumer EIQ values available for the herbicides in this analysis ranged from 2.55 to 8.00. Desmedipham had the lowest rating (2.55) followed by glyphosate at 3.00. All other herbicides had higher ratings indicating that the potential risk to human health is greater for these herbicides than for glyphosate.

- The Chronic Oral RfD for the herbicides analyzed ranges from 0.005 to 1.75, or nearly three orders of magnitude. "In general, if uncertainties of the database are equal, the lower the RfD the greater the potency of the toxicity: by extension, the lower the RfD, the higher the risk given the same dose or exposure. By this measure, glyphosate is considered to pose the least potential risk to human health with an RfD of 1.75. Considering the chronic RfD of the six herbicides expected to be used on greater than 33% of all sugar beet acres under Alternative 1, clethodim (0.01), clopyralid (0.15), desmedipham (0.04), ethofumesate (0.3), phenmedipham (0.24), triflusulfuron-methyl (0.02), the potential hazard posed by these herbicides to Human health and public safety range from 1.75 to nearly 6 fold greater than for glyphosate.

- Aggregate Risk. The chronic dietary risk assessment values as percent of the chronic population adjusted dose is shown in Table 4-24. The first value is for the general population and the second is for the most sensitive subgroup, usually infants or small children. Values range from less than 0.1 for pyrazon to 73 for clethodim. Though there are differences in the degree of potential risk with clethodim the highest and pyrazon the lowest, values for all thirteen herbicides are below 100, and therefore none of these herbicides pose risks of concern when used according to the label. In cases where herbicide is detected in ground or surface water, a dietary risk assessment for drinking water will be conducted. In cases where there is residential use of the herbicide, an additional assessment is conducted for residential use. In accordance with the FQPA, EPA must consider and aggregate (add) pesticide exposures and risks from three major sources: food, drinking water, and residential exposures. In an aggregate assessment, exposures from relevant sources are added together and compared to quantitative estimates of hazard (e.g., a NOAEL or PAD), or the risks themselves can be aggregated. When aggregating exposures and risks from various sources, EPA considers both the route and duration of exposure. . EPA has found that for all thirteen herbicides the aggregate risk does not pose risks of concern.

Table IV-24. Selected Hazard Metrics for Public Exposures[1]

Herbicide	APHIS Relative Risk Score	WIN-PST Exposure Adjusted Toxicity Category	Consumer Environmental Impact Quotient (EIQ)	Chronic Oral Reference Dose (RfD)	Chronic dietary risk assessment for food [2]	Aggregate Risk: Food, Water, Residential
Clethodim	**12**	**Low**	**8**	**0.01**	**27/73**	<LOC
Clopyralid	0.5	Very Low	**8**	**0.15**	**9/23**	<LOC
Cycloate	**192**	**Intermediate**	**7**	**0.005**	**2.4/5.5**	<LOC
Desmedipham	**11**	Very Low	2.55	**0.04**	<1/<1	<LOC
EPTC	**59**	Very Low	**4**	**0.025**	**9.6/17.4**	<LOC
Ethofumesate	**3**	Very Low	**6**	**0.3**	<1/<1	<LOC
Glyphosate	1	Very Low	3	1.75	2/7	<LOC
Phenmedipham	**3**	Very Low	4.**55**	**0.24**	<1/<1	<LOC
Pyrazon	**10**	Very Low	**7**	**0.18**	7.8/25	<LOC
Quizalofop-p-ethyl	**5**	**Low**	**3.33**	**0.009**	**11/29**	<LOC
Sethoxydim	**2**	Very Low	**4.55**	**0.14**	2.7/7.5	<LOC
Trifluralin	**8**	**Intermediate**	**5.5**	**0.024**	3/10	<LOC
Triflusulfuron-methyl	0.8	**Intermediate**	–	**0.024**	<1/<1	<LOC

[1] See the introduction to section IV.F.2.b for the derivation of each of these metrics

[2]Percent of RfD or cPAD. The first value is for the general public; the second is for the highest exposed subgroup

Abbreviations: WIN-PST = Windows pesticide screening tool, LOC= Level of concern; ND –not determined

Aerial broadcast leads to higher herbicide exposures to the public compared to non-aerial methods because of the drift that occurs. As indicted by data in section III.B.1.d(4), Alternative 1 would likely result in about 14 percent of herbicides being applied to sugar beet using aerial broadcast methods compared to 4 percent under Alternative 2. The greater use of aerial spraying under Alternative 1 is another reason to expect the the risk to Human Health and public safety is greater under Alternative 1 compared to Alternative 2.

(2) Alternative 2 – Full Deregulation

Glyphosate use would be seven fold greater under Alternative 2 than Alternative 1, but, the use of most other herbicides would decrease by over 15 fold, as shown in Table 3-18. As described under Alternative 1, this change in herbicide use is expected to reduce the overall risk to the general public because generally glyphosate is less toxic than other herbicides and is less likely to be aerially applied. This conclusion does not mean that herbicide use under Alternative 1 is expected to be unsafe, in both cases the herbicide use is based on a standard of reasonable certainty of no harm. As shown in Table 4-24, for all the herbicides used on sugar beet, risks of concern are not expected when the herbicide is used as directed according to the label. For many of the herbicides which are used on other crops, the risk assessment takes into account these additional uses.

Under Alternative 2, the addition of H7-1 sugar beet is not expected to lead to an increase in the exposure to glyphosate in the diet of the general public because any residue left on H7-1 sugar beet would be removed during refining. The EPA's current aggregate dietary risk assessment concludes there is no concern for any subpopulation regarding exposure to glyphosate, including the use on many fruits and vegetables and H7-1 sugar beet (71 FR 76180, 2006). EPA's current dietary risk estimates are based on a theoretical maximum residue contribution (TMRC), which assumes that residues at the tolerance level are present on all crops that might be treated with glyphosate. Glyphosate is registered for use as a direct application to weeds in several conventionally produced fruits and vegetables, and tolerances are established in the consumable commodities of these crops. The increase in glyphosate use at the national level associated with Alternative 2 would not alter these EPA risk conclusions, which are based on glyphosate use restrictions for any particular application, not based on total quantities used nationally.

(3) Alternative 3 – Partial Deregulation

The potential human health impacts for Alternative 3 would be similar to those presented above for Alternative 2 except that slightly less glyphosate and slightly more conventional herbicides are expected to be used.

2. Worker Health and Safety

This section analyzes potential worker health and safety impacts of the four APHIS action alternatives that are the subject of this EIS. Areas of potential environmental consequences related to worker health and safety include those related to sugar beet and derived products (direct exposure to allergens, risks from farm equipment) and those related to pesticides used on sugar beet.

a. Sugar Beet and Related Products

No meaningful occupational risks are expected to sugar beet farm and processing workers from direct exposure to the sugar beet root crop based on the absence of reported cases and the lack of evidence of any meaningful differences in characteristics between conventional and H7-1 sugar beet. In the limited area where seed is produced, up to 5,000 acres primarily in Oregon and Washington, workers could be exposed to allergens in sugar beet pollen but no differences are expected among the alternatives. Workers also experience risks of injuries and fatalities from the use of equipment involved with sugar beet farming and product manufacturing, as discussed in section III.F.2.a. The use of farm equipment is expected to vary for the four action alternatives and this area is further discussed below.

(1) Alternative 1 – No Action

Equipment Use. The risks of injuries and fatalities from equipment use under Alternative 1 are expected to be similar to the risks prior to the 2005-2006 growing season, when cultivation equipment use was higher and more workers were in the fields (e.g., weeding by hand). Data specific to sugar beet during that timeframe are available only for fatalities. As discussed in detail in section III.F.2.a, these data indicate that about 0.7 fatal injuries occurred per year (or a fatality about every 1.4 years). APHIS developed an estimate of worker injuries from sugar beet farming using data on injuries associated with the use of tractors, rotary hoes and harrows, weed pullers, and other equipment in agriculture in general. As injury data specific to sugar beet farming are not available, APHIS assumed the proportion of injuries specific to sugar beet farming was the same proportion of agricultural land specifically used to farm sugar beet or approximately 4.1 percent of the total injuries due to use of agricultural equipment (section 3.F.2.a.). The resulting estimate is that an average of about 95 non-fatal injuries and 0.7 fatal injuries are expected each year to workers under Alternative 1.

The higher amount of equipment use expected under Alternative 1 compared to the expected use under Alternative 2 should result in higher engine exhaust emissions and fugitive soil particulates from tractor use, as described in section IV.E.3. These emissions and particulates, which are an expected consequence of farming in general, can result in adverse worker health effects. Soil particulates are associated with adsorbed pesticides and other chemicals, which workers then inhale (see section IV.F.2.b for more on pesticide effects on worker health). The larger expected number of field workers under Alternative 1 also means more workers are exposed to emissions and particulates.

(2) Alternative 2 – Full Deregulation

The potential for CP4 EPSPS protein to be a respiratory allergen has been evaluated in a soybean processing facility (Green et al., 2011). In this study, it was found that workers with soy exposure commonly developed allergic sensitization but none of the workers examined were sensitized to CP4 EPSPS protein. Thus workers exposed to CP4 EPSPS protein from H7-1 sugar beet are not expected to face different allergenicity concerns compared to exposure to proteins from conventional sugar beet. APHIS notes that many variations of the EPSPS protein are ubiquitous in nature, and when used to impart tolerance to glyphosate in corn, cotton, and soybean plants, have not resulted in any known adverse worker health effects despite being grown on hundreds of millions of acres across the United States over the past decade. Based on these research findings, and the similarity in the compositional characteristics of H7-1 and conventional sugar beet, risks to worker health would be comparable among the three alternatives.

Equipment Use. The risks of injuries and fatalities from equipment use under Alternative 2 are expected to be similar to the risks during the recent (2010-2011) growing season, when cultivation equipment use was lower compared to earlier (pre-2005-2006) seasons and fewer workers were in the fields (e.g., weeding by hand). Data specific to sugar beet for this time period were not available. Therefore,APHIS conducted an analysis using the pre-2005-2006 estimates and recent equipment use reduction data. This analysis, described in section III.F.2.a, estimated that conventional sugar beet production resulted in average rates of about 95 non-fatal injuries and 0.7 fatal injury each year to workers. The subsequent adoption of H7-1 sugar beet resulted in a reduction of approximately 30 percent fuel use which should translate into at least a 30% reduction in tractor, cultivation, and other equipment use (see section III.F.2). APHIS used the reduction in equipment use under H7-1 sugar beet adoption to estimate a proportional reduction in injuries and fatalities. Therefore, APHIS estimates that Alternative 2 would be associated with a worker fatality rate of approximately 0.5 per year (or approximately 1 fatality every 2 years) and a non-fatal injury rate of about 66 per year.

The lower amount of equipment use under Alternative 2 compared to prior (2005-2006) seasons would likely result in lower engine emission and soil particulate exposures to workers. Fewer workers in the fields also means fewer workers exposed, including to pesticides adsorbed to the soil (see section IV.F.2.b for more on pesticide effects on worker health). Thus under Alternative 2, injuries from equipment operation and exposure to engine emissions and soil particulates are expected to be less than under Alternative 1.

(3) Alternative 3 – Partial Deregulation

Alternative 3 would result in worker exposures to the H7-1 sugar beet and its products and equipment uses that are similar to, though slightly less than, those described above for Alternative 2. Under Alternative 3, APHIS expects that the risks of injuries and fatalities would be similar to the risks described above for Alternative 2. Alternative 3, however, likely would not result in the same reductions in equipment use as expected under Alternative 2 due to lower adoption of H7-1 sugar beet (and thus farming practices) under Alternative 3 compared to Alternative 2. Thus, APHIS expects Alternative 3 to result in only marginally higher injury rates than the approximately 0.5 fatal injury per year (about 1 fatality every 2 years) and 66 non-fatal injuries per year estimated under Alternative 2. Also, similar to Alternative 2, the lower amount of equipment use under Alternative 3 compared to prior (2005-2006) seasons would likely result in lower engine emission and soil particulate exposures to workers. In addition, fewer workers in the fields means fewer workers exposed, including to pesticides adsorbed to the soil (see section IV.F.2.b for more on pesticide effects on worker health).

b. Pesticides

This analysis of environmental consequences to workers from pesticides used on sugar beet was conducted using an approach similar to that used for analyzing public health consequences from pesticides (section IV.F.1.b). That is, while the action alternatives assessed here involve the use of pesticides and create the potential for worker exposures, when the pesticides are used according to the label there should be no unreasonable adverse health effects.

In addition, insecticides and fungicide useage is not expected to differ across the alternatives but herbicide usage is expected to vary between Alternatives 1 and 2 - 3. Therefore, consistent with public health risks (section IV.F.1.b), this section focuses on herbicide use.

For both Alternatives 1 and 2, and similar to what was done for public exposure in section IV.F.1.b, APHIS compiled tables that characterize and compare a series of selected risk-based metrics for worker exposures to the 13 most common herbicides used in sugar beet root production. Unlike public exposure which is primarily assumed to occur through an oral route, worker exposure is thought to occur primarily through dermal and inhalation routes and the risk metrics differ from that used to analyze public exposure effects.

Below is a more detailed description of the various risk metrics considered and their relevance to human health risk.

- **Label Signal Word.** Label signal words are advisories that appear on pesticide product labels. Pesticides signal words are Caution, Warning, and Danger, with Caution representing low relative toxicity, Warning representing moderate relative toxicity, and Danger representing high relative toxicity. Signal words are based on acute toxicity testing of the concentrated product by oral, inhalation, dermal, skin sensitization, and eye exposures. Test results showing the highest toxicity are used to determine the pesticide label signal word. Section III.F.2.b provides additional detail about the label signal word and its use on sugar beet herbicides. As shown in Table 4-25, The **Label Signal Word** indicates that quizalofop-p-ethyl has the highest acute toxicity (Danger), which reflects concern that this herbicide causes irreversible eye damage. Two herbicides, phenmedipham and sethoxydim, have moderate levels of concern (Warning). The remaining nine herbicides, including glyphosate, have the lowest toxicity (Caution).

- **Farm Worker Environmental Impact Quotient (EIQ)**. The EIQ, developed by Kovach et al. (1992)and updated annually) integrates information on different types of environmental and human health impacts of individual pesticides into a single indicator value of impact. The EIQ is a method of determining the environmental impact of different pesticides and pest management programs (Cornell University, 2011a). The EIQ is an average of the impact values for three components: farm workers, consumers, and ecosystems. The farm worker component of the EIQ is the sum of applicator exposure potential and picker exposure potential multiplied by the pesticide's chronic toxicity. Chronic toxicity is identified through various long-term laboratory studies conducted on small mammals to detect potential reproductive, teratogenic, mutagenic, and oncogenic effects. Applicator exposure potential is calculated by multiplying the dermal toxicity rating to small laboratory mammals and by a coefficient of 5 to account for the increased risk associated with handling concentrated pesticides. Picker exposure potential is calculated as dermal toxicity multiplied by the rating for plant surface residue half-life potential. Generally, a lower EIQ indicates that a pesticide is less hazardous. Data are lacking for trisulfuron-methyl. The **Farm Worker EIQ** values available for the herbicides in this analysis ranged from 6.00 to 12.00. Four herbicides, clethodim, cycloate, quizalofop-p-ethyl, and trifluralin, are in the highest third; three herbicides, clopyralid, ethofumesate, and glyphosate, are in the middle third; and the remaining five are in the lowest third.

- Acute Toxicity LD_{50} Values, Dermal Exposure. Lethal doses from laboratory testing are often used as indicators of acute toxicity for risk assessment purposes. Dermal (skin) LD_{50} values are presented in the matrices, as those are the exposure routes most relevant to human health for this analysis. Generally, the higher the LD_{50} value, the lower the overall toxicity of the substance in question. EPA has classified toxicity values such as LD_{50}s into four toxicity categories: Severely irritating (up to 200 mg/kg); Moderately irritating (200-2000 mg/kg); Slightly irritating (2000 thru 20,000 mg/kg; not an irritant (> 20,000 mg/kg). As shown in Table 4-25, the Acute Dermal LD_{50} values for the herbicides compared in the tables ranged from 2,000 mg per kg per day to greater than 20,050 mg per kg per day. This range of values includes EPA Toxicity III (Slightly irritating) and IV (non-irritating) (undated). All the herbicides are in the slightly irritating category with the exception of pyrazon which is not considered to be an irritant.

Note that the metrics considered in this analysis address the active ingredients of these herbicides only, and not the inert ingredients. Although these inert ingredients are known to contribute their own risks or modify the risks of the active ingredients, toxicity data for these inert ingredients and whole pesticide formulations are presently not available. For a more complete understanding of the actual or "absolute" risks of these herbicides and inert ingredients in the environment, see the herbicide-specific risk assessment and pesticide registration documents noted in section III.F.1.b.

Table IV-25. Selected Hazard Metrics for Occupational Exposures

Herbicide	Label Signal Word	Farm Worker Environmental Impact Quotient (EIQ)	Acute Dermal Toxicity, LD_{50} (mg/kg)
Clethodim	Caution	**12**	>5,000
Clopyralid	Caution	8	>5,000
Cycloate	Caution	**12**	>5,000
Desmedipham	Caution	7.1	>4,000
EPTC	Caution	6	>2,000
Ethofumesate	Caution	8	> 20,050
Glyphosate	Caution	8	>2,000
Phenmedipham	**Warning**	7.1	>4,000
Pyrazon	Caution	6	>2,000
Quizalofop-p-ethyl	**Danger**	**10.65**	>5,000
Sethoxydim	**Warning**	7.1	>5,000
Trifluralin	Caution	**9**	>2,000
Triflusulfuron-methyl	Caution	–	>2,000

[1] See the introduction to section IV.F.2.b for the derivation of each of these metrics.

(1) Alternative 1 – No Action

Table 4-25 compares various hazard metrics for occupational exposures. Most of the herbicides including glyphosate are labeled with caution, the least hazardous signal word. Two herbicides, phenmedipham and sethoxydim are labeled with warning. Quizalofop-p-ethyl is labeled with danger. Considering the Farm Worker EIQ, clethodim, cycloate, quizalofop-p-ethyl, and trifluralin had EIQ values higher than the value for glyphosate. Desmedipham, EPTC, phenmedipham, pyrazon, and sethoxydim all had lower Farm Worker EIQ values than glyphosate. All of the herbicides had relatively low acute dermal toxicity. As listed in Table 3-56, desmedipham, EPTC, phenmedipham, sethoxydim, trifluralin, and triflusulfuron-methyl all are in category III for acute dermal while glyphosate and the other herbicides are in the less toxic category IV. For inhalation, three of the herbicides, EPTC, ethofumesate, and triflusulfuron-methyl are in the relatively toxic category II. Clethodim, Sethoxydim, and trifluralin are in category III. Glyphosate and the other herbicides are in category IV. For skin irritation, clethodim is in the very toxic category I. Cycloate is in category III and the other herbicides are in category IV. For eye irritation, clopyralid is in the very toxic category I, desmedipham is in category II, glyphosate and six other herbicides are in category III. Several of the herbicides, cycloate, sethoxydim, and trifluralin can cause skin sensitization. Overall, glyphosate is in the lowest hazard category for each worker category (oral, dermal, inhalation, skin irritation, and skin sensitization) except eye irritation where it is in the second lowest category. Considering the six herbicides expected to be used on greater than 33% of sugar beet acres under Alternative 1, clethodim is very toxic from the standpoint of causing skin irritation (category I vs category IV for glyphosate), clopyralid is much more toxic from the standpoint of causing eye irritation (category I vs category III for glyphosate), desmedipham is more toxic from the standpoint of causing eye irritation (category II vs category III for glyphosate), ethofumesate is more toxic from the standpoint of inhalation (category II vs category IV for glyphosate), and triflusulfuron-methyl is much more toxic from the standpoint of inhalation (category II vs category IV for glyphosate). Based on the comparison of these hazard metrics, APHIS expects that the herbicides used under Alternative 1 have a higher potential risk compared to the predominant use of glyphosate expected under Alternative 2.

Alternative 1 would likely result in more workers in the field, for cultivation and hand-weeding purposes. A greater number of workers would be exposed to herbicide residues in the field from either aerial or ground applications. Furthermore, more frequent herbicide applications are expected to be made under Alternative 1 compared to Alternative 2, further increasing the risk of exposure.

In summary, APHIS concludes that while the potential for adverse worker health impacts associated with herbicide use under Alternative 1 would not pose unreasonable risks, the potential risks for five of the six most widely used herbicides exceed that of glyphosate in one or more toxicity categories. Clethodim causes severe skin irritation. Clopyralid causes severe eye irritation. EPTC, ethofumesate, and triflusulfuron-methyl are relatively toxic by inhalation. The risks to workers associated with the application of these pesticides would be controlled by adherence to the use restrictions established by EPA and specified on the product labels. If the pesticides are applied according to these restrictions, the resulting worker exposures and health risks should not be unreasonable, according to available toxicity information and government approvals. It is expected that worker exposure to herbicides will be greater under Alternative 1 compared to Alternative 2 because more field workers will be needed for cultivation and handweeding and herbicide applications will be more frequent.

(2) Alternative 2 – Full Deregulation

Under Alternative 2, workers in sugar beet fields will be exposed to more glyphosate and less non-glyphosate herbicides. Overall worker exposure to pesticides is expected to decrease compared to Alternative 1 due to the decreased number of field workers needed for weed control and the more frequent herbicide applications. According to EPA (U.S. EPA 1993c), glyphosate exposure to workers and other applicators generally is not expected to pose undue risks, due to glyphosate's low acute toxicity. However, splashes during mixing and loading of some products can cause injury, primarily eye and skin irritation. EPA is continuing to recommend personal protection equipment, including protective eye wear, for workers using end-use products that are in Toxicity Categories I or II for eye and skin irritation. To mitigate potential risks associated with reentering treated agricultural areas, workers are not permitted to enter fields for 12 hours after spraying. As discussed in detail in section III.F.2.b and this section under Alternative I, glyphosate poses a relatively low individual worker risk compared to the other herbicides used for sugar beet.

Herbicide quantity is an indication of how many workers are potentially exposed to the herbicide rather than an indication of how much herbicide any given individual worker is exposed to. Under Alternative 2, most workers will be exposed to glyphosate and will have very little exposure to other herbicides. One factor affecting the potential number of workers exposed to herbicides under this alternative is that as growers have adopted H7-1 sugar beet in recent years, the use of manual labor has declined substantially, as noted in section IV.F.2.a. APHIS would expect that these reductions in field workers would result in fewer workers being exposed to herbicides. In addition, while no change in insecticide and fungicide use would be expected between the alternatives, the expected reduction of workers in the field would mean a reduction in exposure to these other pesticides too.

In summary, APHIS concludes that the potential for adverse worker health impacts associated with herbicide use under Alternative 2 would be less than under Alternative I because there are less human health hazards associated with glyphosate relative to the other herbicides used on sugar beet, there are expected to be less field workers needed to produce sugar beet under Alternative 2, and there are expected to be fewer applications of herbicide. As a result of the reduced need for field workers, workers will be exposed to less insecticides and fungicides. Applications of all herbicides under this alternative – including glyphosate – would be subject to use restrictions specified by EPA that have been established to ensure that resulting worker health risks are not unreasonable.

(3) Alternative 3 – Partial Deregulation

Alternative 3 would result in worker exposure to H7-1 sugar beet production practices similar to, though lower in magnitude than, the exposure described above for Alternative 2. Thus, conclusions on potential worker health impacts for Alternative 3 would be similar to those presented above for Alternative 2.

G. Other Impacts and Mitigation Measures

This section describes other potential impacts associated with the implementation of the alternatives, including unavoidable impacts; short-term versus long-term productivity of the environment; and irreversible/irretrievable commitment of resources. This section also describes potential impact mitigation measures, as applicable, beyond what is already built into the alternatives.

1. Unavoidable Impacts

Unavoidable impacts are any adverse environmental effects which cannot be avoided should the proposal be implemented (40 CFR § 1502.16).

a. Production Management

Sugar beet production practices require herbicide usage in order to be economically feasible. As a result, herbicide application is unavoidable for all of the alternatives. Likewise, even though the adoption of H7-1 increases the use of conservation tillage (including strip-till) methods, some degree of tillage and its resulting disturbance of soil is also unavoidable.

A low level of gene flow between sugar beet and other fertile *Beta* species is unavoidable in sugar beet seed production practices. However, with proper mitigation measures in place, unwanted gene flow can be reduced to negligible levels.

b. Biological Resources

While there are many mechanisms that can delay the occurrence of herbicide resistance in weed populations, the selection of herbicide-resistant weeds is unavoidable under all three alternatives. Selection of herbicide-resistant weeds is greatly influenced by farmer choices such as weed control strategies. The selection of herbicide-resistant weeds can be mitigated to the extent that farmer behaviors can be influenced.

Under Alternative 1, a shift to non-glyphosate herbicides is expected with the return to growing of conventional sugar beet. Potential toxic effects from these herbicides on animals include impaired growth, development, reproduction, and long-term survival. There could be a risk of sublethal or chronic effects on birds (and possibly reptiles) from the application of sethoxydim postemergence, and to a lesser extent, trifluralin applied preemergence (or early postemergence). None of the herbicides is expected to pose risks of population-level effects when used within label limits. Although unlikely, there could be a short-term loss of groundcover for those species using sugar beet fields if farmers allow the land to go fallow for a few years. Potential impacts on aquatic species from conventional tillage include impaired habitat conditions from soil erosion, which can result in harm to individual species, including individual mortality.

Under all three alternatives, potential adverse impacts on soil microbial communities might occur from herbicide use, depending on the herbicides used. Under Alternative 1, the return to conventional tillage practices associated with conventional sugar beet production and removal of crop residues could result in decreased microbial biomass and activity.

Application of herbicides according to EPA label requirements should pose a reasonable certainty of no harm to terrestrial plants at the population level in the vicinity of treated crops, but drift, runoff, or groundwater seepage into unintended areas on some occasions and at some locations is possible under all the alternatives. Under Alternative 1, the increased use of non-glyphosate herbicides could result in impaired plant growth or death, with non-target broadleaf terrestrial plants adjacent to sugar beet fields being at greatest risk. Glyphosate use under Alternatives 2 and 3 could have similar adverse effects to a wide variety of plants adjacent to treated sugar beet fields.

c. Socioeconomic Impacts

Under Alternative 1, sugar beet seed growers would need to discard H7-1 seed grown in 2011 for the 2013 crop production cycle. Returns to past investments in the development of H7-1 varieties that depend on production in the United States would no longer be realized. Also, sugar beet growers and processors would not be able to benefit from any increased returns provided by H7-1 as compared to conventional sugar beet. To the extent that there is a shortage of domestic conventional seed in 2013, sugar beet seed growers would temporarily experience decreased sales of seed.

Under Alternatives 2 and 3, sugar beet seed producers would stop growing any conventional seed that they specifically started growing in anticipation of H7-1 not being approved for planting in 2013, and any costs incurred would not be recovered.

Under Alternative 3, due to imposed planting restrictions, California sugar beet producers and processors would not be able to benefit from any increased returns provided by H71 sugar beet.

d. Physical Environment

Under Alternative 2, for land use impacts it is possible that some Swiss chard and table beet seed producers may decide to use other growing regions due to concern about gene flow, market perceptions of increased risk of gene flow, the cost of testing for the H7-1 gene and lack of available production area in Willamette Valley. As a result, in the long term, Swiss chard and table beet seed production may increase in other areas within the U.S., or overseas and decrease in the Willamette Valley.

Under Alternative 1, use of more intensive tillage practices (conventional/traditional tillage) for soil management by growers planting conventional sugar beet in place of H7-1 would likely increase compared to practices used in planting of H7-1 sugar beet. Adoption of conventional tillage with the planting of conventional sugar beet crops would be expected to result in greater soil erosion, loss of organic matter, soil compaction, and reduced moisture holding capacity, as compared to conservation or reduced tillage methods. This would lead to an increase in potential sedimentation and turbidity in nearby surface waters during rain and irrigation events. A return to more conventional tillage methods would also lead to more limited micro-organism diversity and possible elimination of some micro-organisms. In addition, under Alternative 1 sugar beet growers would shift to more non-glyphosate herbicides which could lead to applying herbicides that are more toxic to micro-organisms in soil. This could limit micro-organism diversity or to possible elimination of some micro-organisms.

e. Human Health

Under Alternative 1, use of cultivation and other equipment would increase compared to recent H7-1 practices, which could increase adverse health effects from exposure to engine exhaust and fugitive soil particulates. Also under Alternative 1, adverse human health impacts from herbicides could be higher compared to the recent H7-1 practices due to higher toxicity of conventional herbicides and the higher potential for use of aerial spraying of these herbicides. While use restrictions would be in place, accidents or misuse may still occur and could have greater impact due to higher toxicities.

Workers would likely be exposed to a higher rate of potential equipment accidents due to the production practices associated with growing conventional sugar beet under Alternative 1, and they would be likely exposed to higher rates and amounts of engine emissions and soil particulates, as compared to practices used in growing H7-1 sugar beet. Also under Alternative 1, the number of workers in the field would likely increase given the different production practices for conventional sugar beet, which could increase the numbers exposed to equipment emissions, soil particulates, and pesticides.

2. Short-term Use vs. Long-term Productivity of the Environment

Short-term uses and long-term productivity of the environment are linked, and opportunities that are acted upon have corollary opportunity costs in terms of foregone options and productivity could have continuing effects well into the future.

One substantial issue of concern for long-term productivity is the extent to which glyphosate-resistant and tolerant weeds are increased by the practices related to each alternative. The stewardship practices are designed to minimize this effect, but it is less clear how effective these will be in concert with rotations with other crops.

Conflicts regarding short-term use versus long-term productivity of the environment were identified with respect to socioeconomic impacts. Under Alternative 1, the choice to plant H7-1 sugar beet seeds for production purposes would no longer be available to farmers. It is possible that for some producer regions, H7-1 varieties have allowed for benefits in production costs or yields. The possibility of exploring potential cost and yield benefits of biotechnology for the production of sugar beet could be hindered by the selection of this alternative.

Under Alternatives 2 and 3, conventional or organic sugar beet seeds might not be available or only available in small quantities to conventional or organic sugar beet producers from the four main domestic sources of sugar beet seeds. This would likely have little to no long-term economic impact, however, given that the commercial market for conventional or organic sugar beet is small or non-existent.

3. Irreversible resource commitments

Irreversible resource commitments represent a loss of future options. It applies primarily to the use of nonrenewable resources and to factors that are renewable only over long time spans, or to adverse impacts that cannot be reversed once they are set in motion. An irretrievable commitment of resources represents opportunities that are foregone for the period of the proposed action. It also includes the use of renewable resources, such as timber or human effort, as well as other utilization opportunities that are foregone in favor of the proposed action.

Based on available data, irreversible or irretrievable loss of any resources related to this proposed action are limited to certain effects to biological resources, socioeconomic resources, and human health. No irreversible or irretrievable commitments of resources were identified with respect to production and management of sugar beet seed and root crops and physical environment resources for any alternative. It is expected that much of the land that would be used for H7-1 sugar beet production under Alternatives 2 and 3 is already in use for sugar beet production or for other agricultural production. Land currently used for sugar beet production could be allowed to go fallow or could be used for crops other than sugar beet. Acreage used for sugar beet seed and root production does not represent an irreversible or irretrievable commitment of resources because the land can be easily converted to serve other purposes such as growing other crops or for commercial or residential use. Soil used for sugar beet seed and root production does not represent an irreversible or irretrievable commitment of resources because the soil composition can be amended through changes in production management (e.g., tillage practices, chemical application) or converted to serve other purposes such as growing other crops or going fallow. Surface water and groundwater used for irrigation purposes would be replenished through the natural water cycle as long as sustainable use of water resources is practiced.

For biological resources, under Alternative 1, the increased use of non-glyphosate herbicides could result in impaired growth or death to non-target plants adjacent to treated fields, which would represent an irreversible loss of those resources. Alternatives 2 and 3 could have similar adverse effects on non-target plants related to glyphosate spray drift.

For socioeconomic impacts, under Alternative 1, the research and development costs that industry has spent to date would represent an irreversible expenditure of resources. The investments that cooperatives and growers have made in developing H7-1 stewardship programs, efficient production techniques, and marketing strategies would also represent an irreversible cost under Alternative 1. In addition, specialized equipment that growers may have purchased that is unique to growing H7-1 sugar beet would also represent an irreversible cost, unless they are able to sell the equipment, which could result in a loss from the original purchase price. Also under Alternative 1, if processing plants were to close, the investment in those resources and the employment and other economic activity associated with them would represent an irreversible or irretrievable commitment of resources. Under Alternative 1, the loss of ability for sugar beet growers and processors to benefit from any increased returns provided by H7-1 sugar beet represents an irretrievable impact. Under Alternatives 3, the restriction on planting of H7-1 in California would result in a similar irretrievable impact of the lost benefit for growers and processors in that State to benefit from any increased returns provided by H7-1.

For human health resources, under Alternative 1 the shift in production practices and the subsequent higher potential for worker injuries and fatalities from equipment accidents, and the potential increased exposure to engine exhaust and fugitive soil particulates, represent potentially irreversible impacts. Also under Alternative 1, use of cultivation and other equipment would increase compared to recent H7-1 practices, which could increase adverse health effects from exposure to engine exhaust and fugitive soil particulates. Also under Alternative 1, human health risks from herbicides could be higher compared to the recent H7-1 practices due to the higher toxicity of herbicides used in conventional production and the higher potential for use of aerial spraying of these herbicides. While use restrictions would be in place, accidents or misuse may still occur and could have greater impact due to higher toxicities. Workers would be exposed to a higher rate of potential equipment accidents due to the production practices associated with growing conventional sugar beet under Alternative 1, and they would be likely exposed to higher rates and amounts of engine emissions and soil particulates. Also under Alternative 1, the number of workers in the field would likely increase, which could increase the numbers exposed to equipment emissions, soil particulates, and pesticides.

4. Mitigation Measures

As defined in the CEQ regulations for implementing NEPA (40 CFR § 1508.20) mitigation includes:

- avoiding the impact altogether by not taking a certain action or parts of an action;
- minimizing impacts by limiting the degree or magnitude of the action and its implementation;
- rectifying the impact by repairing, rehabilitating, or restoring the affected environment;
- reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action; and
- compensating for the impact by replacing or providing substitute resources or environments.

See sections IV.B through IV.F for a discussion of specific impacts resulting from the three alternatives. The only mitigation measures described below are those that are not built into the alternatives (see the descriptions of the alternatives in chapter II). For example, in Alternatives 3, a variety of conditions restricting planting locations would be implemented either by APHIS or another entity. In addition, key measures described in chapter II that apply to many of the adverse impacts described in chapter IV are the MTSA that requires growers to follow the TUG and the Roundup Ready PLUS™ program, which is a voluntary program for reducing the development of herbicide-resistant weeds. The MSTA/TUG measures apply to the impacts described under Alternatives 2 and 3, since under Alternative 1, H7-1 sugar beet would only be allowed to be grown for research and development conditions under the strict conditions of APHIS-imposed Notification or Permit Conditions. In the long term once patents expire, APHIS assumes that there would be no binding enforcement mechanism to ensure that farmers follow the TUG. In addition, without MTSAs in place, Monsanto/KWS SAAT AG would have less ability to track technology users. However, before and after patent expiration, the Grower Cooperatives would likely continue to necessitate certain similar stewardship requirements because all commercial sugar beet is produced under contracts with the grower owned cooperatives. Industry has best practice protocols in place to mitigate

LLP, such as Industry Provisions to Prevent Inadvertent Mechanical Mixing in Seed Production and West Coast Beet Seed Company Protocol for Genetically Modified (GM) Seed Production. In addition, Biotechnology Industry Organization and American Seed Trade Association have initiated efforts to develop principles and processes to manage the regulatory, stewardship, and liability issues posed following the expiration of patents on commercial biotech events. These efforts build on the already established stewardship principles articulated in the Excellence Through Stewardship program that provides detailed guidance on how to develop and implement stewardship programs and quality-management systems that will assist product developers in maintaining plant product integrity.

a. Production Management

(1) Measures to Mitigate Herbicide Impacts

Mitigation measures to oversee the proper usage of herbicides are determined by EPA and are disseminated to the herbicide users through EPA approved labels. Under Alternative 1, non-glyphosate herbicides would be used on sugar beet presumably at similar levels as prior to deregulation. Under Alternatives 2 and 3, more glyphosate, but less non-glyphosate herbicides would be used than under Alternative 1. Adhering to herbicide label requirements, including application rates and techniques and following industry glyphosate stewardship programs, will largely minimize improper herbicide usage.

(2) Measures to Mitigate Gene Flow between Beta crops

Under Alternative 1, there would be no further commercial release of H7-1 and existing H7-1 plants would eventually be harvested. Research and development permits would not be affected by this alternative. Therefore, research and development plantings under APHIS permit could still occur. Those plantings would be subject to the permit conditions, which have gene flow mitigation stipulations.

Under Alternative 2, H7-1 sugar beet could be grown by farmers across the country. Mitigation measures to reduce the potential impact of H7-1 gene flow include the currently utilized geographic separation of seed production regions. Additionally, standard isolation distances currently employed by farmers of *Beta* species to reduce unintended presence of sugar beet in vegetable beet crops, and vice versa, would likely continue to be employed. These isolation distances can reduce the likelihood of successful long distance gene flow to levels established for current crop purity standards. For example, in the Willamette Valley in Oregon (the primary seed production region in the nation), all commercial seed producers and growers of *Beta* crops utilize a pinning map and established isolation distances between sexually compatible species, in accordance with guidelines for isolation and minimum separation distances between fields provided by WVSSA. These include 1 mile between open pollinated fields, or between hybrid pollinated fields of the same color and group; 2 miles between hybrid and open pollinated fields of the same color and group and between stock-seed and hybrid; 3 miles between different colors within a group, between stock seed and open pollination, or between GMOs and any other *Beta* species; and 4 miles between hybrid and open pollination of different groups. In addition, the potential for gene flow between commercial seed fields is also greatly limited by the use of the CMS hybrid method in H7-1 seed production (see section III.B.1.b(8)).

Producers of H7-1 sugar beet seed also implement both voluntary and mandated management practices designed to prevent admixture of seeds during harvest, seed cleaning, storage, and shipping of H7-1 seeds (see section III.B.1.b(18)). These methods include watering fields after seed harvest to germinate shattered seeds in seed production fields followed by tillage or herbicide treatment to reduce the H7-1 sugar beet seed bank. Additionally, field inspections of past sugar beet fields are conducted to monitor and destroy volunteers. Multi-year crop rotations are used in both sugar beet seed and root production to facilitate the detection and elimination of sugar beet volunteers. If unintended mixing of H7-1 seeds with vegetable crop seeds or conventional sugar beet seeds occurs, the use of protein or DNA assays could be used as an additional measure to test for and limit LLP of hybrid H7-1 seeds in conventional seed. Bolting H7-1 sugar beet could be a potential source of gene flow as they would produce H7-1 pollen. However, farmers typically remove bolters as bolting depletes the root of sugars and the woody roots that result from bolters can damage harvesting and processing equipment (Ellstrand, 2003). Additionally under the Monsanto TUG, farmers are required to remove bolters in H7-1 sugar beet fields (Monsanto, 2011a). While such management practices may not always be followed by all growers or may not be 100 percent effective, they help reduce the likelihood of gene flow.

Under Alternative 3, APHIS or another Federal agency, would impose restrictions as described in chapter II which will serve to mitigate nearly all potential for gene flow. Because of the limitations on areas available for cultivating H7-1 sugar beet seeds under these alternatives (banned from western Washington and California), the potential for long distance gene flow is extremely low. The only recognized areas where sugar beet seeds and vegetable beet seeds occur is in the Willamette Valley of Oregon and a single county in southern Oregon. Sugar beet seed production overlaps with Swiss chard seed production in seven counties (Polk, Washington, Clackamas, Benton, Linn, Marion and Jackson) and overlaps with 2.2 percent of table beet seed production in one county (Polk). Use of CMS production in sugar beet with 85% of H7-1 carried on male sterile female plants in 2011, reduces the chance of gene flow between most seed fields. For areas of overlap between H7-1 and conventional sugar beet or vegetable beet seed production, isolation distances that are commonly employed and standard farmer practices can reduce the potential for unintended successful gene flow below detection limits and within levels established for current crop purity standards.

(3) Measures to Mitigate Gene flow to Wild Beet Populations

There are very few situations where gene flow is possible between H7-1 sugar beet and wild beet populations with the exception of sugar beet root crop production in the Imperial Valley. Even in the Imperial Valley the likelihood of gene flow is low because the wild beet are a different species and not likely to cross with sugar beet. Methods to mitigate gene flow into wild populations include using H7-1 sugar beet varieties that require long vernalization times to flower, monitoring fields for bolting plants, and removing flowering plants during the time when wild beet are also flowering.

b. Biological Resources

(1) Measures to Minimize Impacts on Animals and Non-target Plants

Mitigation measures to minimize the potential impacts on animals, micro-organisms, and non-target plants under all of the alternatives include measures that already are a part of standard production practices for sugar beet. Complying with herbicide label instructions as required by EPA should minimize potential toxic effects from all alternatives. In addition, crop rotation and use of herbicides with different mechanisms of action over time not only help to minimize development of resistant weeds, but also minimize the potential for cumulative impacts from repeated use of the same set of herbicides in one location.

Under Alternatives 2 and 3, to mitigate potential adverse effects due to glyphosate drift during applications, EPA has imposed specific label use restrictions for its use, including “the product should only be applied when the potential for drift to adjacent sensitive areas (e.g., residential areas, bodies of water, known habitat for threatened or endangered species, non-target crops) is minimal (e.g., when wind is blowing away from the sensitive areas)” and “avoid application over water.” Additionally, ground-based application of herbicides minimizes the potential for spray drift to occur. For Alternatives 2 and 3, conservation tillage practices associated with H7-1 sugar beet production maximize retention of crop residues and minimize soil disturbance erosion, thereby minimizing potential adverse effects on micro-organisms from soil disturbance and crop residue removal, and minimizing potential adverse effects on aquatic plants and animals from sedimentation, turbidity, and chemical inputs from runoff.

(2) Measures to Mitigate the Development of Resistant Weeds

No glyphosate-resistant weeds have been attributed to the production of H7-1 sugar beet to date. Glyphosate-resistant weeds have developed in continuous cropping systems In addition to crop rotations, the deployment of several other practices by growers, including the use of herbicides with different mechanisms of action and BMPs (as discussed in section III.C.3.a) also will help delay selection of herbicide-resistant weeds.

In growing sugar beet, if recommended herbicides are not effective, hand weeding and mechanical cultivation may be the best options for herbicide-resistant weed control. Stachler and Zollinger (2009) also provide recommendations for managing herbicide-resistant weeds in sugar beet in Minnesota and North Dakota based on the mechanism of action of the resistant herbicide. Once resistant weeds are observed, mechanisms that can help mitigate weed persistence include field scouting and other management practices that can identify weeds that appear to have resisted the herbicide, and the use of high label rates of post-emergent herbicides can help assure that weed plants that have low levels of resistance do not survive to hybridize with other partially resistant plants. Among growers there is increasing awareness of herbicide stewardship needs. Industry is providing more tools to help growers adopt the farming practices that will both delay the development of herbicide resistance and help control the spread of herbicide-resistant weeds from field to field. One of these programs is Monsanto's Roundup Ready PLUS™ program.

c. Socioeconomic Impacts

To the extent that a shortage of conventional sugar beet seed or of herbicides to be used in conventional sugar beet production would occur under Alternative 1, sugar beet producers and processors would be adversely impacted. However, the possibility of deterring these adverse impacts from also occurring in the sugar market would depend on the extent to which cane sugar is available to replenish the market. The U.S. sugar policy does not allow re-allotment of the U.S. sugar market between domestic cane sugar and beet sugar productions, but program actions could be taken to increase imports. Increased use of imported sugar to supply the domestic sugar market faces two obstacles: (1) U.S. sugar refining capacity, and (2) the quality of imported sugar. U.S. sugar refining seems to have been operating near capacity in the recent past and imported refined sugar seems to differ in quality from domestic refined sugar hampering its utilization (see section IV.D.1.b for a discussion).

d. Physical Environment

In general, impacts on the physical environment from sugar beet farming, as with any crop, are minimized through implementation of proper management practices for each agricultural activity, such as tillage, erosion control, and pesticide application.

As described in section IV.E.1, increases in the acreage of H7-1 sugar beet are expected under Alternatives 2 through 4. Land use-related impacts such as potential for gene flow can be minimized by adherence to the management practices, isolation distances, and geographic restrictions, that are established by the regulatory authority or compliance agreements, as applicable.

Impacts on soil quality are an expected consequence of farming in general. As described in section IV.E.2, soil impacts can vary with the tillage practices in use, and can be reduced through increased use of conservation and reduced tillage techniques. Adoption of H7-1 sugar beet facilitates increased use of conservation and reduced tillage and thus can lead to reduced adverse impacts on soil quality.

As described in section III.E.3, the use of tractors and other equipment to cultivate the soil and conduct other activities involved with growing sugar beet can result in engine emissions and fugitive soil particulates being carried by the wind to the neighboring public. These emissions and particulates are an expected consequence of farming in general, but they can be reduced by changes in farming practices. Under Alternatives 2 and 3, there is evidence that the increased use of conservation and reduced tillage associated with adoption of H7-1 sugar beet can decrease usage of fossil fuel-burning equipment, decrease soil erosion by wind, and decrease pesticide usage. However, evidence that these effects reduce emissions of air pollutants, fugitive particulates, and GHGs is uncertain.

As with other agricultural crops, the effects of sugar beet farming on surface water and groundwater (e.g., lakes, streams, aquifers) depend on multiple factors or activities related to crop production, which can include soil preparation, planting and harvesting; tillage practices; tractor and other equipment use; the use of herbicides and fertilizers; and the frequency of irrigation necessary to produce a viable crop. Under Alternatives 2 and 3 and as discussed in section III.E.4, adoption of H7-1 sugar beet facilitates increased use of conservation and reduced tillage practices which, compared to typical tillage practices for conventional sugar beet, decreases soil erosion, reduces water runoff, and reduces contaminant levels in runoff, all of which lead to improved surface water and groundwater quality.

e. Human Health

For the potential adverse effects to human health from the use of pesticides that may occur under all of the alternatives, mitigation measures include the handling and use requirements and precautionary statements on pesticide labels required by EPA. Pesticide labels convey the necessary information developed by EPA on how to handle, store, apply, and dispose of pesticides with a reasonable certainty of no harm to human health. Using a pesticide in a manner that is inconsistent with these directions on the label is a violation of FIFRA and can result in enforcement actions to correct the violations. This does not mean that the correct application of these pesticides will not cause any adverse health effects to some individuals, only that the risk of such adverse effects is minimized by following the label instructions. For the potential higher equipment use under Alternative 1 with the return to conventional sugar beet growing practices, safety labels and equipment already are used and no additional mitigation measures could be identified.

V. Cumulative effects

Cumulative impacts, as defined by CEQ (40 CFR 1508.7), are impacts to the environment that result from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions, regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative impacts may result from individually minor, but collectively significant, actions taking place over time.

This section discusses the cumulative impacts that are associated with the alternatives (for a full description see Chapter II), when combined with other recent past, present, and reasonably foreseeable future actions within the affected environment (See Chapter III for a description of the affected environment). Throughout this document the affected environment has been described to include agricultural land where sugar beet is grown and the surrounding areas. The natural resources discussed include, air, water, and soil resources, biological resources including plants and animals that inhabit areas in and around sugar beet agriculture. This section analyzes the cumulative effects at the local (County level), regional (sugar beet growing regions) and at the national level. Where APHIS has identified effects at the County level the geographic boundaries have been expanded to the regional level to determine if resources are impacted on a regional scale. Where regional effects were identified, the geographic boundary has been expanded to the national level to analyze the impacts at that larger scale. For the purposes of this analysis Alternative 1, the No Action Alternative provides the baseline for the analysis. Under Alternative 1, H7-1 sugar beet would not be grown on a large scale. Instead conventional sugar beet would be grown. Growers would use cultivation practices that allow for the production of sugar beet in their area. This may include tillage, cultivation, irrigation, and pesticide use.

A. Background

1. Geographic Boundaries for the Analysis

This analysis addresses large local, regional, and national-scale trends that have impacts that may accumulate with those of the proposed alternatives.

As described in the Affected Environment, over the past 10 years, the number of acres planted annually in sugar beet in the U.S. has ranged from 1 to 1.4 million acres (USDA-NASS, 2011e). H7-1 sugar beet is produced in five major regions in the U.S. (see Fig. 3-6). Within these regions, sugar beet is grown in areas closest to sugar beet processing plants. APHIS used data from the 2007 Census of Agriculture to identify counties that produce sugar beet. However, APHIS excluded some counties in

California where sugar beet is no longer grown because the area processing plant had closed after the 2007 Census of Agriculture was completed.

2. Temporal boundaries for the analysis

APHIS considers reasonably foreseeable actions as those future actions for which there is a reasonable expectation that the action could occur, a project that has already started, or a future action that has obligated funding. It also includes other actions such as typical crop rotations and associated weed and land management practices that overlap in space and time with areas that are likely to grow sugar beet. For the purposes of forecasting trends, APHIS uses the most appropriate time frame defined by the data. Typically this will be between 5 and 10 years. For the purposes of examining past actions, APHIS will use a 10-year time frame unless a different timeframe is indicated by the type of analysis or the available data. To identify effects from other actions that may interact with the alternatives described in this EIS, APHIS reviewed government reports, crop management recommendations from extension agents and agronomists, natural resource management plans, and published information from other organizations.

3. Resources Analyzed

This cumulative impacts analysis addresses the potential impacts of the alternatives on biological resources, the physical environment, and socioeconomics. APHIS identified changes in agricultural production practices associated with the use of H7-1 sugar beet as the driver for potential indirect effects on resource areas. That is, the sugar beet themselves do not effect these resource areas, but the changes in pesticide use, tillage, or other crop management associated with the increase of H7-1 sugar beet can affect these resource areas. Because the use of H7-1 sugar beet does not require a single specific set of agronomic practices, the magnitude of the effects discussed depend on the adoption rates of various practices by growers. This section analyzes the cumulative impacts related to changes in agronomic practices that might be associated with the adoption of H7-1 sugar beet in the context of the impacts that agriculture has on these resources in the areas where sugar beet is grown.

a. Magnitude of Effects on Resources

The potential impacts of Alternative 2, the preferred alternative, combined with other actions, and the duration of those impacts, are considered in determining the magnitude of the cumulative effects that impact each resource. When possible, the assessment of the effects on a resource is based on a quantitative analysis; however, many effects are difficult to quantify. In these cases, a qualitative assessment of cumulative effects is made. Incomplete or unavailable information is documented in accordance with 40 CFR § 1502.22.

In the following analysis, cumulative effects are considered additive unless designated as otherwise. In the case of most resources that may experience cumulative effects, the preferred alternative is only responsible for a contribution of an incremental portion of the total impact on the resource. The past, present, and reasonably foreseeable connected actions typically contribute to the majority of impacts experienced by the resource, and would continue to have impacts on the resource even if the no action alternative were implemented.

b. Geographic scale of analysis

APHIS assessed the potential for H7-1 sugar beet to contribute to an incremental increase in the cumulative impacts of agriculture on resource areas at the county level, the regional level, and the national level. APHIS conducted the analysis at various scales because although the alternatives are national in scope, the effects of the adoption of H7-1 sugar beet might not be measurable at a large scale, but may have a meaningful incremental contribution to cumulative impacts at a smaller scale. For the purposes of this analysis, national means the entire United States; regional means each of the sugar beet growing regions as defined in section III.B.1. Local is on the county level, because county level is the smallest geographic area for which APHIS was able to obtain data. For the assessment of cumulative impacts on water resources, the analysis is at the level of the counties within the watershed or basin where sugar beet product exceeded 10% of the harvested cropland.

c. Assumptions and Methodology

In the analysis throughout chapter four, APHIS concludes that all of the effects on the human environment are indirect effects of changes in agricultural practices associated with the adoption of H7-1 sugar beet. This conclusion is based on the evidence that H7-1 sugar beet closely resembles conventional sugar beet and by itself does not directly affect the environment differently than other sugar beet. Rather, the adoption of H7-1 sugar beet allows for the adoption of changes in certain production practices which have the potential to impact biological resources, the physical environment, human health or animal feed, and the costs associated with production of sugar beet. The principal changes that APHIS has identified are changes in pesticide use and changes in tillage and cultivation practices. As described in section III.B, APHIS found that other practices used for growing sugar beet are unlikely to differ between H7-1 and conventional sugar beet and, therefore, in this section APHIS assumes other production practices will remain unchanged.

With the increase of H7-1 sugar beet, there is a corresponding increase in glyphosate use and a decrease in other herbicide use (See section III.B.1.f.). Changes in herbicide use have the potential to impact biological resources and the physical environment. APHIS concludes that the changes in pesticide use are not likely to affect human health (see discussion in section IV.F.). The shift toward post-emergent glyphosate use in sugar beet, when combined with the use of glyphosate in other agricultural activities, also has the potential to contribute to selection for glyphosate-resistant weeds. This is discussed extensively in section (IV.C.3.). Decreases in the use of non-glyphosate herbicides can reduce selection for weeds resistant to the modes of action of non-glyphosate herbicides. Use of non-glyphosate herbicides may increase if glyphosate-resistant weeds become more prevalent or if resistance management programs are adopted to decrease the potential selection of glyphosate-resistant weeds.

The adoption of H7-1 results in an increase in conservation tillage in some regions (See section III.B.1.C.(2)) and a reduction of cultivation in all regions during the growing season. The change in tillage practice is associated with the effectiveness of controlling weeds by applying glyphosate post planting. When weeds are not adequately controlled, growers may increase tillage prior to planting or resort to mechanical cultivation of the soil around the sugar beet plants during the growing season with the intent of uprooting weeds.

In some areas, like the Midwest, the soil may still be tilled prior to planting of H7-1 sugar beet, because the tilling is used to address other management objectives not related to weed management. However, even in these areas, the number of cultivations during the growing season may be reduced with the adoption of H7-1 sugar beet and post planting glyphosate application. In areas where conservation tillage increases, a reduction in pesticide run-off and soil erosion may occur (see sections III.E.2 and IV.E.2). If glyphosate-resistant weeds become prevalent, there may be a return to cultivation during the growing season and in areas that have adopted conservation tillage in sugar beet a return to tillage may occur. The prevalence of glyphosate-resistant weeds and the difficulty of managing those weeds in a low-till system will influence the choice of growers to resume tillage practices.

To analyze the potential for the changes in production practices associated with the adoption of H7-1 sugar beet to contribute to the effects associated with pesticide use and tillage in agriculture, APHIS first determined the overall contribution of sugar beet production to harvested cropland. Harvested cropland is all land used for agriculture excluding land used for pasture, orchards, livestock, and fallow. While the excluded lands are important to agriculture, these lands are not used to cultivate sugar beet or the crops rotated with sugar beet. As sugar beet, sugar beet rotation crops, and all Roundup Ready® crops are only grown on the land characterized as harvested cropland, APHIS chose harvested cropland for the analysis. By excluding these other farm areas, the ratio of sugar beet acres relative to land area considered is maximized and so the potential cumulative effect attributable to the adoption of H7-1 sugar beet is also maximized.

APHIS used data from the 2007 Census of Agriculture to identify the acres of sugar beet planted at the county level and the amount of harvested cropland in each county. In one instance, the NASS study did not report harvested cropland for one county in 2007 but did so in 2002. For that one county, APHIS used the 2002 data, which may result in an imprecise estimate of the sugar beet acreage for that county relative to the other counties in 2007. APHIS also used 2007 census data to derive the amount of corn, soy, canola, cotton and alfalfa grown in each county. APHIS examined the acreage of these crops because they also have been genetically engineered to resist over the top application of glyphosate. In counties where NASS did not report data for these crops because there were too few growers to maintain anonymity, APHIS assumed the acreage was zero. While this may cause an underestimate in those cases, this is a reasonable assumption because the acreage represents a small percentage of sugar beet acres planted and an even smaller percentage of herbicide-resistant crops planted. Adoption rates of herbicide-resistant crops by State were derived from ERS (USDA-ERS, 2011a). APHIS used 2007 adoption rates for herbicide-resistant corn, cotton, and soy. APHIS assumed that both sugar beet and canola had adoption rates of 100% for the purposes of this analysis. APHIS used the 10-year (2010-2020) adoption rate by region for alfalfa predicted by industry market research (USDA-APHIS, 2010a).

APHIS analyzed variation in acres of common crop production to set a threshold, below which there is no measurable incremental contribution, to be a 10% change in herbicide-resistant crop acreage due to H7-1 adoption. APHIS set the threshold at 10% because changes in production practices, such as shifts in pesticide use and tillage, also occur with crop rotation, fluctuations in acreage planted to a particular crop, variations in weather that result in changes in pest load, and economic influences such as price of the commodity and cost of inputs. In areas where sugar beet production accounts for less than 10% of the total harvested cropland, the effects from changes in tillage patterns or herbicide use are likely to be smaller than the changes associated with normal variation in the crop production cycles and yearly adaptations to environmental conditions. APHIS assumed that all the sugar beet acreage would be used to produce H7-1 sugar beet and analyzed the extent to which this additional acreage of herbicide-resistant crops increased the amount of herbicide-resistant crops in the area.

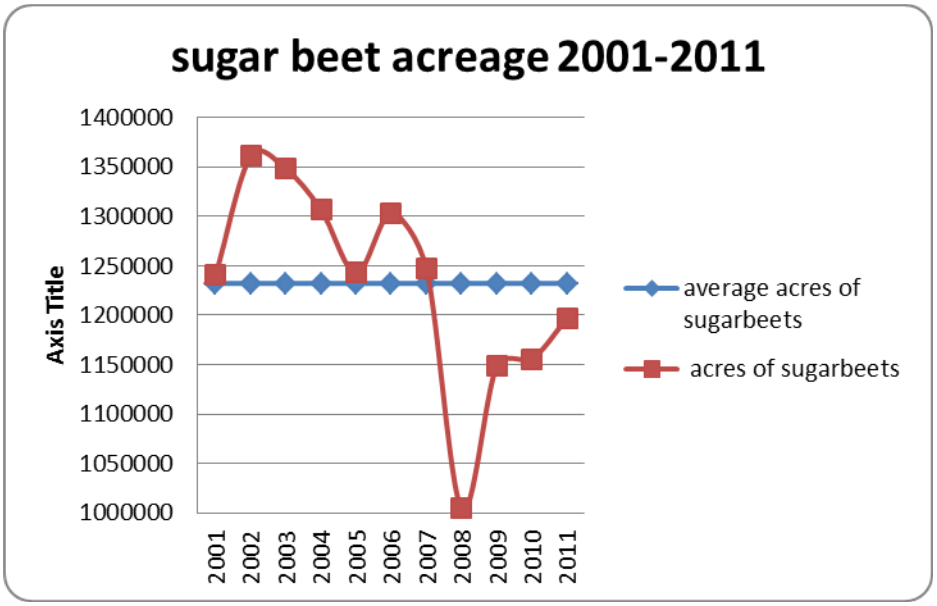


Figure 5- 1. Sugar Beet Acreage 2001-2011

Sugar beet acreage ranged from a high of 1,360,700 acres in 2002 to 1,004,500 in 2008. Throughout this period the average number of acres was 1,232,290 acres.

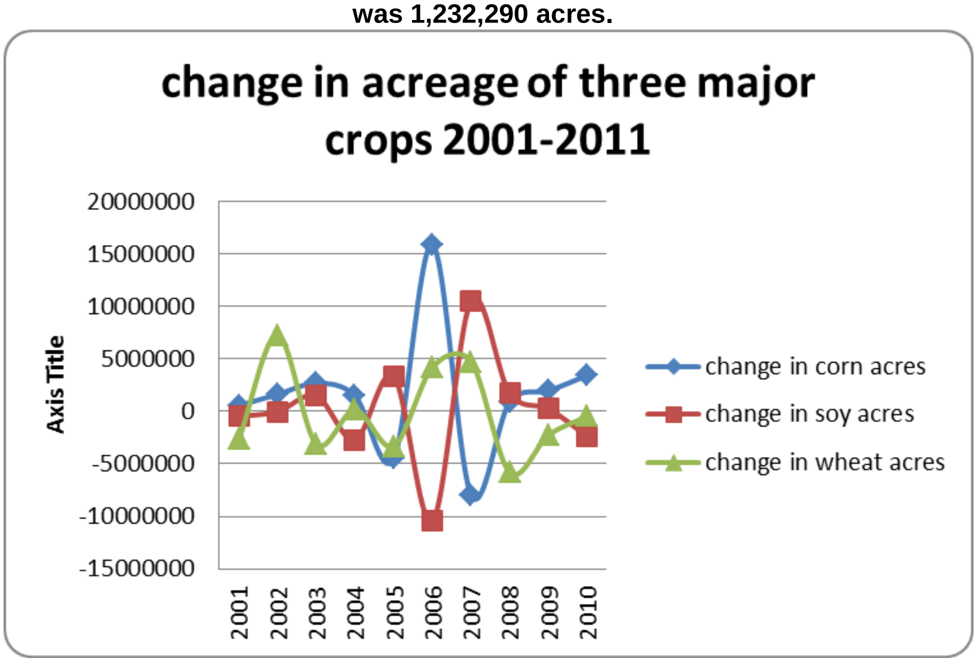


Figure 5- 2 Change in acreage of three major crops 2001-2011

Variation in acres planted in corn, soy, and wheat within the U.S. varies from year to year. Corn typically varies by about 5 million acres each year, while soy and wheat vary by about 2 million acres each year. (USDA-NASS, 2011d)

4. Resource Areas

According to USDA-NRCS, major natural resource concerns facing cropland include: (1) erosion by wind and water, (2) maintaining and enhancing soil quality, (3) water quality from nutrient and pesticides runoff and leaching, and (4) managing the quantity of water available for irrigation. (http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/landuse/crops)

APHIS has identified changes in tillage practices, cultivation practices, and herbicide use as the principal causes of direct and indirect effects associated with the use of H7-1 sugar beet. These effects are analyzed throughout section IV. In this section APHIS examines how the incremental effects associated with these changes in management practices affect the major national resource concerns facing cropland, as well as interrelated sociocultural resources.

Changes in tillage, and to some extent cultivation, of agricultural crops have been associated with impacts on soil, water, and air resources. Changes in pesticide use can also affect these resources and, in addition, can affect biological resources and sociocultural resources related to the economics of farming and its contribution to rural life.

Conservation of natural resources
USDA-NRCS has several programs aimed to help farmers conserve natural resources. In this cumulative effects section we examine the incremental effect of using H7-1 sugar beet on each of these resources (soil health, water, air) and the identified components that contribute to the conservation of these resources.

(1) Soil Health

According to USDA-NRCS, there are six components of soil quality and soil health management. Choosing specific practices within each component depends on the situation since different types of soil respond differently to the same practice. Each combination of soil type and land use calls for a different set of practices to enhance soil quality.

1. **Enhance organic matter**: Whether your soil is naturally high or low in organic matter, adding new organic matter every year is perhaps the most important way to improve and maintain soil quality. Regular additions of organic matter improve soil structure, enhance water and nutrient holding capacity, protect soil from erosion and compaction, and support a healthy community of soil organisms. Practices that increase organic matter include: leaving crop residues in the field, choosing crop rotations that include high residue plants, using optimal nutrient and water management

practices to grow healthy plants with large amounts of roots and residue, growing cover crops, applying manure or compost, using low or no tillage systems, and mulching.

2. **Avoid excessive tillage**: Reducing tillage minimizes the loss of organic matter and protects the soil surface with plant residue. Tillage is used to loosen surface soil, prepare the seedbed, and control weeds and pests. But tillage can also break up soil structure, speed the decomposition and loss of organic matter, increase the threat of erosion, destroy the habitat of helpful organisms, and cause compaction. New equipment allows crop production with minimal disturbance of the soil. For more information about conservation tillage, visit the Conservation Technology Information Center (http://www.ctic.purdue.edu/).

3. **Manage pests and nutrients efficiently**: An important function of soil is to buffer and detoxify chemicals, but soil's capacity for detoxification is limited. Pesticides and chemical fertilizers have valuable benefits, but they also can harm non-target organisms and pollute water and air if they are mismanaged. Nutrients from organic sources also can pollute when misapplied or over-applied. Efficient pest and nutrient management means testing and monitoring soil and pests; applying only the necessary chemicals at the right time and place to get the job done; and taking advantage of non-chemical approaches to pest and nutrient management such as crop rotations, cover crops, and manure management.

4. **Prevent soil compaction**: Compaction reduces the amount of air, water, and space available to roots and soil organisms. Compaction is caused by repeated traffic, heavy traffic, or traveling on wet soil. Deep compaction by heavy equipment is difficult or impossible to remedy, so prevention is essential.

5. **Keep the ground covered**: Bare soil is susceptible to wind and water erosion, and to drying and crusting. Ground cover protects soil, provides habitats for larger soil organisms, such as insects and earthworms, and can improve water availability. Ground can be covered by leaving crop residue on the surface or by planting cover crops. In addition to providing ground cover, living cover crops provide additional organic matter and continuous cover and food for soil organisms. Ground cover must be managed to prevent problems with delayed soil warming in spring, diseases, and excessive build-up of phosphorus at the surface.

6. **Diversify cropping systems**: Diversity is beneficial for several reasons. Each plant contributes a unique root structure and type of

> residue to the soil. A diversity of soil organisms can help control pest populations, and a diversity of cultural practices can reduce weed and disease pressures. Diversity across the landscape can be increased by using buffer strips, small fields, or contour strip cropping. Diversity over time can be increased by using long crop rotations. Changing vegetation across the landscape or over time not only increases plant diversity, but also the types of insects, microorganisms, and wildlife that live on your farm. (http://soils.usda.gov/sqi/management/management.html)

This section will analyze how the adoption of H7-1 sugar beet influences the adoption of each of these practices with the assumption that increasing the use of these practices contributes to good soil health while decreasing their use detracts from good soil health.

(2) Water

Water resources include both surface water and subsurface water resources. Agriculture impacts water resources through soil erosion, run-off of agricultural chemicals, and water use for agricultural production. Water management is the control and movement of water resources to minimize damage to life and property and to maximize efficient beneficial use (http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/water/manage)

Agricultural lands are the focus of certain water management programs because "the drained farmlands in the Upper Mississippi River Basin have been identified as a contributor to nutrient loading of receiving waters, that often leads to adverse environmental and economic consequences." http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1045702.pdf Therefore,the incremental effect of the adoption of H7-1 and its contribution to the associated effects of agricultural drainage on surface water basins is examined at a water basin level.

(3) Air

According to NRCS there are four broad categories of air-related resource concerns: particulate matter, ozone precursors, odors, and greenhouse gases and carbon sequestration. http://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/national/air/quality/?&cid=stelprdb1046159 APHIS has examined the direct and indirect effects of the use of H7-1 on these four resource concerns. See section [III.E.3 and IV.E.3]

In summary, these changes in production practices indirectly affect physical and biological resources. The impacts caused by the changes in tillage and herbicide use are observed with the cultivation of other Roundup Ready® crops and are not unique to H7-1 sugar beet production.

Several types of cumulative effects are possible. Adoption of H7-1 sugar beet would lead to increased glyphosate use and, depending on management practices, might promote the selection of glyphosate-resistant weeds. Additional adoption of H7-1 sugar beet would improve weed control in sugar beet fields and could reduce the spread of weeds into neighboring fields. Adoption of H7-1 sugar beet has increased the use of conservation tillage in some regions and reduced the number of cultivations during the growing season in most areas. This could lead to beneficial effects on water and air quality and the organisms that rely on these resources. In this section, we examine sugar beet production under the different alternatives on a national, regional, and local level, and the contribution to tillage and herbicide use in agriculture.

Biological resources

Changes in natural resources and in pesticide use can directly or indirectly affect biological resources. The direct and indirect effects on biological organisms is discussed extensively in sections III.C and IV.C. This section will discuss the cumulative effects of these changes on biological resources.

The analysis in this section will also consider the incremental contribution of H7-1 sugar beet use to the evolution of glyphosate-resistant weeds and their spread on a national, regional, and local level.

Sociocultural Resources

Changes in production practices associated with the adoption of H7-1 sugar beet have been directly associated with reduced management costs and reduced work hours. See sections III.D.1 and IV. D.1. In this section, APHIS analyzes the cumulative effects of each alternative on sociocultural resources.

Climate Change

Indirect effects of H7-1 sugar beet on climate change are discussed in section IV.E.3. Outside of these indirect effects, APHIS was unable to identify any cumulative effects related to the three alternatives proposed.

Human Health and Safety Impacts

Indirect effects of H7-1 sugar beet on human health are described in section IVF. Outside of these indirect effects, APHIS was unable to identify any cumulative effects related to the three alternatives proposed.

B. Local Level

For the purposes of this analysis APHIS is using county level divisions to define the local area. County level data is the smallest subset available from NASS. APHIS has used this county level data to identify the counties where sugar beet production represents at least 10% of the harvested crop acres. As described in the Assumptions (V.B.3) 10% was chosen as the threshold because the contributions to the effects on natural and biological resources from changes in cultivation practices associated with the adoption of Alternative 2 or 3 would not be measurably different than the baseline (Alternative 1) because the year to year variation in the application of these practices to other crops (corn, soy, wheat etc.) is greater than the total potential contribution from sugar beet.

To identify these counties APHIS used data on harvested sugar beet acres and harvested cropland in each county from the 2007 Census of Agriculture (USDA-NASS, 2007a), Of all of the counties that produce sugar beet for sugar in the U.S. only sixteen counties have 10% or more of the harvested cropland planted in sugar beet (Table 5-1). Adoption of H7-1 sugar beet could contribute to overall use of glyphosate-resistant crops and the increased use of glyphosate above the background variation in agricultural production in these 16 counties.

Table V-1. Counties with Ten Percent of Harvested Cropland in Sugar Beet Production

Sugar Beet Region	State	County	Percent harvested acres in sugar beet production
Great Lakes	Michigan	Huron	14%
Midwest t	Minnesota	Clay	12%
		Kittson	10%
		Norman	12%
		Polk	13%
		Chippewa	12%
		Wilkin	13%
	North Dakota	Pembina	14%
Great Plains	Montana	Treasure	14%
	Wyoming	Big Horn	10%
		Park	12%
		Washakie	16%
Northwest	Idaho	Cassia	11 %
		Minidoka	23%
		Elmore	11%
		Power	10%

In the 16 counties where sugar beet production exceeds 10% of the harvested cropland (see Table 5-1), APHIS examined the contribution of changing production practices in sugar beet to impacts associated with agricultural practices. Throughout this section APHIS will compare the use of H7-1 sugar beet (Alternatives 2-3) to the use of conventional varieties of beet (Alternative 1). The discussions are divided by county or groups of counties where appropriate. Changes in tillage practices have the potential to indirectly affect soil erosion, which in turn can affect air and water quality (See section III.E.2.a. of the affected environment and IV.E.2.a. of the environmental consequences sections). Besides tillage, pesticide uses can also affect air and water quality. Changes in water quality can affect aquatic organisms. Runoff of chemicals used in agriculture can also affect water resources. In section (IV.E.2. and

IV.E.4), APHIS analyzed the direct and indirect effects of the use of H7-1 sugar beet on soil and water resources. In this section we extend the analysis to consider the potential for H7-1 sugar beet to contribute incrementally to the cumulative impacts on these resources. Herbicide-resistant corn, soybean, cotton, alfalfa, and canola are commercially available. In areas with greater than 10% of the harvested farmland in sugar beet, cotton is not grown. Adopters of herbicide-resistant soybean are also adopters of conservation tillage. However, that correlation is not as strong for corn (NRC, 2010). Throughout this section we examine the impacts of agricultural practices on the resources in particular areas and the contribution of sugar beet production practices to those impacts. We examine the contribution to those impacts of both conventional sugar beet and H7-1 sugar beet.

1. Counties in the Great Lakes region

Only one county in MI, Huron County, has sugar beet production on more than 10% of its harvested cropland. Huron County's five major crops are corn, dry beans, wheat, sugar beet, and soy. In Huron county 445 farms or 32% of farms use conservation practices. Nationally the average is 23%. Therefore,the adoption of conservation practices in this county is higher than the national average. http://www.agcensus.usda.gov/Publications/2007/Full_Report/Volume_1,Chapter_2_County_Level/Michigan/st26_2_044_044.pdf Conservation practices are methods such as no-till or limited tilling, filtering runoff to remove chemicals, fencing animals from streams and other practices that reduce impacts on natural resources.

The adoption of H7-1 sugar beet under Alternatives 2 or 3 has the potential to increase the proportion of harvested cropland in herbicide-resistant crops from 1/4 to about 1/3 of the available acres when compared to baseline (Alternative 1). Increases in acres planted to herbicide-resistant crops are likely to be associated with the increased use of glyphosate, a decreased use in other herbicides, a reduction in cultivation to control weeds, and in this county a potential to increase to use of stale seed beds. These practices are consistent with those recommended by the NRCS to promote soil health. Therefore,when compared to the baseline (Alternative 1) Alternatives 2 and 3 are likely to result in the use of agronomic practices that promote soil health, reduce runoff, and reduce erosion which contributes to a reduction in the adverse incremental contributions of the baseline (Alternative 1) to agricultural soil loss and effects on water and biological resources associated with soil loss. It is unlikely that the selection of Alternative 2 or 3 would substantially change the number of farms that practice conservation methods, because the farms that grow sugar beet also grow other crops in which conservation practices are typically used. However, the proportion of the land using conservation practices on a given farm may increase because H7-1 sugar beet can be grown with low-till methods and less cultivation.

In this county, glyphosate-tolerant crops are expected to account for a large proportion of the herbicide-resistant crop acres, because glyphosate-resistant varieties are available for many of the crops grown in this county. H7-1 sugar beet is likely to incrementally contribute to an increase in glyphosate use in counties where sugar beet is a major crop, like Huron County. However, counties which previously had high adoption rates of herbicide-resistant crops, and/or where sugar beet is a minor crop, are unlikely to have measurable increases in glyphosate use with the adoption of H7-1 sugar beet. Clinton and St. Clair are examples of counties where the adoption of H7-1 sugar beet is unlikely to influence overall glyphosate use in the county. In these counties, glyphosate-resistant crops already account for 89 and 60 percent of the harvested acres under the no action alternative. H7-1 sugar beet would only increase the amount by 2 and 1%, respectively under Alternatives 2 and 3 when compared to Alternative 1. Therefore, when comparing the incremental contribution of each alternative to overall soil health, there is no change between the alternatives for these two counties. Counties, such as Arenac, Bay, Midland, Saginaw, Tuscola, Lapeer and Sanilac have intermediate adoption of herbicide-resistant crops; in these counties, between 5 and 10% of the harvested cropland is devoted to sugar beet production. In these areas, the adoption of H7-1 sugar beet may incrementally increase the amount of glyphosate used within these counties on harvested cropland. However, whether the changes exceed the normal fluctuations in glyphosate use will depend on other uses of glyphosate, including its use as a pre-emergent herbicide. Given the small amount of potential H7-1 sugar beet acres under Alternative 2 and 3, the incremental effects of sugar beet production practices on soil health is not different than the baseline (Alternative 1) in these counties.

Huron County is the only county in the Great Lakes Region that uses more than 10% of its harvested cropland for sugar beet production. It is surrounded on three sides by water. Agriculture is a major industry in Huron County. Because of its location, the impacts of agricultural practices on water quality and soil conservation are important considerations when choosing tillage methods. In Huron County the top five crops are corn, dry beans, wheat, sugar beet, and soybean. All of these crops can be grown in rotation using conservation tillage even without incorporating H7-1 sugar beet (Sanchez et al., 2001).

As discussed in section IV.C.3.c, 25% of the sugar beet acreage in MI was planted using stale seedbeds in 2010. These are beds that are cultivated in the fall but are not cultivated again in the spring at planting time. This is up from less than 5% three or four years earlier (Lilleboe, 2011). This transition is attributed to the use of H7-1 sugar beet. However, the extents to which no-till or other conservation tillage methods are employed are not well documented because such information is not typically collected in Michigan. If the use of H7-1 sugar beet increases the use of conservation tillage in crop rotations in this area, H7-1 sugar beet can contribute incrementally to improvements in the water quality of Lake Huron and Saginaw Bay. Saginaw Bay is part of the Michigan State Conservation Reserve Enhancement Program (Michigan State Conservation Reserve Enhancement Program, undated). One of the goals of this program is to decrease agricultural runoff into Saginaw Bay. Therefore,compared to Alternative 1, the no action alternative, Alternatives 2 and 3 would likely decrease the amount of cultivation in Huron County

Growers apply Triflusulfuron-methyl, phenmedipham, and desmedipham to more than 80% of the sugar beet acres in MI (see Appendix G). Clopyralid is applied to about 78% of the acreage. Clopyralid is also used on corn. Based on the NASS statistics, in Michigan about twice as much clopyralid is applied to corn as to sugar beet. Therefore, there could be a reduction of 25% of the clopyralid used in Michigan under Alternatives 2 and 3 compared to Alternative 1 and 90% of the triflusulfuron-methyl, phenmedipham , and desmedipham used. Glyphosate use would increase. Under Alternatives 2 and 3 when compared to Alternative 1. APHIS does not have data on existing glyphosate use per county and cannot predict the percentage increase expected. Glyphosate is used in other GE crops, nonGE crops, home and gardens, and on government lands for the control of weeds. Use on sugar beet is likely to increase about 7-fold (See Table 3-18), but this is not a reflection of the change in total glyphosate use in this county because it does not account for the other uses.

According to section IV.C., none of these herbicides have acute or chronic toxicity to mammals, birds or reptiles, amphibians or invertebrates. Laboratory studies suggest that desmedipham could be associated with eggshell cracking (U.S. EPA 1996b). Therefore,reduction in desmedipham use under Alternatives 2 or 3 could reduce the likelihood that birds are exposed to doses that affect eggshells as compared to Alternative 1.

The increased use of glyphosate under Alternatives 2 and 3, when compared to Alternative 1 could increase the exposure of animals (terrestrial and aquatic) to glyphosate. Glyphosate is not toxic to animals and so the differences in glyphosate use under Alternative 2 or3 when compared to Alternative 1 is not expected to cause any cumulative impacts to terrestrial or aquatic animal populations. In section IV.C.1 APHIS concluded that in rare cases, larval forms of amphibians could be exposed to concentrations of glyphosate formulations (containing surfactants) that may cause sublethal effects. These would be cases where glyphosate was sprayed prior to a storm and a shallow pool formed were an amphibian laid eggs. Because this event is rare, isolated, and not unique to any of the alternatives (glyphosate is used in many applications), APHIS has concluded that the adoption of Alternative 2 or 3 is no different than Alternative 1.

As discussed in section IV.C.1, soil erosion can result in turbidity and decreased dissolved oxygen concentrations in the water body, ultimately affecting fish and aquatic-phase amphibians by impairing growth, reproduction, development, and long-term survival. Also, soil erosion can result in the transport to surface waters of chemicals that are bound to soil particles. Compared to Alternative 1, these potential impacts would be reduced under Alternative 2 and 3 because the management practices used with H7-1 sugar beet are likely to result in less soil erosion and agricultural runoff.

Plants which grow in and around agricultural settings are affected by agricultural processes. Undesirable plants that grow within agricultural fields are considered weeds. Weeds are often the target of control. The wide adoption of glyphosate-resistant cropping systems has resulted in improved control of weeds within agricultural fields. However, with the reliance on this type of cropping system has also come the increase in glyphosate-resistant or tolerant weeds within these cropping systems. The potential contributions of H7-1 sugar beet to the selection for glyphosate-resistant or tolerant weeds are discussed extensively in section IV.C.3.

In areas, like Michigan, where glyphosate-resistant crops are used extensively, there is a concern that glyphosate-resistant weeds will develop within these cropping systems. Section IV.C.3 discusses the likelihood of development of glyphosate-resistant weeds in sugar beet production fields and the likelihood of dispersal of glyphosate-resistant weeds from other crops to sugar beet. Given the analysis in that section, H7-1 sugar beet could contribute to the selection of glyphosate-resistant weeds in agricultural systems in Huron County and the whole Great lakes regions, where glyphosate-resistant weeds have been identified in rotation crops. Cultural management (tillage) of sugar beet fields combined with application of non-glyphosate herbicides may control these weeds, so they may not persist as well in sugar beet fields as other rotation crops. However, if conservation tillage is adopted, alternative measures may be needed to control glyphosate-resistant weeds in H7-1 sugar beet fields and the rotation crops in which they are currently found. Under Alternative 2 and 3, H7-1 sugar beet might contribute incrementally to the persistence of glyphosate-resistant weeds in the seed bank (see section III.C.3.a.(4)), when compared to Alternative 1. However, Alternatives 2 and 3 may also contribute to the decrease in the weed seed bank of weeds resistant to other herbicides when compared to Alternative 1. Because glyphosate-resistant crops are widely adopted in Huron County, and Michigan as a whole, many of the weeds that are difficult to control in conventional beet fields (due to resistance to herbicides used on conventional beet) are controlled in corn and soy bean fields under all three alternatives.

In Huron County, the choice to use of tillage to control glyphosate-resistant weeds under Alternatives 2 and 3 may decrease the benefits associated with the use of stale seed beds in this area which would result in the impacts on soil health and the potential for erosion to be similar under all three alternatives.

Glyphosate use and herbicide-resistant weeds are discussed more extensively at the regional level (see section V.C.1).

2. Counties in the Midwest region

In the Midwest, six counties use greater than 10% of the harvested cropland for sugar beet and will experience at least a 10% increase in the use of herbicide-resistant crops from the adoption of H7-1 sugar beet. These counties include, Pembina, Polk, Norman, Clay, and Wilkin in the North and Chippewa in the South. In the South, herbicide-resistant crops are more prevalent because corn and soybeans are grown on a greater proportion of the harvested cropland acreage than in the other counties (USDA-NASS, 2009a). In Chippewa County the top five crops are corn for grain, soybeans for beans, sugar beet for sugar, vegetables harvested for sale, and dry edible beans, excluding lima. http://www.agcensus.usda.gov/Publications/2007/Online_Highlights/County_Profiles/Minnesota/cp27023.pdf In Chippewa County, 200—or 28%—of the farms used conservation practices according to the 2007 Census of Agriculture. Adoption of conservation practices in this county is higher than the national average.

Polk County, Minnesota is in the Red River Valley in the northwestern part of the State. The top five crops by acreage are wheat for grain, soybean for beans, sugar beet for sugar, corn for grain and dry edible beans, excluding lima (USDA-NASS, 2009a). Polk County produces more acres of sugar beet than any other county in the U.S.. In Polk County, 326—or 20%—of the farms used conservation practices. In this county use of conservation practices is below the national average.

Norman is just south of Polk County on the River Red River. The top five crops grown in this county are soybean for beans, wheat for grain, corn for grain, sugar beet for sugar, and sunflower seed http://www.agcensus.usda.gov/Publications/2007/Online_Highlights/County_Profiles/Minnesota/cp27107.pdf. In Norman County, 163—or 24%—of farms used conservation practices. In this county the use of conservation practices is at or slightly above the national average.

Clay county is south of Norman County. The top five crops by acreage are soybean for beans, wheat for grain, corn for grain, sugar beet for sugar, forage (land used for all hay and haylage, grass silage, and greenchop). http://www.agcensus.usda.gov/Publications/2007/Online_Highlights/County_Profiles/Minnesota/cp27027.pdf. 198 farms—or 21%—used conservation practice. http://www.agcensus.usda.gov/Publications/2007/Full_Report/Volume_1,_Chapter_2_County_Level/Minnesota/st27_2_044_044.pdf. In this county the use of conservation practices is below the national average.

Wilkin County is south of Clay County also on the Red River. The top five crops by acreage are soybean for beans, wheat for grain, corn for grain sugar beet for sugar, and forage (land used for all hay and haylage, grass silage, and greenchop) http://www.agcensus.usda.gov/Publications/2007/Online_Highlights/County_Profiles/Minnesota/cp27167.pdf. In this county, 126—or 29%—of farms used conservation practices. In this county the use of conservation practices is above the national average.

Pembina is located in Northeastern North Dakota on the Red River. In this county the top five crops by acreage are wheat for grain, dry edible bean, excluding lima, sugar beet for sugar, soybean for beans, and corn for grain http://www.agcensus.usda.gov/Publications/2007/Online_Highlights/County_Profiles/North_Dakota/cp38067.pdf. In Pembina, 65 farms—or 12.5%—used conservation practices (http://www.agcensus.usda.gov/Publications/2007/Full_Report/Volume_1,_Chapter_2_County_Level/North_Dakota/st38_2_044_044.pdf). In this county the use of conservation practices is well below the national average. The extent to which no-till and low-till practices are used in sugar beet in this region is not well documented. Discussions with growers in the Red River Valley indicate that the majority use conventional tillage because the soil is cold and wet. However, research on no-till and strip-till plots in this area indicate that there is no statistically significant difference in yield between the no-till, strip-till, and conventional tillage. http://www.sbreb.org/research/prod/prod11/TillageStudiesFargoRyan.pdf.

Given that low-till and no-till methods can result in lower input costs, it is reasonable to predict that in those counties where conservation practices are already adopted at a higher rate than the national average that growers may choose to use more low-till methods in sugar beet. The studies that indicate that there is no difference in yield use H7-1 sugar beet. Therefore,in Chippewa, Norman, and Wilkin counties, Alternative 2 and 3 may increase the use of conservation practices in sugar beet which can incrementally contribute to an increase in soil health when compared to Alternative 1. In remaining counties with greater than 10% sugar beet production, it is uncertain whether Alternatives 2 and 3 would contribute to an increase in conservation practices when compared to Alternative 1 because the adoption of conservation practices in these counties is lower than the national average. There may be factors other than the availability of herbicide-resistant crops that are influencing the adoption of conservation practices.

In those counties where no-till or low-till methods are adopted with the use of H7-1 sugar beet, Alternatives 2 and 3 can also result in an incremental decrease in the impacts of run-off on aquatic systems, soil erosion, and the effects of these processes on biological organisms when compared to Alternative 1.

In the Midwest, all of the counties that plant 10% or more of the harvested cropland to sugar beet fall within the Red River of the North basin (Minnesota Pollution Control Agency, undated) and (USGS, undated). Two thirds of the land in the MN portion of the Red River Basin is in cropland (Board, 2006). More than forty percent of the phosphorous and thirty percent of the nitrogen that eventually flows to Lake Winnipeg comes from the Red River, even though it only accounts for eleven percent of the flow. These nutrients contribute to algal blooms in the lake (Bruce Paakh et al., 2006). Cultivation practices can lead to sedimentation and runoff in this river basin (USGS, 2008). Available data on pesticides in surface water in the Red River of the North Basin predate the introduction of H7-1 sugar beet. (See (USGS Minnesota Water Science Center, 2008). In these studies pesticides were below EPA allowable levels.

Because nutrient runoff and sedimentation are problematic in the Red River of the North Basin, the potential for the adoption of conservation tillage with H7-1 sugar beet under Alternatives 2 and 3 could contribute incrementally to a decrease in agricultural runoff in this Basin. However, as described in section III.B.1.c.(2), conservation tillage has not been widely adopted in the Red River Valley, even with the adoption of H7-1 sugar beet. Ultimately, the potential benefits to water quality in this region would only be realized if H7-1 adopters convert to conservation tillage methods. Research is being conducted on applying methods of conservation tillage to sugar beet production in this region (Overstreet, 2011). However, unless growers adopt the practices on a large extent of the sugar beet acres in this region, there will be no measurable incremental difference with respect to sedimentation and water quality between the alternatives.

Clethodim, clopyralid, desmedipham and triflusulfuron-methyl are applied to more than 80% of the sugar beet acres in this region. Clopyralid is used on corn, oats, sugar beet, and wheat in this area. Adopting Alternatives 2 or 3 would result in a 20% reduction on clopyralid use when compared to

Alternative 1. Clethodim is used on sugar beet and soybean in this region. Adoption of Alternatives 2 or 3 would result in a 50% reduction in use when compared to Alternative 1. Desmedipham and trisulfuron-methyl use are expected to decrease by more than 10 fold. Glyphosate use would increase. APHIS does not have data on existing glyphosate use per county and cannot predict the percentage increase expected. Based on data from this region, APHIS expects that the amount of glyphosate used on sugar beet would increase 7 fold under Alternatives 2 and 3 when compared to Alternative 1. However, this increase does not represent the change in total glyphosate use. Glyphosate is used for other glyphosate-resistant crops as well as for other agricultural applications. It is also used on residential and public lands.

According to section IV.C., none of these herbicides have acute or chronic toxicity to mammals, birds or reptiles, amphibians or invertebrates. Laboratory studies suggest that desmedipham could be associated with eggshell cracking (U.S. EPA 1996b). Therefore,reduction in desmedipham use under Alternatives 2 or 3 could reduce the likelihood that birds are exposed to doses that affect eggshells as compared to Alternative 1.

The increased use of glyphosate under Alternatives 2 and 3, when compared to Alternative 1 could increase the exposure of animals (terrestrial and aquatic) to glyphosate. Glyphosate is not toxic to animals and so the differences in glyphosate use under Alternative 2 or3 when compared to Alternative 1 is not expected to cause any cumulative impacts to terrestrial or aquatic animal populations. In section IV.C.1, APHIS concluded that in rare cases, larval forms of amphibians could be exposed to concentrations of glyphosate formulations (containing surfactants) that may cause sublethal effects. These would be cases where glyphosate was sprayed prior to a storm and a shallow pool formed were an amphibian laid eggs. Because this event is rare, isolated, and not unique to any of the alternatives (glyphosate is used in many applications), APHIS has concluded that the adoption of Alternative 2 or 3 is no different than Alternative 1.

As discussed in section IV.C.1, soil erosion can result in turbidity and decreased dissolved oxygen concentrations in the water body, ultimately affecting fish and aquatic-phase amphibians by impairing growth, reproduction, development, and long-term survival. Also, soil erosion can result in the transport of chemicals that are bound to soil particles to surface waters. While conservation tillage is not widely used in sugar beet in this region, the opportunity to decrease cultivation during the growing season could contribute to less erosion or runoff. Decreasing cultivation not only causes less disturbance to the soil, but it can also result in less soil compaction because there are fewer tractor passes across the field during the growing season. Therefore, Alternatives 2 and 3 could have less soil erosion, soil compaction, and runoff than Alternative 1. The extent of this difference is determined by the cultivation practices that are adopted by growers in this area. As stated above, studies in this area on low-till and no-till sugar beet cultivation have shown no changes in yield between the different practices using H7-1 sugar beet. Therefore,in the future, more growers might adopt low-till or no-till practices because they can result in higher net returns. However, the also require upfront equipment costs, so there are many factors to growers consider that can influence adoption rates of low-till and no till practices.

Plants which grow in and around agricultural settings are affected by agricultural processes. Undesirable plants that grow within agricultural fields are considered weeds. Weeds are often the target of control. The wide adoption of glyphosate-resistant cropping systems has resulted in improved control of weeds within agricultural fields. However, with the reliance on this type of cropping system has also come the increase in glyphosate-resistant or tolerant weeds within these cropping systems. The potential contributions of H7-1 sugar beet to the selection for glyphosate-resistant or tolerant weeds are discussed extensively in section IV.C.3.

In areas, like Minnesota, where glyphosate-resistant crops are used extensively, there is a concern that glyphosate-resistant weeds will develop within these cropping systems. Section IV.C.3 discusses the likelihood of development of glyphosate-resistant weeds in sugar beet production fields and the likelihood of dispersal of glyphosate-resistant weeds from other crops to sugar beet. Given the analysis in that section, H7-1 sugar beet could contribute to the selection of glyphosate-resistant weeds in agricultural systems in the counties described in this section, where glyphosate-resistant weeds have been identified in rotation crops. Cultural management (tillage) of sugar beet fields combined with application of non-glyphosate herbicides may control these weeds, so they may not persist as well in sugar beet fields as other rotation crops. Under Alternative 2 and 3 H7-1 sugar beet might contribute incrementally to the persistence of glyphosate-resistant weeds in the seed bank (see section III.C.3.a.(4)), when compared to Alternative 1. However, Alternatives 2 and 3 may also contribute to the decrease in the weed seed bank of weeds resistant to other herbicide-resistant crops when compared to Alternative 1. Because glyphosate-resistant crops are widely adopted in the Midwest as a whole, many of the weeds that are difficult to control in conventional beet fields (due to resistance to herbicides used on conventional beet) are controlled in corn and soy bean fields under all three alternatives.

In these counties in the Midwest, the spread of glyphosate-resistant weeds could influence the choice to use of tillage to control glyphosate-resistant weeds in sugar beet under Alternatives 2 and 3 because tillage can be used to control some weeds. This choice would result in the impacts on soil health and the potential for erosion to be similar under all three alternatives.

Glyphosate use and herbicide-resistant weeds are discussed more extensively at the regional level (see section V.C.1).

3. Counties in the Great Plains region

Three counties, Park and Washakie, Wyoming and Treasure, Montana, have more than 10% of the harvested cropland planted to sugar beet and the potential for more than a 10% increase in the acreage planted to herbicide-resistant crops as the result of the adoption of H7-1 sugar beet. Park County Wyoming is located in the Northwest corner of Wyoming. In this county, livestock and the crops that feed livestock are the main agricultural industries. Of the farmland in the county less than 13% is used as cropland. Of this cropland, the top five crops by acreage are: forage (land used for all hay and haylage, grass silage, and greenchop), barley for grain, sugar beet for sugar, dry edible bean, excluding lima and field and grass seed crops. In Park County, 189 (24%) of the farms use conservation practices. http://www.agcensus.usda.gov/Publications/2007/Full_Report/Volume_1,_Chapter_2_County_Level/Wyoming/ This percentage is near or slightly above the national average. Park County is also home to federal lands managed by several different agencies including the U.S. Forest Service and the National Park Service.

Washakie County, located in north central Wyoming, also uses the majority of its agricultural land for livestock production. Less than 10% of the total farm acres are cropland. The top five crops by acre produced in Washakie County are forage (land used for all hay and haylage, grass silage, and greenchop), barley for grain, sugar beet for sugar, corn for grain and corn for silage. In Washakie County, 83 farms (39%) use conservation practices, well above the national average. In Washakie County, more than 70% of the land is State or Federal land. (http://www.washakiecounty.net/).

Treasure County, Montana, located in the south central part of the State has less than 8% of its total farmland in cropland. Livestock is the major agricultural industry in this area. The top five crops by acre are Forage – (land used for all hay and haylage, grass silage, and greenchop), wheat for grain, barley for grain, sugar beet for sugar, and corn for silage. In Treasure County, 32 farms (32%) use conservation practices, well above the national average.

In these counties, although sugar beet production is more than 10% of the harvested cropland, it is less than one percent of the total farmland in the area. Livestock production dominates this region. Therefore,impacts to soil, water, and air resources from agriculture will be driven by the practices used in livestock production. To the extent that the adoption of H7-1 sugar beet facilitates the use of no-till or low-till production methods it could, under Alternatives 2 and 3 contribute to an increase in soil health, a reduction in runoff, and a shift to glyphosate from other herbicides used on sugar beet when compared to the baseline. However, most of the land in these counties is not cropland. Because such a small about of the land is cropland (most land is forest, parkland, or pastureland), the percent of the cropland in sugar beet production is more than 10% of that acreage. Therefore,in the context of all land uses in the local (county) areas, improvements to soil health from changes in sugar beet production practices under Alternative 2 or 3 are not likely to be measurably different than soil health under Alternative 1. Because changes to water and air resources are related to production practices, there are also no incremental changes that in the context of the other land use activities in these counties that would contribute to adverse impacts on water or air when comparing Alternatives 2 and 3 to the baseline in Alternative 1.

Treasure County overlaps four watersheds, although most of the county is in the Lower Yellowstone-Sunday watershed and part of the Yellowstone basin. Big Horn, Park, and Washakie counties in Wyoming also are in the Yellowstone River Basin. According to a 1999 USGS report on the Yellowstone River Basin (USGS, 1999), agriculture, contributes to water quality issues. Within this region, grazing, mining, and other natural resource extraction also contribute to overall water quality impacts. Under Alternatives 2 and 3, changes in tillage practices associated with H7-1 sugar beet production may offer some incremental improvement in areas where agricultural runoff is impacting the local watershed. However, impacts from other anthropomorphic activities are negatively impacting the surface water, so the changes may not offer a significant improvement when compared to Alternative 1. As described above, the majority of the agricultural land in this county is in pasture. Row crop production is a minor land use in this county, so changes in production practices under Alternatives 2 and 3 that reduce runoff from sugar beet fields are not likely to result in measurable changes on water quality when compared to Alternative 1. Phenmedipham, desmedipham, and triflusulfuron-methyl which are used almost exclusively on conventional sugar beet are used on more than 80% of the sugar beet acres in this area. Clopyralid is also used on more than 80% of the sugar beet acres in this area. According to NASS (USDA-NASS, 2008) it is used on both barley and sugar beet in this area. Adopting Alternatives 2 or 3 could result in a 60% reduction in the amount of clopyralid used in this area when compared with Alternative 1. Phenmedipham, desmedipham, and triflusulfuron-methyl use are expected to decrease by over 10 fold while glyphosate use would increase. APHIS does not have data on existing glyphosate use per county and cannot predict the percentage increase expected. Glyphosate-resistant crops have not been widely adopted in these counties, because soybean and corn make up a much smaller percent of the cropland in these counties than in regions like the Midwest or Great Lakes Region. The types of crops that are grown in these counties are not available in GE herbicide-resistant varieties. Under all three alternatives, the amount of glyphosate-resistant alfalfa is expected to increase in these counties and other counties in this region. Use of glyphosate on GR alfalfa, other agriculture, and public lands all contribute to the overall glyphosate use in the area. Therefore,it is difficult to predict the overall change in glyphosate use in these counties.

According to section IV.C., none of these herbicides have acute or chronic toxicity to mammals, birds or reptiles, amphibians or invertebrates. Laboratory studies suggest that desmedipham could be associated with eggshell cracking (U.S. EPA 1996b). Therefore,reduction in desmedipham use under Alternatives 2 or 3 could reduce the likelihood that birds are exposed to doses that affect eggshells as compared to Alternative 1.

The increased use of glyphosate under Alternatives 2 and 3, when compared to Alternative 1 could increase the exposure of animals (terrestrial and aquatic) to glyphosate. Glyphosate is not toxic to animals and so the differences in glyphosate use under Alternative 2 or3 when compared to Alternative 1 is not expected to cause any cumulative impacts to terrestrial or aquatic animal populations. In section IV.C.1 APHIS concluded that in rare cases, larval forms of amphibians could be exposed to concentrations of glyphosate formulations (containing surfactants) that may cause sublethal effects. These would be cases where glyphosate was sprayed prior to a storm and a shallow pool formed were an amphibian laid eggs. Because this event is rare, isolated, and not unique to any of the alternatives (glyphosate is used in many applications) APHIS has concluded that the adoption of Alternative 2 or 3 is no different than Alternative 1 for this local area.

As discussed in section IV.C.1, soil erosion can result in turbidity and decreased dissolved oxygen concentrations in the water body, ultimately affecting fish and aquatic-phase amphibians by impairing growth, reproduction, development, and long-term survival. Also, soil erosion can result in the transport of chemicals that are bound to soil particles to surface waters. Because sugar beet is grown on such a small amount of land in these counties and the major contributors to water turbidity are grazing, mining, and other natural resource extraction, changes in sugar beet production practices that decrease erosion and runoff are not likely to be large enough to cause a change in the baseline condition of surface waters in these counties. Therefore, the cumulative impacts on water quality are the same under all three alternatives in these counties.

Plants which grow in and around agricultural settings are affected by agricultural processes. Undesirable plants that grow within agricultural fields are considered weeds. Weeds are often the target of control practices. The wide adoption of glyphosate-resistant cropping systems has resulted in improved control of weeds within agricultural fields. However, with the reliance on this type of cropping system has also come the increase in glyphosate-resistant or tolerant weeds within these cropping systems. The potential contributions of H7-1 sugar beet to the selection for glyphosate-resistant or tolerant weeds are discussed extensively in section IV.C.3.

Because glyphosate-resistant crops are not widely adopted in these counties, glyphosate-resistant weeds have not been identified in these counties of the Great Plains Region. In other counties in the region, however, glyphosate-resistant kochia has been identified (see section III.C.3). Kochia is a weed of wheat, barley, and sugar beet. In the counties discussed in this section, under all three alternatives, glyphosate-resistant weeds could occur in the future. If glyphosate-resistant weeds were to occur in these counties, tillage or herbicides other than glyphosate might be used to control these weeds. Because production practices in sugar beet are unlikely to have a measurable effect on soil health or water quality at the county level in these counties, changes in production practices associated with the future production practices are also not likely to incrementally effect these resources in these counties.

4. Counties in Northwest region

In the Northwest four counties produce sugar beet on more than 10% of the harvested cropland in the county. All of these counties are in Idaho. APHIS examined the potential for changes in production practices associated with the use of H7-1 sugar beet under Alternatives 2 and 3 to impact soil health, water and air resources. Indirect effects on biological resources are derived from the effects in the physical resources through agricultural wastewater runoff, soil erosion, or emissions from farm equipment.

Cassia County is in located in south central Idaho. More than half of the land in farms is in cropland. The top five crops by acres are wheat for grain, forage (land used for all hay and haylage, grass silage, and greenchop), vegetables harvested for sale, potatoes, and barley for grain. Sugar beet is not among the top five crops in the county. http://www.agcensus.usda.gov/Publications/2007/Online_Highlights/County_Profiles/Idaho/cp16031.pdf In Cassia, 128 farms (20%) are using conservation practices. http://www.agcensus.usda.gov/Publications/2007/Full_Report/Volume_1,_Chapter_2_County_Level/Idaho/st16_2_044_044.pdf. This percentage is below the national average.

Minidoka County lies to the north of Cassia County. In this county nearly 90% of the farmland is cropland. The top five crops by acre are sugar beet for sugar, wheat for grain, forage (land used for all hay and haylage, grass silage, and greenchop), barley for grain and vegetables harvested for sale. Minidoka is the top sugar beet producing county in the State. http://www.agcensus.usda.gov/Publications/2007/Online_Highlights/County_Profiles/Idaho/cp16067.pdf. In Minidoka, 113 farms (18%) use conservation practices. This percentage is below the national average.

Elmore is in southwest Idaho. About 35% of the farmland in this county is in cropland. The top five crops in this county by acres are Forage (land used for all hay and haylage, grass silage, and greenchop), sugar beet for sugar, wheat for grain, vegetables harvested for sale, and potato. http://www.agcensus.usda.gov/Publications/2007/Online_Highlights/County_Profiles/Idaho/cp16039.pdf. Eighty-four farms or 22% use conservation practices. This percentage is consistent with the national average.

Power County is located in southeastern Idaho. In this county 78% of the farmland is cropland. The top five crops by acre are wheat for grain, vegetables harvested for sale, potatoes, sugar beet for sugar and forage (land used for all hay and haylage, grass silage, and greenchop). Of the 336 farms 72 use conservation practices (21%). This percentage is below the national average for farms using conservation measures.

Sugar Beet Grower Magazine does have reports of people using strip-till in Idaho (http://www.sugarpub.com/5/post/2012/01/inexpensive-yet-effective-idaho-growers-modify-cultivator-to-meet-their-strip-till-implement-needs.html). John Schorr, Director of Agriculture at Amalgamated Sugar Company, informed APHIS that the number of growers using minimum tillage (strip till and no-till) increased from 0 to 17% with the introduction of H7-1 sugar beet and that 80-90% of growers using conventional tillage have reduced cultivations from 3-4 cultivations down to 1-2 (Schorr, 2012). Furthermore, based on interest expressed by growers, the amount of conservation practices used in sugar beet cultivation is expected to increase. Strip-till in this area can decrease soil erosion due to wind which also effects air quality. Therefore,Alternatives 2 and 3 have the potential to incrementally contribute to increased soil health, decrease erosion, and decrease particulate matter in the air when compared to Alternative 1 in these counties in Idaho. However, if strip-till is not widely adopted in sugar beet production in these counties, then the incremental contribution to soil health, erosion, and air quality will not be large enough to distinguish among the three alternatives.

Within Idaho, four counties, Cassia, Minidoka, Elmore, and Power use more than 10% of the harvested cropland for sugar beet production. Sugar beet in this area are grown in the Snake River Valley. According to the

"Envirowater mapper" website (http://watersgeo.epa.gov of the EPA, many of the streams in this area have issues with sedimentation. One of the primary causes of sedimentation is runoff, to which agriculture can contribute. According to the USGS,

> "Almost half of the stream segments in the study unit assessed for water-quality conditions by the Idaho Department of Health and Welfare were affected by nonpoint-source activities. The primary nonpoint-source activities are irrigated and non-irrigated agriculture, grazing, stream flow regulation from dams and diversions, and recreation. Primary point-source activities are agricultural-related industry, municipal wastewater-treatment facilities, mining related industry, and aquaculture. Water quality of lakes and reservoirs in the study unit is affected primarily by agricultural and aquacultural-related activities." (USGS, 2009)

The same report identifies the following specific water-quality issues:

- Elevated concentrations of sediments and nutrients, and the occurrence of low dissolved oxygen and elevated water temperature in surface water associated with agriculture, grazing, and aquaculture; the result is degraded water quality and impairment of beneficial uses of water in some tributary basins and along the Snake River.
- Potential ground-water contamination by nutrients and pesticides associated with agricultural activities in intensively irrigated areas; and
- Potential surface- and ground-water contamination by nutrients from recreational activities in the upper part of the study unit.

As was discussed in the affected environment section, adoption of conservation tillage within this region could be beneficial because.it would reduce erosion and runoff which reduces sediment and nutrient load on water ways. Growers have informed APHIS that they are adopting conservation tillage in the Northwest (Grant, 2010) (Schorr, 2012). If growers adopt conservation tillage practices in these counties Alternative 2 and 3 may result in an incremental increase in soil health, a reduction in erosion, and an improvement in water quality when compared to Alternative 1. The greatest potential for these improvements are in Minidoka County where sugar beet is the number one crop in the county and the overall amount of farmland in cropland is high within the county.

Idaho growers used a variety of pesticides prior to the adoption of H7-1. They used triflusulfuron-methyl, phenmedipham, ethofumesate, and desmedipham on 80% or more of the sugar beet acres. Ethofumesate is used on *Beta* species, carrots, and turf (U.S. EPA Undated-a), and it is expected to continue to be used on these crops under all three alternatives. The other three herbicides are used almost exclusively on conventional sugar beet (U.S. EPA 1996b), (U.S. EPA 2005e), (U.S. EPA 2002a). According to the 2007 Census of Agriculture (USDA-NASS, 2007a), carrots and turf are not major crops in these four counties. Therefore, almost all of the environmental exposure to these herbicides is from conventional sugar beet production. Under Alternatives 2 and 3, herbicide use of triflusulfuron-methyl, phenmedipham, ethofumesate, and desmedipham is expected to decrease by tenfold or more in these four Idaho counties compared to Alternative 1, but glyphosate use would increase when compared to Alternative 1. APHIS does not have data on existing glyphosate use per county and cannot predict the percentage increase expected. However, based on the use increase in the Midwest, it is likely to be similar at a 7-fold increase on sugar beet. Because glyphosate is used in other applications, including other agricultural uses and residential and public land uses, it is difficult to predict the overall change in glyphosate use in these three counties.

According to section IV.C., none of these herbicides have acute or chronic toxicity to mammals, birds or reptiles, amphibians or invertebrates. Laboratory studies suggest that desmedipham could be associated with eggshell cracking (U.S. EPA 1996b). Therefore,reduction in desmedipham use under Alternatives 2 or 3 could reduce the likelihood that birds are exposed to doses that affect eggshells as compared to Alternative 1.

The increased use of glyphosate under Alternatives 2 and 3, when compared to Alternative 1 could increase the exposure of animals (terrestrial and aquatic) to glyphosate. Glyphosate is not toxic to animals and so the differences in glyphosate use under Alternative 2 or 3 when compared to Alternative 1 is not expected to cause any cumulative impacts to terrestrial or aquatic animal populations. In section IV.C.1, APHIS concluded that in rare cases, larval forms of amphibians could be exposed to concentrations of glyphosate formulations (containing surfactants) that may cause sub-lethal effects. These would be cases where glyphosate was sprayed prior to a storm and a shallow pool formed were an amphibian laid eggs. Because this event is rare, isolated, and not unique to any of the alternatives (glyphosate is used in many applications) APHIS has concluded that the adoption of Alternative 2 or 3 is no different than Alternative 1 in this area.

In conventional beet fields, in this region, there is often poor weed control in sugar beet fields that can result in weeds blowing into neighboring farms. Most of the principal weeds of sugar beet, described in section III.B.1d, also are problematic weeds in other crops growing in the area. Thus, the spread of weed seeds from a field that has poor weed control has the potential to impact neighboring fields of unrelated crops.

Therefore,under Alternatives 2 and 3, area weed populations are expected to decrease when compared to Alternative 1.

Before the introduction of H7-1 sugar beet, growers had difficulty controlling weeds in their regions due to the selection of weeds with resistance to conventional herbicides such as ALS inhibitors, ACCase inhibitors, PSII inhibitors, synthetic auxins, mitosis inhibitors and fatty acid synthesis inhibitors. As evident in Table 3–9, glyphosate is much more effective than alternative herbicides in the control of the major sugar beet weeds and the concurrent use of glyphosate as a preferred herbicide have vastly improved the control of many weed species, including weeds that have been identified as having non-glyphosate herbicide-resistant biotypes. (See section 3B.1.d.(4) for a description of why glyphosate controls weeds more effectively than non-glyphosate herbicides).

In farm scale experiments with sugar beet, (Heard et al., 2003a; Heard et al., 2003b) weed biomass and seed rain (seeds deposited to the soil) were lower for Roundup Ready® crops compared to conventional crops. As adoption of H7-1 sugar beet has resulted in a decrease in weeds, the adoption of H7-1 sugar beet in Alternatives 2 and 3 is likely to incrementally contribute to a decrease in the seed banks for weeds resistant to several common herbicides. The control of weeds resistant to other herbicides within sugar beet fields decreases the likelihood that weed seed from these fields will spread to other agriculture production fields and reduce the resources needed for weed control in the neighboring fields. It also decreases the likelihood that weeds resistant to different herbicide (including glyphosate) will cross with uncontrolled weeds in sugar beet fields. Therefore,Alternatives 2 and 3 will decrease the likelihood that uncontrolled weeds in sugar beet fields will spread outside of those fields when compared to Alternative 1. Alternatives 2 and 3 will also decrease the available weed plants that may cross with weeds resistant to other herbicides, thus decreasing the likelihood that weeds with resistance to different herbicides will produce offspring that are resistant to more than one herbicide when compared to Alternative 1.

There may be a reduction in pesticide runoff as glyphosate replaces other herbicides under Alternatives 2 and 3 when compared to Alternative 1.

C. Regional Level

1. Introduction

In section V.B, APHIS considered the county level cumulative impacts of adopting Alternative 2 or Alternative 3 when compared to the baseline, Alternative 1 for counties that grow sugar beet on more than 10% of the harvested cropland in the county. From this local level analysis, APHIS concluded that Alternatives 2 and 3 have the potential to incrementally increase soil health, decrease erosion, and decrease runoff. These changes in turn could lead to incremental improvements to water and/or air quality which may reduce impacts to biological organisms in these counties when compared to Alternative 1. The relative contribution of Alternatives 2 and 3 to these improvements varied by the area in which the county is located. In those counties in the Great Plains Region, APHIS concluded that the changes would not be large enough to distinguish between the three alternatives. APHIS also concluded that the development and spread of glyphosate-resistant weeds would reduce the benefits of Alternatives 2 and 3 on natural resources. Depending on the production practices used to manage glyphosate-resistant weeds in sugar beet, the benefits to natural resources may disappear and the impacts of Alternatives 2 and 3 would be the same as Alternaive 1.

In this section APHIS examines the contribution of Alternatives 2 and 3 to the overall adoption of herbicide-resistant crops in each sugar beet growing region when compared to Alternative 1. APHIS also estimates the change in glyphosate use on glyphosate-resistant crops in each region to look at the relative contribution of Alternatives 2 and 3 to the selection and spread of glyphosate-resistant weeds in each region when compared to Alternative 1.

On a regional level, two sugar beet growing regions, the Midwest and the Great Lakes are near or exceed the national average for percent of harvested cropland planted to herbicide-resistant crops. Table 4-18 shows the weeds that have already been identified within or proximal to these regions. The past and present influences of glyphosate-resistant soybean and corn production in these areas has contributed to the distribution of glyphosate-resistant weeds on the landscape. In the near and midterm future, the adoption of resistance management practices in herbicide-resistant crops could reduce the spread of herbicide-resistant weeds. To the extent that the spatial distribution of herbicide-resistant crops influence the selection and spread of glyphosate-resistant weeds, these two growing regions are likely to experience the most glyphosate-resistant weed pressure of any of the sugar beet growing regions.

2. Regional adoption of herbicide-resistant crops

APHIS modeled the potential herbicide-resistant acres in each county that grows sugar beet within the sugar beet growing regions defined in the affected environment. Sugar beet is grown in five regions, described in Chapter IIIB.1c.1)
These regions include:

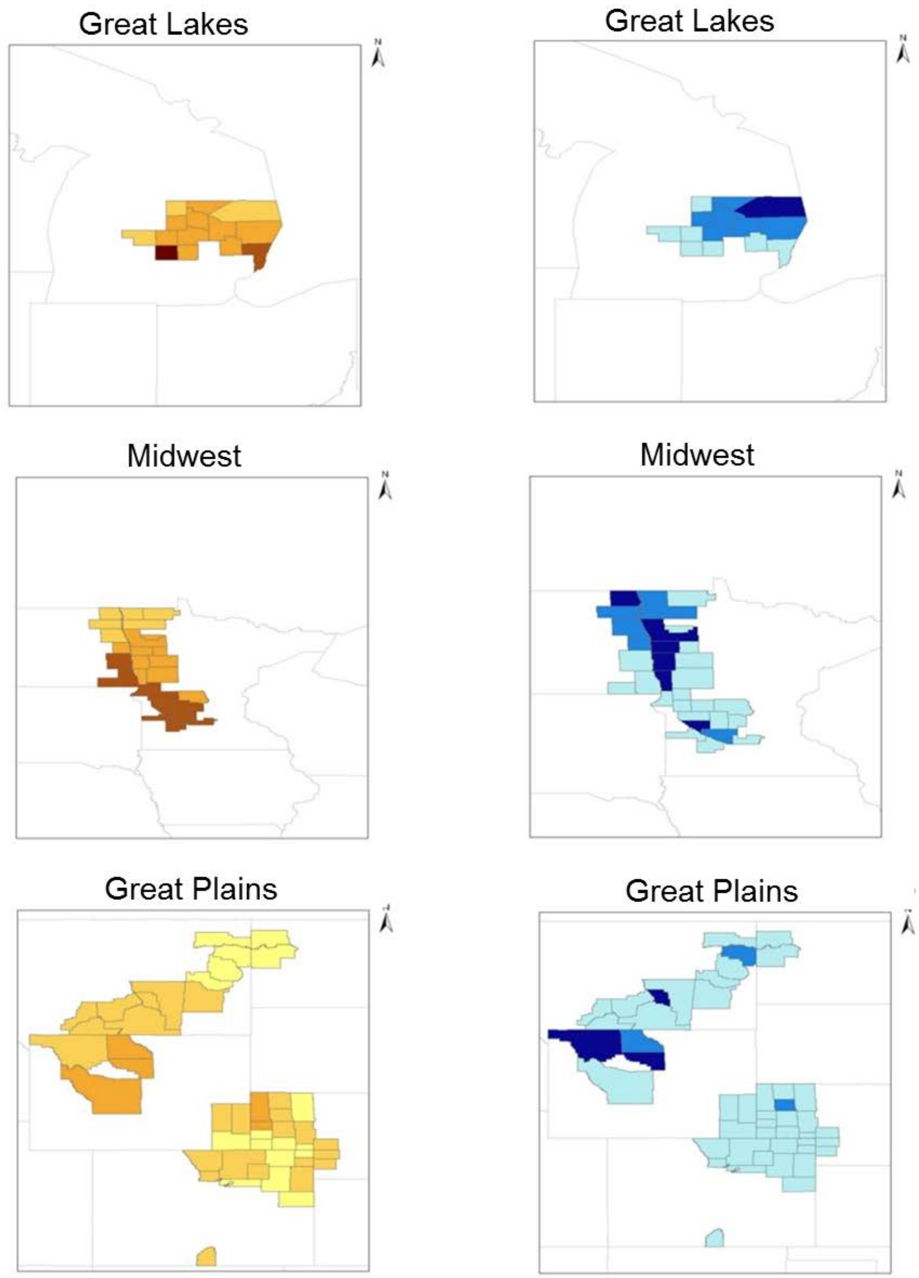
- Great Lakes – Michigan and Ontario
- Midwest– Minnesota and Eastern North Dakota

- Great Plains – Montana, Wyoming, Colorado, Nebraska, and Western North Dakota
- Northwest – Idaho, Oregon, and Washington
- Imperial Valley – California

To estimate the percent of harvested cropland in a county that will be potentially planted in herbicide-resistant crops, APHIS used county level crop data from the 2007 Census of Agriculture. APHIS chose this data because it represents the most current and complete data set at the county level for all of the crops grown in a given region. APHIS used State level adoption rates of herbicide crops (USDA-ERS, 2011a) for corn, cotton, and soy based on USDA surveys. APHIS used the 2007 rates in the ERS table to match the 2007 acreage data. Alfalfa adoption rates were obtained from USDA-APHIS (USDA-APHIS, 2010a) based on industry predictions from market research. APHIS used the industry projected year 10 regional adoption rates to define potential alfalfa adoption. In the short term this could overestimate the amount of herbicide-resistant alfalfa acreage planted. However, it provides a longer-term view of the potential herbicide-resistant acreage within a county. APHIS assumed that the adoption rate for both canola and sugar beet is 100%. APHIS chose this rate for canola because press accounts imply it is widely adopted (Pollack, 2010). APHIS chose 100% for sugar beet because H7-1 sugar beet adoption has approached 100% in all growing regions except California. APHIS chose to use harvested cropland because this is the type of cropland defined in the NASS survey that includes row crops and hay crops. It excludes pastureland and fallow land (USDA-NASS, 2009a).

APHIS examined the contribution of sugar beet to land used for harvested cropland in each region. APHIS considered only the acreage in counties that reported sugar beet production in the 2007 Census of Agriculture. APHIS did not consider total harvested cropland acreage in each State within a region because sugar beet root production is clustered within the State around processing plants. NASS reports data by county, so finer scale divisions are not possible based on the available data.

Potential HR crops including H7-1 | **Potential Increase in HR crops from H7-1**



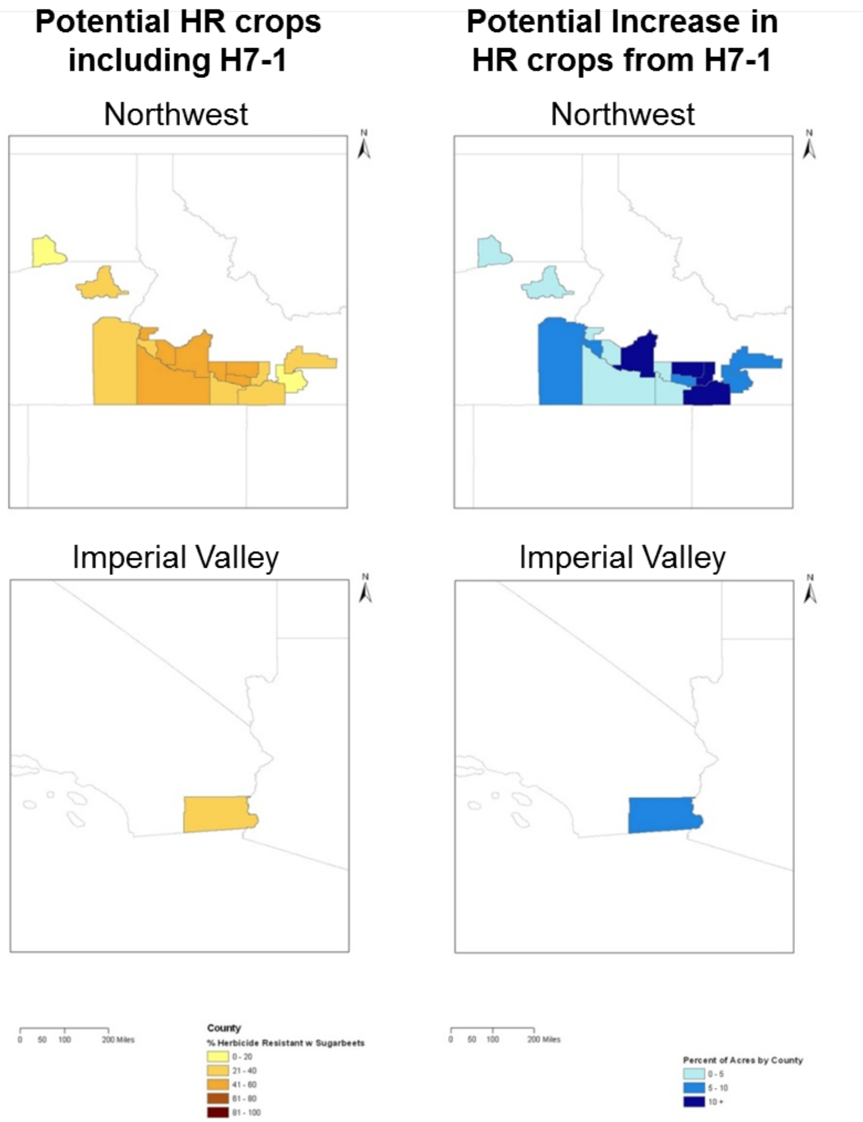


Figure 5-3 Percent of Harvested Cropland Planted to Herbicide-resistant Crops:

The percent of harvested cropland planted to herbicide-resistant crops was calculated for counties which grow sugar beet. Estimates include herbicide-resistant corn, cotton, soybean, canola, alfalfa, and sugar beet. The left panels show the estimated percent of herbicide-resistant acres planted by county. The right panels show the potential incremental increase in herbicide-resistant crops from the adoption of H7-1 sugar beet. The panels for California include an estimate of a 50% adoption rate of herbicide-resistant alfalfa in Imperial Valley based on industry projections, expected 10 years after deregulation of GE alfalfa (USDA-APHIS, 2010a). APHIS has been informed that, at this time, herbicide-resistant alfalfa has not been adopted in Imperial County by a consensus of growers and so APHIS may have overestimated the GE crops in the county.

3. Glyphosate use on glyphosate-resistant crops-regionally

APHIS examined the contribution of glyphosate use on H7-1 sugar beet to the total glyphosate used on GE herbicide-resistant crops in each region. Glyphosate is applied at different rates to each GE crop. For example, the average application rate on corn (0.96 lbs a.e./acre/year) is less than half that applied to sugar beet (2.21 lbs a.e./acre/year). Like at the local level, APHIS could not estimate the percent contribution of glyphosate use on total glyphosate use by region, because the distribution of use was not available at a regional level with the exception of use on sugar beet in the Midwest. The national level distribution of glyphosate use can be found in Table 5-7.

Because APHIS cannot determine the total amount of glyphosate used each year on conventional crops, public lands, or residential uses in each region, we cannot estimate the total change in glyphosate use under Alternative 2 or 3 when compared to Alternative 1 at the regional level.

APHIS predicts that the proportion of glyphosate used on conventional crops will be larger in those areas where corn, soy, or canola does not constitute a large portion of the harvested crop acres. For example, in the Great Plain Region where a large portion of the land is public land, the glyphosate used on public lands is likely to be higher than in the Midwest where there is far less public land. In the Great Plains, wheat and barley are grown on a higher percentage of the cropland than corn and soy. Glyphosate is often used on wheat pre-planting or post-harvest. These other agricultural uses make up a larger percentage of the overall glyphosate use than the use on GE crops in this region.

In 2009-2010 USDA NASS conducted a survey on use of agricultural chemicals on wheat, in a select group of program states (including some sugar beet growing states. http://www.nass.usda.gov/Data_and_Statistics/Pre-Defined_Queries/2009_Wheat_Chem_Usage/index.asp. The application rate is 0.97 lbs a.e./acre/year on winter wheat, 0.718 lbs a.e./acre/year on spring wheat, and 0.589 lbs a.e./acre/year on durum wheat. Based on these use rates and the acres of wheat produced in the Great Plains region (using numbers from the 2007 Census of Agriculture), we can estimate the amount of glyphosate used to be 2.6 million pounds. This is equal to the amount used on glyphosate-resistant crops in this region.

Based on this analysis, the adoption of H7-1 sugar beet is likely to increase the use of glyphosate in each of these regions. However glyphosate use on non-glyphosate crops is significant as shown in the illustration above where glyphosate use on wheat was as much as glyphosate use on all the GE crops in that region. APHIS was not able to calculate the contribution of sugar beet to the total glyphosate use in the area because total glyphosate use is not known.

Table V-2. Contribution of Glyphosate Use on H7-1 Sugar Beet to the Total Amount of Glyphosate Used on Glyphosate-resistant Crops by Sugar Beet Growing Region

In areas where glyphosate-resistant crops have not been widely adopted, sugar beet will contribute a larger change in glyphosate used on glyphosate-resistant crops than in those areas were GE glyphosate-resistant crops are already widely adopted. The total amount of glyphosate used on GE glyphosate-resistant crops in the Imperial Valley and the Northwest regions is less than those in the Great Lakes, Midwest, or Great Plains. With respect to the national level use of glyphosate on corn, cotton, soy, and canola, the amount of glyphosate used in sugar beet growing areas is a small proportion of the total use on these GE crops. For example, just 7% of the glyphosate used on corn is used on corn in the sugar beet growing area.

Regions	**Corn (lbs X1000)**	**Cotton (lbs X1000)**	**Soy (lbs X1000)**	**Canola (lbs X1000)**	**Sugar beet (lbs X1000)**	**Alfalfa[1] (lbs X1000)**	**Total glyphosate used on GE crops (lbs. X 1000)**	**Percent of the total glyphosate used on GE crop that is applied to sugar beet by region**
Great Lakes	449.7	0	786.5	0	327.1	199.2	1762.5	19%
Great Plains	852.1	0	16.6	46.2	287.7	1393.0	2595.6	11%
Midwest	2689.3	0	4744.0	49.4	1581.0	448.8	9512.5	17%
Northwest	152.0	0	0	.8	387.7	850.7	1391.2	28%
Imperial Valley	0.9	4.3	0	0.0	56.4	179.1[2]	240.7	23%
Total	**4144.0**	**4.3**	**5547.1**	**96.4**	**2640.0**	**3071.0**	**15502.8**	**17%**
Percent of the total glyphosate use on GE crop in sugar beet growing regions[1]	7%	0.03%	7%	6%	**100%**	**16%**		

1 Predicted amount of glyphosate that would be used on alfalfa if industry predicted adoption rates are met.

[2]APHIS conservatively assumed a 50% adoption rate of Roundup Ready® Alfalfa in Imperial Valley. Growers here have decided by consensus not to plant RRA at the present time. If they continue to chose not to plant RRA, the contribution of H7-1 sugar beet to glyphosate use in the Imperial Valley is predicted to increase from 23% to 92% while the percent of glyphosate used on alfalfa in sugar beet growing areas would decrease from 16% to about 15%.

[3]Total amount of glyphosate used on a crop in areas growing sugar beet divided by the total amount of glyphosate used on that crop from Table 5-7

With the benefits of adopting H7-1 or any other glyphosate-resistant crop come some adverse effects. These are also discussed extensively in section IV. Among these are the development and spread of glyphosate-resistant weeds. A recent CAST paper (Schwartz, 2012) discusses the impact of glyphosate-resistant weeds on conservation programs.

According to the report, conservation tillage practices in the Southeast in cotton areas where Palmer amaranth (*Amaranthus palmeri*) has become a problem have decreased and have been replaced by inversion tillage, which has been shown to control this weed. However, these practices also may expose fields to greater soil erosion or high grower input costs than a no-till system that uses exclusively glyphosate for weed control. Therefore, the development of glyphosate-resistant weeds can have an adverse effect on conservation programs run by the NRCS thereby adversely impacting soil resources, water, and air quality, as well as indirectly affecting biological resources, if run-off is impacting those resources. To the extent that H7-1 sugar beet incrementally contribute to the development or spread of glyphosate-resistant weeds, these sugar beet may indirectly incrementally contribute to alternative weed management practices. These weed management practices in sugar beet fields are discussed in section IV.C.3. Section IV.C.3 also discusses the relative likelihood that certain glyphosate-resistant weeds are to become problem weeds in sugar beet fields.

For H7-1 sugar beet to contribute incrementally to the past, present, and future actions that are driving the current trends in glyphosate-resistant weed development and spread, H7-1 sugar beet needs to be spatially associated with those actions. Good data is not available for the specific locations, density, or even distribution of glyphosate-resistant weeds. Therefore,APHIS could not conduct a simple geography-based correlation analysis.

Because glyphosate-resistant weeds that are associated with glyphosate-resistant crops are the weeds that would have the largest impact on shifts in tillage and herbicide use, APHIS examined the percent of the national glyphosate use on each glyphosate-resistant crop grown in sugar beet growing areas as a function of the glyphosate used on that glyphosate-resistant crop nationally. As can be seen from Table 5.2, only 0.03% of the glyphosate used on glyphosate-resistant cotton is used in areas where sugar beet is grown. Therefore,the contributions of glyphosate use on sugar beet to the regions that grow cotton crops do not spatially overlap. Therefore,any contribution of glyphosate use from the adoption of Alternative 2 will have no effect on the contributions of glyphosate use on cotton and its resulting effects. Nearly all (greater than 99%) of the glyphosate used on cotton occurs in areas where sugar beet is not grown. Alternatives 1 and 3 would not allow the overlap of sugar beet production and cotton production at all. So there is no potential for glyphosate use on sugar beet to contribute incrementally to weed problems in cotton under

Alternatives 1, 2, or 3. Therefore,there is no incremental contribution of the adoption of H7-1 sugar beet to effects associated with the adoption of glyphosate-resistant cotton varieties such as the development and spread of glyphosate-resistant Palmer amaranth (*Amaranthus palmeri*) throughout the Southeastern U.S.

For soybean, corn, and canola, just 6-7% of the glyphosate used on these crops occur in areas where sugar beet is grown. In other words, 93-94% of each of these crops is not grown in areas where sugar beet is produced. Furthermore, of the 6-7% of each of these crops that is grown in the same regions as sugar beet, only a small fraction of these crops are rotated with sugar beet. This is because the acreage of soybean and corn is much greater than sugar beet, so most land used for corn and soybean in the sugar beet regions is not actually ever used to grow sugar beet. Canola is not typically rotated to sugar beet (Table 3-6) because of disease concerns (GLCA, 2012). Because most corn, soy, and canola is not grown in the same areas as sugar beet production, H7-1 sugar beet cannot contribute to the issues associated with the development and spread of glyphosate-resistant weeds in the majority of the areas where these crops are grown. The converse is not true; the widespread distribution of GR corn and soybean and the use of these crops in rotation with sugar beet can contribute to the spread of GR weeds in sugar beet.

The overlap of alfalfa and sugar beet is higher than the other crops at a potential for 16% of the glyphosate used on GE alfalfa to be used in the sugar beet growing regions. However, most of the glyphosate used on alfalfa (84%), would be on alfalfa planted in an area that does not grow sugar beet. In the majority of the areas planting alfalfa, the incremental increase in the use of glyphosate and the potential adverse impacts as the result of adopting H7-1 sugar beet under Alternative 2 would not occur because the two crops do not overlap in the majority of the range where glyphosate-resistant alfalfa is likely to be adopted. For alfalfa, the amount of glyphosate use is based on predicted adoption rates of alfalfa over the next decade and may not reflect the ultimate distribution of the crop. Greater or fewer acres of alfalfa and H7-1 sugar beet may ultimately be regionally co-localized. In regions where the two crops are co-localized, the adoption of H7-1 sugar beet under Alternative 2 or 3 may result in H7-1 sugar beet incrementally contributing to an increase in glyphosate use and the adverse and beneficial impacts associated with increased glyphosate use.

APHIS also considered the overall contribution of H7-1 sugar beet to the adoption of herbicide-resistant cropping systems at a regional level. Herbicide-resistant cropping systems are associated with the use of less tillage (NRC, 2010). A decrease in tillage is associated with less erosion and less fossil fuel use, both of which have benefits to air and water quality. It has also been suggested that heavy reliance on a single herbicide, often associated with herbicide-resistant crops can contribute to the development of herbicide-resistant weeds (NRC, 2010).

Herbicide-resistant crops facilitate farmer's use of conservation tillage practices and reduce the number of herbicides they apply to their crops. APHIS examined the past and present impacts of agricultural systems on resources within these areas and considered the trends for the impacts of future actions on these resources. In addition, APHIS considered the influence of herbicide-resistant crops on these resources and how the inclusion of H7-1 sugar beet in these agricultural systems cumulatively contributes to these impacts.

Herbicide-resistant crops such as corn, soy, canola, sugar beet and, more recently, alfalfa, have been adopted across the U.S.. The level of adoption of herbicide-resistant crops, however, has not been uniform across or within regions primarily because herbicide-resistant varieties have not been developed for the principal crops grown in certain regions, particularly the Western States. As a result, in certain regions, H7-1 sugar beet may be the only herbicide-resistant crop grown in the area, while in others, H7-1 sugar beet will represent a very small percentage of the herbicide-resistant crops grown in the area.

4. Cumulative effects at a regional level

a. Great Lakes Region

Within the Great Lakes Region, Michigan is the only sugar beet producing State in the United States; data was not analyzed for Ontario, Canada. In Michigan, there are nineteen (19) counties that reported sugar beet production in the 2007 Census. Of those, NASS did not report specific acreage on five (5) counties because there were too few farms in these counties that raise the crop to maintain anonymity of the growers if the data were disclosed. These counties do not contribute much acreage to the total and APHIS excluded these counties from the regional analysis. In those areas where sugar beet is cultivated and data is reported, sugar beet production accounts for approximately 5.7% of the harvested cropland. Within these same counties, soybean, corn, and alfalfa account for about 71% of the harvested cropland[40]. Glyphosate-resistant varieties of each of these crops are commercially available. Based on published adoption rates, APHIS estimates that approximately 41% of the harvest cropland in this region has the potential to be planted in glyphosate-resistant crops (other than sugar beet) under Alternative 1 and 46.7% of the harvested cropland acreage has the potential to be planted in glyphosate-resistant

[40] The majority of this acreage is corn and soybeans (63%).

crops (including sugar beet) under Alternatives 2 and 3. Over the past decade the adoption of glyphosate-resistant crops in this region has been considerable (Fig. 5-4). Based on adoption rates it is expected that percent of acres devoted to herbicide-resistant corn varieties may continue to increase, but the percent of acres planted to herbicide-resistant soybean is likely to remain about the same (Fig. 5-4). Currently, the adoption rate for herbicide-resistant crops measured as a percent of harvested cropland is below that of the national average. The addition of H7-1 sugar beet to this area does not raise the adoption rate above the national average. In the mid to long term it is likely that the percent of harvested cropland planted to herbicide-resistant crops will reach the national average because the rate of adoption of herbicide-resistant corn appears to be increasing. What is not certain is if all of the acres planted to herbicide-resistant crops will be resistant to a single herbicide or if a portion of those acres will be planted in crops resistant to different herbicides. For example, growers may choose to plant Liberty Link® soy or corn as a part of their rotation. Liberty Link® crops are resistant to the herbicide, glufosinate.

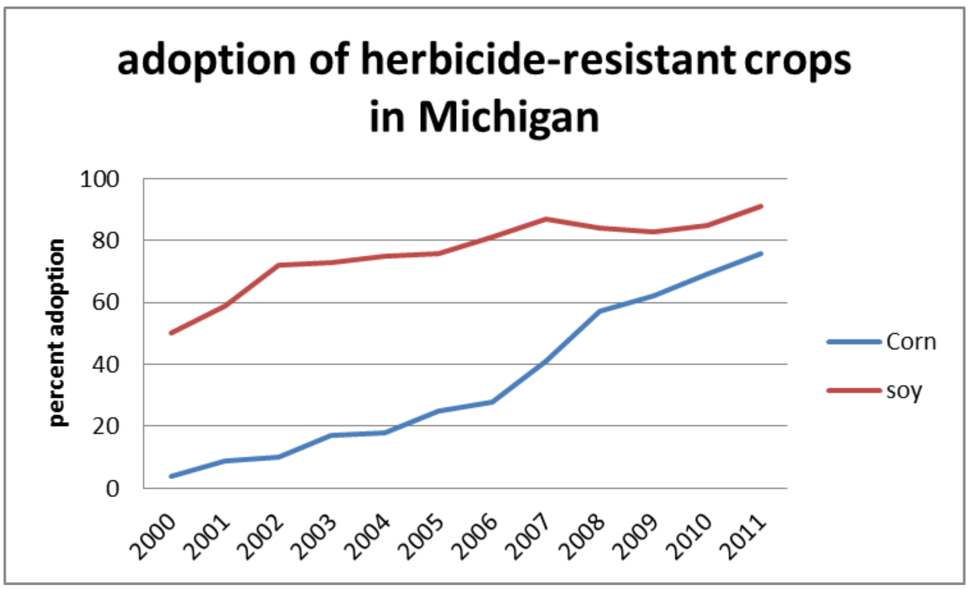


Figure 5- 4 Adoption Rate of Herbicide-resistant crops in The Great Lakes Region.

ERS reports the trend in the adoption of herbicide-resistant crops (both stacked with insect resistance and herbicide or insect resistance alone) by State. It appears that the trend in adoption of herbicide-resistant soybean in this region has leveled off but the adoption rate of corn continues to rise.

Within this region the adoption of Alternative 2 or 3 is likely to result in 19% of the total glyphosate use on herbicide-resistant crops to be used on sugar beet (See Table 5-2). This is 327,100 lbs more than under Alternative 1. Therefore,on a regional level, H7-1 sugar beet may contribute incrementally to overall glyphosate use and the adverse impacts that may result from its use, such as the selection and spread of glyphosate-resistant weeds.

As discussed in section III.B.1.c and IV.B.1, it is possible in this region for sugar beet to be incorporated into a three crop rotation that includes glyphosate-resistant soy, corn and sugar beet. Approximately 34% of Michigan sugar beet growers used a three crop rotation. Another 41% used a four-year rotation and 24% used a five year rotation, where non-glyphosate-resistant crops were included in the four and five year rotations (Company, 2012). APHIS does not have data on what percentage of the growers using a three crop rotation only grew glyphosate-resistant crops.

Glyphosate-resistant horseweed has been identified in Michigan in both soy and sugar beet (See Table 4-18). Under conventional tillage horseweed is not identified as a problem weed in sugar beet. In Michigan there has been a trend to plant sugar beet in stale seed beds where cultivation occurs in the fall but is not used in the spring prior to planting. GR horseweed could alter the trend in this practice; either an alternative herbicide would be used as a preplant burndown or spring cultivation may become more common place (Sprague, 2011).). If enough growers choose to cultivate again in the spring, then the benefits associated with the reduction in tillage under Alternative 2 or 3 would be lost and the impacts would be the same under all three alternatives. Horseweed would continue to be a problem in soybean fields and conventional tillage would be used for sugar beet. Common waterhemp, is also identified in Table 4-18 as a potential future glyphosate-resistant weed that could impact the Great Lakes region. It is a tier 3 weed, meaning that it is not presently identified as a glyphosate-resistant weed in that region, but glyphosate-resistant biotypes have been selected elsewhere and there are populations in the neighboring State of Indiana that could disperse into Michigan. The addition of H7-1 sugar beet to the crop rotation of glyphosate-resistant soy and corn in this region could incrementally contribute to the establishment and spread of glyphosate-resistant waterhemp in this region as compared to Alternative 1 by increasing the total number of acres under selection with glyphosate. However, under Alternative 1 there is still 41% of the harvested cropland potentially planted to herbicide-resistant crops. If the majority of these acres are planted in glyphosate-resistant crops, then selection and spread of common waterhemp is almost as likely to occur under Alternative 1 as under Alternatives 2 and 3. Under all three alternatives, if growers adopt proactive best management practices, the establishment of glyphosate-resistant biotypes in this region may be prevented or delayed.

b. Midwest Region

Within the Midwestern Region, seven (7) counties in North Dakota report sugar beet production in the 2007 Census of Agriculture. Of these, NASS reports specific acreage on six (6) counties (USDA-NASS, 2007a). In

Minnesota there are thirty-one (31) counties that report sugar beet production; of these NASS provides specific acreage data for twenty-four (24) counties (USDA-NASS, 2007a). In this region there is almost 12.5 million acres of harvested cropland (USDA-NASS, 2007a). Of those acres, 715,000 are planted in sugar beet. This represents 5.7% of the total harvested cropland. In this same region, corn, canola, soybeans, and alfalfa are grown on about 65% of the harvested cropland acres. APHIS calculated the percent of the harvested acres that are likely to be planted in glyphosate-resistant crops using published adoption rates. Under Alternative 1 (without sugar beet) there is the potential for 48% of the acres to be planted in glyphosate-resistant crops. This increases to 53.7% under Alternatives 2 and 3. The Midwest has above average adoption of herbicide-resistant crops as a function of harvested cropland. The trend of continued increase in the adoption of herbicide-resistant corn suggests that the percent acres in herbicide-resistant crops are likely to increase for the next several years under all three alternatives (Fig. 5-5).

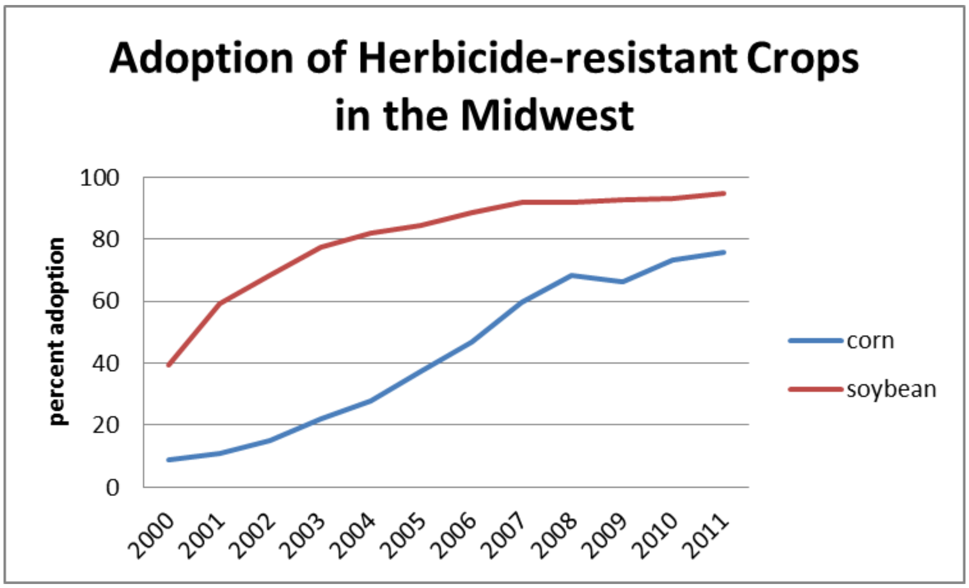


Figure 5-5 Adoption of Herbicide-resistant Crops in the Midwest:

Corn and soybean are the predominant herbicide-resistant crops grown in the Midwest Region. Soybean adoption rates have remained consistent for the last five years but corn adoption rates continue to rise.(USDA-NASS, 2007a)

In the Midwest, glyphosate-resistant common waterhemp has already been observed in corn, soybean and sugar beet fields in MN and ND (Table 3-26, 4-18) (Heap, 2012; Stachler and Christoffers, 2012). Glyphosate-resistant giant ragweed (MN) and common ragweed (MN/ND) are present in soybean fields (Heap, 2012). GR kochia has recently been reported in cropland in North Dakota (Hildebrant, 2011).

Table 3-25 lists the weeds that have acquired resistance to herbicides that are weeds of sugar beet. In this region, common ragweed, giant ragweed, common waterhemp, and kochia have been identified to be resistant to glyphosate. In addition, biotypes of these weeds are also resistant to other herbicides (See Table 3-25). Extension agents in this region have collected data on the development of herbicide-resistant weeds (http://www.ag.ndsu.edu/weeds/sugarbeet-files/ResistanceMap.pdf) When comparing the counties with confirmed and suspected glyphosate-resistant weeds (Table 5-3) to the counties with the highest glyphosate-resistant crop adoption rates (Fig. 5-3), there appears to be a correlation. . Under the no action alternative, the prevalence of glyphosate-resistant weeds and weeds resistant to other herbicides is likely to continue because they are already present in the area and have spread under the agronomic practices used in the region. The adoption of glyphosate-resistant crops, combined with a reliance on glyphosate for weed control, has contributed to the selection of weeds with resistant biotypes (Schwartz, 2012).

Table V-3. Counties with Confirmed or Suspected Glyphosate-resistant Weeds

State	County	Confirmed or suspect glyphosate-resistant weed[1]	%HR crops
ND	CASS	Y	59
ND	TRAILL	Y	50
ND	GRAND FORKS	N	25
ND	PEMBINA	N	17
ND	WALSH	N	15
ND	WILLIAMS	N	4
ND	RICHLAND	Y	60
ND	SARGENT	N	60
ND	MCKENZIE	N	9
MN	KANDIYOHI	Y	64
MN	MEEKER	Y	68
MN	RENVILLE	Y	60
MN	SIBLEY	Y	67
MN	STEARNS	Y	57
MN	BECKER	Y	48
MN	CLAY	Y	5
MN	KITTSON	N	28
MN	MAHNOMEN	N	54
MN	MARSHALL	N	31
MN	NORMAN	Y	42
MN	POLK	Y	31
MN	RED LAKE	Y	43

MN	ROSEAU	N	32
MN	REDWOOD	Y	71
MN	CHIPPEWA	Y	58
MN	GRANT	Y	61
MN	OTTER TAIL	Y	50
MN	POPE	N	64
MN	STEVENS	Y	66
MN	SWIFT	Y	66
MN	TRAVERSE	Y	66
MN	WILKIN	Y	43
MN	YELLOW MEDICINE	Y	70

[1] based on http://www.ag.ndsu.edu/weeds/sugarbeet-files/ResistanceMap.pdf

Under Alternatives 2 and 3, the counties with the largest change in the acreage dedicated to herbicide-resistant crops will likely have greater increased selection for glyphosate-resistant weeds than those counties with little change in the acreage dedicated to herbicide-resistant crops when compared to Alternative 1. Therefore,in this region the adoption of Alternatives 2 or 3 would result in an incremental increase in the selection of glyphosate-resistant weeds when compared to Alternative 1.

Because glyphosate-resistant weeds are found in crops other than sugar beet, and those crops are grown on more acres than sugar beet, the adoption of Alternative 1 alone will not change the trend toward spreading glyphosate-resistant weeds in this region. Proactive weed management programs have been developed which use alternative herbicides to prevent the selection and spread of these weeds. Reactive management strategies are being adopted by growers who have identified resistant weeds in their fields. Under all three alternatives resistance management programs can be adopted by growers to control the spread of resistant biotypes.

This region, which produces 55% of the sugar beet grown in the U.S., collects yearly data on pesticide use in sugar beet from growers. In 2008, about half of the sugar beet grown in this region was H7-1. In 2010, H7-1 had risen to 93%. In 2011, H7-1 production declined to 89.5%. This reduction was driven in part by the uncertainty of the availability of H7-1 beet seed. Of the acres planted in H7-1 sugar beet in 2011, 71% were treated with only glyphosate (Stachler, 2012). The remaining 29% were treated with glyphosate as well as other herbicides. Table 5-4 indicates the other herbicides used and the amounts used on H7-1 sugar beet in the past four years.

Table V-4. Recent Trends in Herbicide Active Ingredients Use on H7-1 Sugar Beet Fields in the Midwest

Herbicide Active Ingredient	2008 Lbs. a.i.	2009 Lbs. a.i	2010 Lbs. a.i	2011 Lbs. a.i
clethodim	0	5,516	122	5,788
clopyralid	585	856	61	3039
dimethenamid-p	12,223	0	1,275	0
ethofumesate (pre)	0	0	4894	26015
glyphosate	737,279	1,345,115	1,547,527	1,676,268
metolachlor	0	3788	1827	0
quizalofop	0	111	54	286
sethoxydim	0	0	391	0
trifluralin	0	0	978	0
Total sugar beet acreage	637,564	676,345	652,552	693,740
% H7-1 sugar beet	49	88	93	89.5
H7-1 sugar beet acreage	312,406	595,184	606,873	620,840
Source: (Stachler et al., 2008; Stachler et al., 2009b; Stachler et al., 2011; Stachler et al., 2012a)				

Table V-5. Data from Table 5-4 Calculated on a Per Acre Basis (lbs a.i. applied/acre x 10^3)

Herbicide Active Ingredient	2008	2009	2010	2011
clethodim	0	9.3	0.2	9.3
clopyralid	1.9	1.4	0.1	4.9
dimethenamid-p	39.1	0	2.1	0.0
ethofumesate (pre)	0	0	8.1	41.9
glyphosate	2,360	2,260	2,550	2700.0
metolachlor	0	6.4	3.0	0.0
quizalofop	0	0.2	0.1	0.5
sethoxydim	0	0	0.6	0.0
trifluralin	0	0	1.6	0.0

For most of the herbicides there are no clear trends. Ethofumesate, a residual preplant incorporated herbicide increased significantly in the past two years. Glyphosate use decreased 4% from 2008 to 2009 but then increased by 12.8% from 2009 to 2010 and by 5.9% from 2010 to 2011. The increased use of glyphosate and ethofumesate may be the result of an adaptation of the weed management strategy to cope with weed shifts to glyphosate-tolerant and resistant species. However the changes in herbicide use may also be in response to differences in weed pressure caused by changes in the weather between different years.

Under Alternative 1, herbicide use on sugar beet is expected to be similar to that used on conventional sugar beet during the most recent growing seasons. This herbicide use pattern would not change the trend of selection for glyphosate-resistant weeds in the Midwest Region because the trend is being driven by herbicide use patterns on other crops. It would contribute to the selection for weeds resistant to herbicides other than glyphosate in sugar beet fields because many of these herbicides are used only on sugar beet and have been used on sugar beet for more than a decade (see section III.B.1). Increasing the weed seed bank for these weeds, coupled with the selection of sexually compatible weeds that are glyphosate-resistant would increase the likelihood of multiple resistant biotypes of weeds like ragweed and kochia. This would occur if cross-pollination were to occur between different biotypes of a weed. If the biotypes are in the same area and are not being controlled, crossing can occur. Under Alternatives 2 and 3, H7-1 sugar beet could contribute to an incremental increase in the selective pressure applied to glyphosate-resistant biotypes of weeds. However, the use of this sugar beet may also contribute to a decrease in the weed seed bank for biotypes resistant to other herbicide modes of action because it allows for an additional management tool to be used on these weeds in sugar beet fields. By decreasing the overall population of weeds resistant to various herbicide modes of action, these two alternatives can contribute incrementally to a decrease in selection for weeds resistant to multiple herbicides.

It is important to note under all three alternatives, the choice of management practices of growers in the region will have the most influence on the selection and spread of herbicide-resistant weeds, whether the weeds are resistant to a single chemistry or multiple chemistries.

Indirect effects of H7-1 sugar beet on socioeconomic issues such as the U.S. sugar and sugar beet markets, the sugar beet seed market, the organic and conventional sugar beet and sugar markets, and vegetable beet markets are described in section IV.D.

Based on public comment on the DEIS, APHIS is including a discussion of the cumulative impacts of glyphosate-resistant weed management in glyphostate resistant crops and the potential for H7-1 to incrementally increase that cost in this section. The analysis could apply to other regions as well, however, the Midwest is the only region that has currently identified glyphosate-resistant weeds in sugar beet production.

5. Production costs from glyphosate-resistant weeds

Glyphosate-resistant soybeans were the first herbicide-resistant crop to be widely adopted by growers. The adoption of herbicide-resistant soybeans has exceeded 90% of the total soybean acres planted in the U.S. Corn adoption rates are lower, at about 70% across the country. Herbicide-resistant cotton peaked in 2010 at 78% and in 2011 was about 73%. (USDA-ERS, 2011a). About 95% of growers have adopted herbicide-resistant sugar beet in 2009 and 2010 while the adoption rate in 2011 was down to about 92% nationwide (Schwartz, 2012). Herbicide-resistant canola has also been adopted at levels above 90%. The adoption rate of herbicide-resistant alfalfa is not known, but the developer predicts that the adoption will be about 50% 10 years after introduction. Given these adoption rates and the number of grower comments received on the draft EIS supporting the use of the technology, it is likely that the use of herbicide-resistant crops will continue in American agriculture well into the future.

In the public comments received on the DEIS, growers cite the ease of use and lower costs of herbicides associated with the use of GE crops as reasons for their adoption. In one survey, about two thirds of the growers used only glyphosate-resistant crops either as a continuous crop or a two glyphosate crop rotation (Wilson et al., 2011). While the survey only overlapped sugar beet growing areas in one State, from a national perspective, the heavy reliance on glyphosate as the sole means of weed control appears to be a common practice amongst growers of glyphosate-resistant crops.

The long-term use of herbicide-resistant crops will depend in part on the long-term effectiveness of these crop systems for managing weeds. One thing that can reduce the effectiveness is the development and spread of weeds resistant to the herbicide to which to crop is resistant. Glyphosate-resistant crops are the most widely adopted types of herbicide-resistant crop and the development of glyphosate-resistant weeds has been documented.

Glyphosate-resistant weeds in herbicide-resistant crop fields were first identified in soybean fields in 2000 (Beckie, 2011VanGessel, 2001 #1792). In these fields, growers continuously cultivated glyphosate-resistant soybeans using glyphosate as the sole form of weed control. Section III.C.3 discussed the history of glyphosate-resistant weed development.

The identification of glyphosate-resistant weeds did not result in growers reverting to conventional soybeans in this case They instead altered their management practices (Scott and VanGessel, 2007). Glyphosate is still effective on most of the weeds in the field, but to manage those weeds that are resistant to glyphosate other practices need to be employed.

According to a survey of Delaware soybean growers, producers chose to apply an herbicide with a different mode of action before planting, increased the frequency of glyphosate applications, or used tillage before planting to manage glyphosate-resistant weeds. Some 76 percent of growers estimated that resistance in horseweed increased their management costs by more than $2.02/acre, and 28 percent reported cost increases of over $8.09/acre (Scott and VanGessel, 2007). Similarly, a survey of 400 corn, soybean, and cotton producers in 17 states found that most would not limit the use of glyphosate-resistant crops when facing problematic glyphosate-resistant weeds (Foresman and Glasgow, 2008). Instead, producers planned to increase the rotation of herbicides, the use of tank-mixes, or the amount of tillage. They expected that additional measures for the control of glyphosate-resistant weeds would cost $13.90–16.30/acre (Foresman and Glasgow, 2008).

A benchmark study on the costs associated with weed management in glyphosate-resistant corn, soy, and cotton showed that the costs associated with the management recommendations of academic weed scientists were higher than the costs incurred by growers from $24.92-14.31/ha ($10.08-5.79/acre). However, there was no significant difference between the net returns under the two recommendations (Weirich et al., 2011b). This study implies that following the academic recommendations will not cost more when one considers the net return and over the long term may delay resistant weeds from becoming a problem in growers fields. However, it also illustrated that growers, in spending less on their treatments than the academic weed scientists treatments, are not using the same treatments as those recommended by the weed scientists.

As stated in Weirich (2011a) "When a grower selects a production practice, the decisive factor is usually the impact on net returns instead of which best management practice (BMP) may be optimal from a weed management perspective."

In an economic analysis of weed-management costs with a hypothetical reduction of control with glyphosate in three regions of the United States, the projected cost of new resistance management practices for horseweed was $12.33/acre in a cotton–soybean–corn rotation in western Tennessee (Mueller et al., 2005). Additional costs were due to a shift from no-till to conventional tillage for cotton and the need for new preplant herbicides for soybean. The projected cost of new herbicide resistance-management practices for waterhemp was $17.91/acre in a corn–soybean rotation in southern Illinois; this cost resulted from use of different pre-emergence and postemergence herbicides for soybean (Mueller et al., 2005). For cotton grown in Georgia, the extra cost of controlling shifts in tropical spiderwort (*Commelina benghalensis*), a weed that is naturally tolerant to glyphosate, was predicted to be $14.91/acre; an additional herbicide application after cotton emergence explained this cost (Mueller et al., 2005)."

It is too soon to tell what types of herbicide costs will be faced by sugar beet growers to control glyphosate-resistant weeds. Jeff Stachler, the sugar beet extension specialist at North Dakota State University, informed APHIS that he has been experimenting with an herbicide management regime for glyphosate-resistant common waterhemp. He was most successful using a preplant soil incorporated protectant such as ethofumesate, metolachlor, cycloate, or EPTC, post-emergent sprays that include glyphosate at maximum strength, and potentially clopyralid, phenmedipham and desmedipham, and layby applications of ethofumesate, metolachlor, or dimethenamid-p. The additional herbicides are estimated to increase herbicide costs by $133/acre (Stachler, 2012).

(NRC, 2010) has suggested that the evolution of glyphosate resistance and weed shifts could lead to two important changes in practices: increased use of herbicides generally and reductions in conservation tillage (Mueller et al., 2005). Such changes would also increase weed-management costs and reduce producers' net returns. If production of a particular crop is not cost effective, growers will move to different crops or choose different production methods. A decrease in production of row crops could result in an increase in price for these commodities.

Under Alternative 1, the costs for managing glyphosate-resistant weeds in glyphosate-resistant row crops will continue to increase as the number of acres with glyphosate-resistant weeds increases. Proactive management strategies could delay the spread of glyphosate-resistant weeds in each region. Reactive management strategies wait until weeds have been found before changing practices to control them. Section III.B.1 identifies the difference in profits to be $276 less per acre in conventional sugar beet production systems as in glyphosate only H7-1 systems averaged across all regions. A study comparing H7-1 sugar beet costs to conventional sugar beet production costs indicated that the cost for conventional herbicides is $57 to $393/ha and for glyphosate is $40 to $69/ha(Kniss, 2010a). Therefore,under Alternative 1 growers would expect over time to increase input costs for weed management in glyphosate-resistant crops where glyphosate-resistant weeds are present in all sugar beet production fields regardless of the presence of glyphosate-resistant weeds.

Under Alternative 2 growers would incur additional costs to manage glyphosate resistance in glyphosate-resistant crops including sugar beet, as the selection and spread of glyphosate-resistant weeds continues. The costs of weed management vary by crop. Growers may choose to use certain rotation schedules or cultural practices to manage weeds. Under Alternative 2, growers can choose to use H7-1 sugar beet as part of their rotation schedule. While proactive weed management would involve using a combination of herbicides on H7-1 sugar beet, including glyphosate, many growers are likely to adopt a reactive strategy, waiting until glyphosate-resistant weeds become an issue in their cropping systems. (Weirich et al., 2011b). Depending on the type of management strategy adopted, the cost will range from slightly more than the use of glyphosate alone to close to the cost for managing conventional sugar beet. If the net return for growing H7-1 sugar beet is lower than conventional sugar beet (or other crops), growers are likely to choose the more profitable choice of growing H7-1 sugar beet.

Under Alternative 3, growers will have the same potential economic impacts as Alternative 2, except growers in California cannot realize the economic benefit of adopting H7-1 sugar beet and growers in other areas will have additional compliance costs. The addition of compliance costs decreases the net return for H7-1 sugar beet when compared to Alternative 2.

a. Great Plains

Within the Great Plains region, North Dakota reports two counties with sugar beet production. However, only one county has specific acreage reported in the 2007 Census of agriculture (USDA-NASS, 2007a). Montana reports eleven counties with sugar beet production, nine have specific acreages reported. Nebraska reports 14 counties that grow sugar beet, eleven have specific acreage reported. Colorado reports twelve counties that produce sugar beet, with nine counties having specific acreage data. In this region there is approximately 6.7 million acres of harvested cropland. Approximately 2.4% of the harvested cropland is planted in sugar beet. Approximately 44% of the harvested cropland is planted in canola, corn, alfalfa, and soybean. Nearly all of this cropland is planted into corn and alfalfa[41]. When considering adoption rates for herbicide-resistant crops, approximately 21% of the acreage has the potential to be planted in glyphosate-resistant crops under Alternative 1 if H7-1 is not used in sugar beet production. This increases to about 23.4% if H7-1 is used exclusively in sugar beet production under Alternatives 2 and 3 when compared to Alternative 1. The percent of the harvested land planted in herbicide-resistant crops within this region is below the national average.

Glyphosate-resistant horseweed has been identified in NE (see Table 3-25) in both corn and soybeans (Heap, 2012). Table 4-18 also identifies glyphosate-resistant kochia and giant ragweed as being found in sugar beet growing areas in corn and soybean fields. Glyphosate-resistant common ragweed has been identified in areas where it could over time disperse to sugar beet growing areas in the Great Plains region (Table 4-18). Within

[41] Soybeans and canola make up less than 0.3% of the total acreage in this region

this region, conservation tillage is being adopted in sugar beet as well as other crops (Wilson Jr, 2012) to help control for wind erosion. In this region, Alternatives 2 and 3 incrementally contribute to growers adopting practices that promote soil health and improved air quality (See discussion above). Under Alternative 1, fewer growers may use soil conservation practices. Therefore,Alternative 1 may contribute to an incremental increase in soil erosion for agricultural fields.

Despite the overall lower adoption rates of herbicide-resistant crops in this region, herbicide-resistant weeds have been documented. It is unclear how the distribution of glyphosate-resistant crops influences the selection and spread of glyphosate-resistant weeds. The density of glyphosate-resistant crops in this area is much lower than in areas like the Great Lakes Region. However, both have glyphosate-resistant weeds present in soybean and corn fields.

Under Alternative 1, glyphosate-resistant weeds are expected to continue to be found in corn and soybean fields throughout this region. These weeds may also be found in conventional sugar beet fields that are used in rotation with corn or soy. In addition weeds resistant to herbicides that are used in conventional sugar beet will also be found in this region. Herbicide-resistant weeds may be controlled using weed management techniques such as crop rotation, incorporating herbicides with different modes of action, or using tillage to control weeds. Under Alternatives 2 and 3 growers may use glyphosate for weed control in sugar beet fields as well as other agricultural areas. Glyphosate-resistant weeds are likely to occur in glyphosate-resistant crops.

b. Northwest

Within the Northwest, the State of Washington reports one county that grows sugar beet for sugar[42]. Oregon reports two counties and Idaho reports fifteen (15) counties of which thirteen (13) report specific acreage. In this region there are approximately 2.4 million acres of harvested cropland. Production of sugar beet grown for sugar makes up 7.3% of the harvested cropland acreage in this region. Within this region corn, alfalfa, soybean, and canola are reported. However, the acreage of soybean and canola are minor and specific acreage is not reported for most counties. Approximately 40% of the harvested cropland in this region is devoted to crops that have herbicide-resistant varieties on the market. Using published adoption rates, 23% of the harvested crop acreage has the potential to be planted in glyphosate-resistant crops under Alternative 1. This increases to 31% under the remaining two alternatives so that the

[42] Seed crops are not included because the acreage is minimal and glyphosate use and tillage practices are typically not different for H7-1 and conventional sugar beet seed production because glyphosate is seldom used for post-emergent weed control in seed fields.

contribution of H7-1 sugar beet to the total of glyphosate-resistant crop acreage is about 8%. The assumption is that the majority of this acreage would be planted to herbicide-resistant alfalfa (17%) based on industry predicted adoption rates.

Herbicide-resistant weeds in the northwest are a problem in sugar beet, as well as in other crops. As described in section IV.C.3, and IV.E.1 under Alternative 1, it is expected that weeds resistant to non-glyphosate herbicides would cause some growers to not produce conventional sugar beet because they could not afford to manage weeds in their fields. Weeds resistant to multiple herbicides exist in this region. For example, Italian Ryegrass is listed as resistant to Herbicide Groups 1,2,9,10, and 15 (Idaho, 2011). Italian ryegrass is not typically considered a weed of sugar beet. The same publication lists Group 4 and 5 resistant kochia, which is an important weed of sugar beet.

Table V-6. Herbicide-resistant Weeds of Sugar Beet

APHIS compared the list of important weeds of sugar beet in section III.B.1 with herbicide-resistant weeds in the Northwest (Idaho, 2011)

Herbicide-resistant Weed	Herbicide Group	Herbicide used in Sugar Beet [1]
Kochia	2 4 5 5 5	Triflusulfuron Clopyralid Phenmedipham Desmedipham Pyrazon
Pigweed	5 5 5	Phenmedipham Desmedipham) Pyrazon
Common lambsquarter	5 5 5	Phenmedipham Desmedipham Pyrazon
Wild oats	1 1 1 3 8 8 8	Clethodim Quizalofop-p-ethyl Sethoxydim Trifluralin Cycloate EPTC Ethofumesate
Sowthistle	2	Triflusulfuron

[1] Weed may be documented to have resistance to a different herbicide in the same herbicide group, but not be documented to be resistant to the herbicide used on beet.

Under Alternative 1, weeds of sugar beet with resistance to herbicide in groups 1, 2, 3, 4, 5, and 8 are likely to continue to persist in this region. Because herbicides in the same groups are used extensively in conventionally managed sugar beet, this alternative will contribute to selection for these weeds. Under Alternatives 2 and 3, these weeds that are resistant to herbicide groups used in sugar beet can be controlled with glyphosate. Decrease in the weed seed bank for these resistant biotypes may reduce the selection and spread of these weeds in neighboring fields. The majority of the harvested cropland in this area is not planted in crops with herbicide-resistant varieties. Therefore,decreasing weeds in sugar beet fields can aid in weed management in neighboring crops (See discussion in section (IV.C.3)). Glyphosate-resistant Italian ryegrass has been identified in this region. However, because it is not a problem weed in sugar beet, the increased use of glyphosate in sugar beet production is not likely to affect the selection and spread of this weed.

c. Imperial Valley CA

The Imperial Valley is in Imperial County, CA. It is the only county in California that still produces sugar beet. The production cycle in this area is different in that sugar beet is a winter crop in the valley. This southern CA county borders Mexico. The top five crops in the valley are forage (land used for all hay and haylage, grass silage, and greenchop), vegetables harvested for sale, field and grass seed crops, wheat for grain, and lettuce. Sugar beet is not among the top five crops and in fact is less than 10% of the harvested cropland in the county. The adoption of H7-1 sugar beet under Alternative 2 would not result in an increase in no-till or strip-till agriculture (see section III.B.1). However, better weed control in this area could result in less irrigation water use in this crop and a reduction in overall herbicide use. It could also result in fewer cultivations during the growing season which can reduce evaporative loss of soil moisture, tractor use, and particulate matter in the air. However, because the proportion of acres planted to sugar beet is small, there is not likely to be a net reduction in water use or particulates in the air over the landscape of the valley when comparing Alternative 2 to Alternatives 1 or 3.

In the Imperial Valley there are very few herbicide-resistant crops planted. Under the current partial deregulation, H7-1 sugar beet is not permitted in California. In addition, alfalfa growers in the Imperial Valley have not adopted herbicide-resistant alfalfa. Because corn, soy, and cotton are grown on limited acres, the potential herbicide-resistant acres are currently about 1% of the total cropland. The adoption of H7-1 sugar beet could increase the acreage to approximately 8% under Alternative 2. If herbicide-resistant alfalfa varieties are grown in the future, alfalfa varieties could account for about 26% of the total harvested cropland in the Imperial Valley under all three alternatives. In areas where glyphosate use is low, such as the Imperial Valley of California, essentially no cumulative effects are expected from H7-1 adoption because essentially no other glyphosate-resistant crops are grown there. In the Imperial Valley, the adoption of Alternative 2 will not change tillage practices because tillage is used to facilitate irrigation in this crop. These practices are not expected to change under any of the three alternatives. However, post-emergent cultivation to control weeds is expected to decrease when compared to Alternatives 1 and 3. The UCIPM guidance (California-Davis, 2005) for sugar beet advises that some weeds, like velvet leaf, dodder, and curly dock are particularly hard to manage in sugar beet using the herbicides available under Alternatives 1 and 3. Under Alternative 2, growers can use glyphosate on sugar beet to control weeds. Studies (Felix and Ishida, 2009; Reif et al., 2011) show that partial control of dodder was possible on sugar beet using glyphosate. Therefore,the adoption of Alternative 2 will incrementally contribute to providing better control of difficult to control weeds in sugar beet and thus decreasing the weed seed bank. This reduction in the seed bank can lead to a reduction in herbicide use in rotation crops in subsequent years.

D. National Level

1. Contribution of sugar beet production to total harvested cropland and glyphosate use

APHIS has concluded that there are no measurable incremental contributions from the adoption of H7-1 sugar beet to cumulative impacts at the national level. The contributions are not measureable because the effects from the changes in production practices associated with the use of H7-1 are smaller than the yearly variations associated with production practices in other agriculture.

APHIS examined the contribution of glyphosate use on agricultural land to the total herbicide use on a national scale over the past 20 years. The total amount of herbicides used, in pounds of active ingredients, has remained relatively constant. However, the contribution of glyphosate to the total has increased (Fig. 5-6). This increase in glyphosate use is correlated temporally with the adoption of both no-till agriculture and the adoption of glyphosate-resistant crops. Therefore, while the use of GE crops may contribute to the overall use of glyphosate, this use is due to a shift in types of herbicides used, not the use of additional quantities of herbicide. Based on this trend for glyphosate use, combined with the data analyzed in section IV, production of H7-1 sugar beet is not likely to increase the total amount (in lbs. of active ingredients) of herbicide use on agricultural lands at a national level.

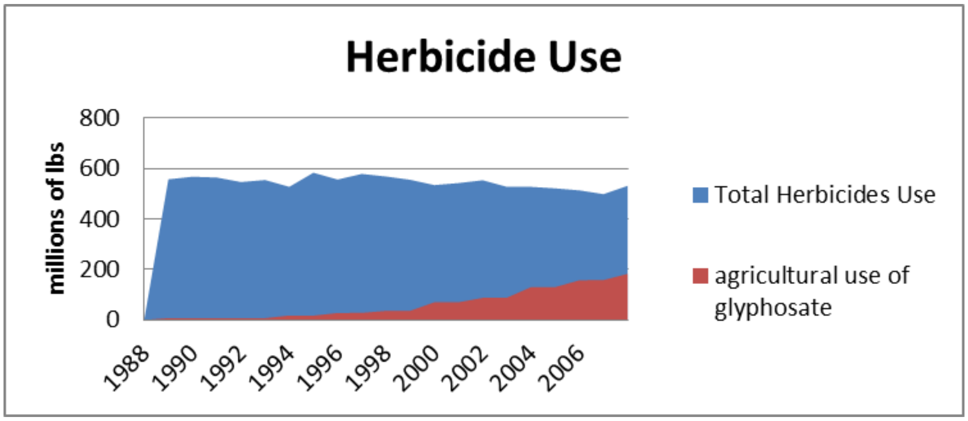


Figure 5-6 Herbicide use trends in the U.S. 1988-2007:

The total amount of herbicide active ingredients used within the U.S. has remained relatively consistent over the past 20 years. However, during that time the amount of glyphosate active ingredients used in the U.S. has increased to become about 1/3 of the total herbicide active ingredients used in the U.S.. (data compiled from http://www.epa.gov/opp00001/pestsales/index.htm)

Glyphosate is not only used in agriculture. Its use in home and garden applications has remained consistant over the the last decade. Uses in industry, commerical, and government applications has also remained consistant. (Fig. 5-7) Therefore,the increases in glyphosate use are the result of its increased use in agriculuture. The use of glyphosate on H7-1 sugar beet is equivalent to about 2/5 of the use in home and garden applications in the U.S.. On a national level, the home and garden applications contribute more to the overall glyphosate use than does sugar beet.

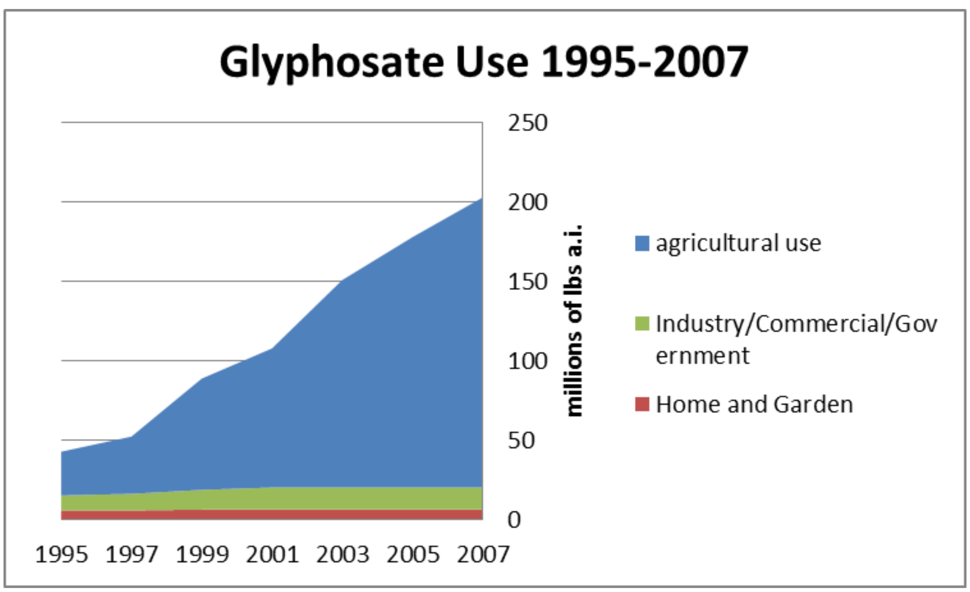


Figure 5-7 Glyphosate Use in the U.S. 1995 -2007.

Glyphosate use for agriculture has been steadily increasing but other uses remain relatively unchanged. Changes in agricultural practices associated with the adoption of glyphosate-resistant crops are correlated with the increased glyphosate use.

Under the preferred alternative, glyphosate use would increase on H7-1 sugar beet by about 7-fold compared to the glyphosate use on conventional sugar beet (Table 3-18). APHIS evaluated this increase in glyphosate usage in the context of all national glyphosate usage (see Table 5-7). Glyphosate is widely used on corn and soybean crops which are, respectively, over 70 and 90%, Roundup Ready®. As indicated in Table 5-7, glyphosate use on sugar beet with the adoption of H7-1 sugar beet is about 1% of the total glyphosate use. Therefore, the increase in glyphosate use as a result of the adoption of H7-1 is minor compared to other uses on a national scale. Variations in the number of acres of other glyphosate-resistant crops planted from year to year will have a larger effect on the total amount of glyphosate used than the total contribution of glyphosate used on sugar beet at a national level. The current trend is for glyphosate use to continue to rise in agricultural applications; the addition of H7-1 sugar beet to U.S. agriculture does not change that trend in a measurable way. Under Alternatives one, two, and three, glyphosate use is expected to continue to rise at about the same rate on a national scale. Total herbicide use is expected to remain the same on a national scale, and the proportion of glyphosate used as a fraction of the total herbicide used is expected to increase over the next five years on a national level.

Herbicide-resistant soybeans and cotton appear to have peaked in percent adoption, but percent herbicide-resistant corn adoption still continues to rise (USDA-ERS, 2011a)). Adoption of glyphosate-resistant alfalfa is also expected to increase over the next five to ten years contributing to the overall increase in glyphosate used in agriculture. If the level of adoption rate of other herbicide-resistant crops cease to increase, the rate of increase of glyphosate use may also slow.

Table V-7. Glyphosate Usage on a National Scale

Glyphosate usage on a National Scale						
RR crops	Lbs a.e./acre[1]	RR adoption[2]	total acres x 1 million[3]	RR acres x 1 million	lbs x 1000	% of total
Corn	0.96	0.7	87.9	61.5	59040	26%
Cotton	1.5	0.78	10.9	8.5	12750	6%
Soybean	1.1	0.93	79	73.5	80850	36%
Canola	1.125	1	1.5	1.5	1687	1%
Sugar beet	2.21	1	1.1	1.1	2431	1%
Alfalfa	1.9	.5	20	10	19000	8.5%

Estimated glyphosate use on "other" applications[4]			
2007	agricultural uses (non RR ready)	28000	12%
2007	home and garden[4]	6500	3%
2007	industry commercial government	14000	6%
Total all uses		224258	

[1]corn (NASS chemical survey 2010), cotton (NASS chemical survey 2007), soybean glyphosate rates from (NASS chemical survey 2006) , canola rate from (Benbrook, 2009), sugar beet from (Stachler et al., 2012b) alfalfa from maximum label rate of one application
[2]http://www.ers.usda.gov/Data/BiotechCrops/;
[3]2010 acres from NASS (http://www.nass.usda.gov, accessed Sept 8, 2010).
[4]from Grube 2011
Non GE (total ag with the sum of corn, cotton, soy, canola, sugar beet estimates subtracted)

The sugar beet root crop is produced on less than 0.4% of the acres of harvested cropland in the U.S. (USDA-NASS, 2009a). This production is conducted on approximately 0.3% of the farms that include harvested cropland in the U.S. (USDA-NASS, 2009a). The associated changes in tillage will have little influence on the overall tillage practices within the U.S. because the acreage is so small. Approximately 47% of all harvested cropland is planted in herbicide-resistant varieties of corn, soy, cotton, and canola. If glyphosate-resistant varieties of alfalfa are adopted at levels predicted, the percent of acres in herbicide-resistant crops will increase to about 50% of the harvested cropland acres in the U.S..

The variation in the amount of corn, soy, or wheat that is planted from year to year are each greater than the total amount of sugar beet acres planted in each year. Over the past ten years, the average variation in these crops has been 5 million acres for corn and 2 million acres for soy and wheat.[43] In the same period, sugar beet production has ranged from 1 million to 1.4 million acres (USDA-NASS, 2011d). Therefore, variability in the tillage associated with major crops such as corn, soy, and wheat will exceed the total change in tillage expected from H7-1 sugar beet adoption. Relative to the uses on these major crops, the national scale changes in sugar beet production practices will not exceed changes to the baseline variation that typically occur from year to year in the planting of other crops. Consequently, on a national scale, H7-1 sugar beet production under Alternatives 2 and 3 is not expected to contribute a measurable incremental increase in cumulative impacts associated with changes in

[43] Total crop acres planted in corn over the past ten years ranged from 75 million to 93 million acres. Total crop acres for soy over this period ranged from 65 million to 77 million acres. Total crop acres for wheat over this period ranged from 53 million to 63 million acres (NASS survey data 2001-2011).

tillage practices in agricultural production in the U.S. when compared to Alternative 1

VI. Executive Orders and other Environmental Laws

Executive Order (EO) 12898 (US-NARA, 2010), "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations," requires Federal agencies to conduct their programs, policies, and activities that substantially affect human health or the environment in a manner so as not to exclude persons and populations from participation in or benefiting from such programs. It also requires federal agencies to identify and address adverse effects to human health and the environment that may have disproportionately high and adverse impacts on minority and low-income people.

The Council on Environmental Quality (CEQ) guidance for implementation of EO 12898 in the context of NEPA *(National Environmental Policy Act*, December 10, 1997) suggests that minority populations should be identified where more than 50 percent of the population in an affected area belongs to a minority group or where the percentage presence of minority groups is meaningfully greater than in the general population. Under this guidance, for the purpose of determining the relative impact of Alternatives 1, 2, and 3, Imperial County, California, which encompasses the Imperial Valley and has a minority population of 79.8% (2010 U.S. Census), is the only region in the U.S. where sugar beets are grown and a minority population resides. Thus, Imperial County, CA is the only minority population in the U.S. that could be subjected to disproportionately high and adverse human health or environmental effects under Alternative 1, 2, or 3.

Each alternative was analyzed with respect to EO 12898. Based on the information submitted by the applicant and assessed by APHIS, in almost all respects, H7-1 does not differ from conventional sugar beet with respect to human health or environmental effects (IV.F.1.a).

Sugar beet is used for food, feed, and various other products to which people are exposed. Direct human ingestion of sugar beet product occurs primarily via white sugar, which is obtained by crystallization from sugar beet juice. No meaningful differences in characteristics have been found between H7-1 and conventional sugar beet, aside from the production of the CP4 EPSPS protein responsible for glyphosate resistance by H7-1. No adverse human health effects related to the ingestion of CP4 EPSPS have been identified (III.F.1.a). H7-1 has also successfully completed the FDA voluntary consultation for food and feed use (U.S. FDA, 2004). Diverse regulatory authorities have all reached the same conclusion – that food and feed derived from H7-1 sugar beet are as safe and nutritious as food and feed derived from conventional sugar beet (III.F.1.a). Therefore, none of Alternatives I, II, or III are expected to have an adverse impact on human health.

Pollen and sugar beet seed have both been found to induce allergy symptoms in sensitized people. Allergenicity of conventional sugar beet comes primarily from pollen and is limited to those areas that grow sugar beet seed (III.F.1.a). There are no differences between any of the alternatives with respect to beet pollen allergies (IV.F.1).

As noted in section III.B.1.d, cultivation of conventional sugar beet uses several different herbicides than cultivation of H7-1. EPA has determined that the use in accordance with the labeling of currently registered pesticide products containing glyphosate and other herbicides will not pose unreasonable risks or adverse effects to humans or the environment, including where these products are used on sugar beets. Based on historical experience with sugar beet production and the data submitted by the applicant and assessed by APHIS, H7-1 should eliminate the use of a variety of conventional herbicides. Glyphosate has less of an adverse effect on human health than many of the herbicides used in cultivation of conventional sugar beets. Examples of conventional herbicides replaced by glyphosate and their relative impact on human health are as follows: herbicides clethodim is a much more toxic skin irritant than glyphosate, clopyralid and desmedipham are much more toxic eye irritants, and EPTC, ethofumesate, and triflusulfuron-methyl are much more toxic by inhalation than is glyphosate (IV.F.1.a). Accordingly, with respect to the human health impact, Alternative 1 and, in Imperial County CA, Alternative 3, is expected to result in a greater adverse impact on human health than Alternative 2 or Alternative 3 (in all U.S. regions other than Imperial County, CA).

Agricultural workers are expected to be exposed to herbicides used in the cultivation of sugar beet more frequently than the general public, and so are more likely to suffer from any herbicide related adverse impact on human health. Worker exposure to herbicides will be greater under Alternative 1 because more field work is expected to be needed and herbicide applications are expected to be more frequent (IV.F.2.b). In addition, APHIS estimated that about 95 non-fatal injuries would occur each year to sugar beet growers from tillage and herbicide applications. Production of H7-1 sugar beet reduces the equipment use for both by about 70 percent (IV.F.1.b). Consequently a proportional decrease in non-fatal worker injuries is expected under Alternative 2 as compared to Alternative 1.

APHIS expects Alternative 1 and, in Imperial County CA, Alternative 3, to result in a greater adverse impact on human health or environmental effects than Alternative 2 or Alternative 3 (in all U.S. regions other than Imperial County, CA). Under EO 12898, Alternatives 1 and 3 will subject the minority community in Imperial County, CA, to disproportionately high and adverse human health or environmental effects.

EO 13045 (US-NARA, 2010), "Protection of Children from Environmental Health Risks and Safety Risks," acknowledges that children may suffer disproportionately from environmental health and safety risks because of their developmental stage, greater metabolic activity levels, and behavior patterns, as compared to adults. The EO (to the extent permitted by law and consistent with the agency's mission) required each Federal agency to identify, assess, and address environmental health risks and safety risks that may disproportionately affect children.

As described above, based on the information submitted by the applicant and assessed by APHIS, in almost all respects, H7-1 does not differ from conventional sugar beet with respect to human health or environmental effects (IV.F.1.a). Therefore,there is no differential effect on children.

EO 13112 (US-NARA, 2010) "Invasive Species," states that Federal agencies shall take action to prevent the introduction of invasive species, to provide for their control, and to minimize the economic, ecological, and human health impacts that invasive species cause. Based on historical experience with sugar beet and the data submitted by the applicant and assessed by APHIS, H7-1 sugar beet plants are very similar in fitness characteristics to other sugar beet varieties currently grown and are not expected to become weedy or invasive(USDA-APHIS, 2012). None of Alternatives 1, 2, or 3 is expected to introduce an invasive species.

EO 13186 (US-NARA, 2010), "Responsibilities of Federal Agencies to Protect Migratory Birds," states that Federal agencies taking actions that have, or are likely to have, a measurable negative effect on migratory bird populations are directed to develop and implement, within 2 years, a Memorandum of Understanding (MOU) with the Fish and Wildlife Service that shall promote the conservation of migratory bird populations.

Data submitted by the applicant has shown no difference in compositional and nutritional quality of H7-1 compared to conventional sugar beet, apart from the presence of the enzyme 5-enolpyruvylshikimate-3-phosphate synthase protein (EPSPS). The migratory birds that occasionally forage or injure sugar beets are unlikely to be affected by the H7-1 plants, since the variety was grown for four years before it was re-regulated, and no adverse effects on birds are known to APHIS.

Most non-glyphosate herbicides used on sugar beet are essentially nontoxic to birds on an acute basis. However, some of the herbicides used for conventional sugar beet (sethoxydim and trifluralin) could increase the risk of sublethal or chronic effects on birds. Glyphosate is not expected to pose an acute or chronic risk to birds when used within label limits (IV.C.1(c), Table 4-11).). Under Alternative 3, conventional sugar beet is expected to be grown in the Imperial Valley of California. Sethoxydim and trifuralin are extensively used in the cultivation of sugar beet in the Imperial Valley (Table 3-14).

Thus, the extent of potential impacts on migratory birds is expected to be somewhat higher under Alternative 3 than under Alternative 2, but lower than Alternative 1.

International Implications. EO 12114 (US-NARA, 2010), "Environmental Effects Abroad of Major Federal Actions," requires Federal officials to take into consideration any potential environmental effects outside the U.S., its territories, and possessions that result from actions being taken. APHIS has given this due consideration and does not expect an environmental impact outside the U.S. under any of the alternatives.

Under Alternative 1, the movement of the Canadian H7-1 beets into the US would require a permit. Under Alternative 3 a compliance agreement would be necessary. Certain Canadian growers sell to US processors on a yearly basis (Ontario growers; Michigan Sugar Co.) Therefore,alternatives 1 and 3 may have economic effects on exporting Canadian growers.

It should be noted that all the considerable, existing national and international regulatory authorities and phytosanitary regimes that currently apply to introductions of new sugar beet cultivars internationally, apply equally to those covered by an APHIS determination of nonregulated status under 7 CFR Part 340. Any international trade of H7-1 subsequent to a determination of nonregulated status for the product would be fully subject to national phytosanitary requirements and be in accordance with phytosanitary standards developed under the *International Plant Protection Convention* (IPPC, 2010).

The purpose of the IPPC "is to secure a common and effective action to prevent the spread and introduction of pests of plants and plant products and to promote appropriate measures for their control" (IPPC, 2010); the protection it affords extends to natural flora and plant products and includes both direct and indirect damage by pests, including weeds. The IPPC set a standard for the reciprocal acceptance of phytosanitary certification among the nations that have signed or acceded to the Convention (172 countries as of March 2010). In April 2004, a standard for pest risk analysis (PRA) of living modified organisms (LMOs) was adopted at a meeting of the governing body of the IPPC as a supplement to an existing standard, International Standard for Phytosanitary Measure No. 11 (ISPM-11, Pest Risk Analysis for Quarantine Pests). The standard acknowledges that all LMOs will not present a pest risk and that a determination needs to be made early in the PRA for importation as to whether the LMO poses a potential pest risk resulting from the genetic modification. APHIS pest risk assessment procedures for genetically engineered organisms are consistent with the guidance developed under the IPPC. In addition, issues that may relate to commercialization and transboundary movement of particular agricultural commodities produced through biotechnology are being addressed in other international forums and through national regulations.

Compliance with Clean Water Act and Clean Air Act.

The adoption of Alternatives 2 of 3 may lead to the increased production of sugar beet in U.S. agriculture when compared to Alternaive 1 (IV.B.1) because weed pressure in some regions may result in decreased plantings of sugar beets. Changes in cultivation practices associated with Alternatives 2 and 3 could result in reductions in water use, tillage, and wind and water caused soil erosion when compared to Alternaive 1. These changes in production practices may result in less run-off under alternatives 2 and 3 than under Alternaive 1 (IV. E. and V). The change in pesticide usage under Alternaive 2 and 3 may reduce the uses of volatile agricultural chemicals when compared to Alternaive 1 (IV.E.3). Since Alternative 1 is compliant with the Clean Water and Clean Air Acts, adopting either Alternaive 2 or 3 would also be compliant.

National Historic Preservation Act (NHPA) of 1966 as amended. The NHPA of 1966, and its implementing regulations (36 CFR 800), requires federal agencies to: 1) determine whether activities they propose constitute "undertakings" that have the potential to cause effects on historic properties and, 2) if so, to evaluate the effects of such undertakings on such historic resources and consult with the Advisory Council on Historic Preservation (i.e. State Historic Preservation Office, Tribal Historic Preservation Officers), as appropriate. None of Alternatives 1, 2, or 3 will impact cultural resources on tribal properties. Any farming activities that may be taken by farmers on tribal lands are only conducted at the tribe's request; thus, the tribes have control over any potential conflict with cultural resources on tribal properties.

None of Alternatives 1, 2, or 3 will adversely impact districts, sites, highways, structures, or objects listed in or eligible for listing in the National Register of Historic Places, nor would they likely cause any loss or destruction of significant scientific, cultural, or historical resources. Standard agricultural practices for land preparation, planting, irrigation, and harvesting of plants would be used on these agricultural lands including the use of EPA registered pesticides. Applicant's adherence to EPA label use restrictions for all pesticides will mitigate impacts to the human environment. None of Alternatives 1, 2, or 3 is an undertaking that may directly or indirectly cause alteration in the character or use of historic properties protected under the National Historic Preservation Act. In general, common agricultural activities conducted under this action do not have the potential to introduce visual, atmospheric, or audible elements to areas in which they are used that could result in effects on the character or use of historic properties. There is potential for audible effects on the use and enjoyment of a historic property when common agricultural practices such as the use of tractors and other mechanical equipment are in close proximity to such sites. A built-in mitigating factor for this issue is that virtually all of the methods involved would only have temporary effects on the audible qualities of a site and can be ended at any time to restore those qualities of such sites to their original condition with no further adverse effects.

In summary, Alternatives 1, 2, and 3 comply with the National Historic Preservation Act (NHPA) of 1966 as amended.

Threatened and Endangered Species Act

Section 7 (a)(2) of the ESA requires that a Federal agency, in consultation with the USFWS or NMFS, ensure that any action the agency authorizes, funds, or carries out is not likely to jeopardize the continued existence of a listed species or result in the destruction or adverse modification of designated critical habitat. It is the responsibility of the Federal agency taking the action to assess the effects of the agency's action and to consult with the USFWS or NMFS if it is determined the action "may affect" listed species or critical habitat. To facilitate the APHIS ESA consultation process, APHIS met with the USFWS from 1999 to 2003 to discuss factors relevant to APHIS' regulatory authority and effects analysis for petitions for nonregulated status, and developed a process for conducting an effects determination consistent with the Plant Protection Act (PPA) of 2000 (Title IV of Public Law 106-224). This process is described in a decision tree document, which is presented at the end of Appendix F. APHIS uses this process to help fulfill its obligations and responsibilities under section 7 of the ESA for biotechnology regulatory actions.

After reviewing the potential effects of H7-1 sugar beets on the environment that could result from a determination of nonregulated status of H7-1 sugar beets, APHIS has not identified any stressor that could affect the reproduction, numbers, or distribution of a listed threatened or endangered species or species proposed for listing. As a result, a detailed site-specific (or spatially explicit) exposure analysis for individually listed threatened or endangered species is not needed for APHIS to reach a determination of nonregulated status for H7-1 sugar beets. APHIS considered the effect of H7-1 sugar beet production on designated critical habitat or habitat proposed for designation and could identify no difference from effects that would occur from the production of other sugar beet varieties. Sugar beets are not considered a particularly competitive plant species and are ecologically limited due to susceptibility to plant pathogens and herbivores and are not typically described as weeds outside of agricultural fields (Bartsch et al., 2001). Sugar beets are not considered weedy and feral populations of sugar beet have not been identified in the U.S. H7-1 sugar beets are not sexually compatible with, or serve as a host species for, any listed species or species proposed for listing. Consumption of H7-1 sugar beet by any listed species or species proposed for listing will not result in a toxic or allergic reaction. Based on these factors, APHIS has determined that H7-1 sugar beets would have no effect on listed threatened or endangered plant or animal species or such species proposed for listing and would not affect listed threatened or endangered plant or animal species' designated critical habitat or habitat proposed for designation. Because of this no effect determination, consultation under Section 7(a)(2) of the Act or the concurrence of the USFWS or NMFS is not required. The complete analysis can be found in Appendix F of this EIS. The complete species list is in Appendix E.

VII. Index

VIII. Acronyms and Glossary

A

a.e.	Acid equivalent is the portion of a formulation that theoretically could be converted back to the corresponding parent acid. It's weight includes just the acid portion of the active ingredient and not the salt or other part of the derivative.
a.i.	Active ingredient. The active ingredient of a pesticide formulation is the component responsible for its toxicity. Its weight includes the derivative used in the formulation (ester, salt, amine, etc.).
Abiotic	Describing non-living, environmental factors such as cold, heat, drought, flooding, salinity, toxic substances, and ultraviolet light.
ACCase	Acetyl CoA carboxylase.
Actinomycetes	A type of rod-shaped bacteria found in soil.
Acute exposure	Single or short-term exposure to a substance.
Acute toxicity studies	Those that study the effects of a single or short-term exposure to a substance.
Adjuvant	Something that is added to a spray solution to increase the effectiveness of the active ingredient. For example, a substance added to an herbicide to improve the adherence of an herbicide to a crop.
Agrobacterium tumefaciens	A bacterium that causes crown gall disease in some plants and canincorporate a piece of its own DNA into the host plant genome. When this DNA-transfer mechanism is commonly used in the genetic engineering of plants, the *Agrobacterium* is modified so crown gall disease does not occur
Agrobacterium-	The process of DNA transfer from

mediated transformation	*Agrobacterium tumefaciens* to plants, which occurs naturally during crown gall disease and can be used as a method to introduce foreign DNA into plant cells.
Agronomics	A branch of agriculture that deals with field-crop production and soil management.
Alleles	One of two or more forms of a gene occupying the same locus on paired chromosomes and controlling the same inherited characteristic.
Allelochemical	A chemical produced by a plant of one species that has an effect on another species.
Allelopathy	The inhibition of growth in one species of plants by chemicals produced by another species .
Allergen	Any substance that causes an allergic reaction.
ALS	Acetolactate synthase
AMPA	Aminomethyl phosphonic acid; degradation byproduct of glyphosate
Anoxia	Absence of oxygen usually resulting in cellular damage.
Anti-nutrient	A natural or synthetic compound that interferes with the utilization of one or more nutrients by affecting intake, absorption, metabolism, or all three processes.
APHIS	Animal and Plant Health Inspection Service
ARMS	Agricultural Resources Management Survey
ATP	Adenosine triphosphate
Autotoxicity	A form of allelopathy in which a species inhibits growth or reproduction of members

of that same species through the production of chemicals that are released into the environment.

B

BCF Bioconcentration factor

BCTV Beet curly top virus

Beet molasses A product of beet that contains about 50 percent sugar and is used for yeast, chemical, and pharmaceutical production and in mixed cattle feeds.

***Beta* crops** Cultivated crops form the genus, *Beta* which includes sugar beet, table beet, Swiss chard, and fodder beet.

Betaine A nutritional supplement commonly marketed as a pro-vitamin in the food, animal feed, and pharmaceutical industries.

Biennial A type of plant species that typically requires 2 years of growth in order to produce flowers and complete the plant life cycle.

Biotechnology Industry Organization

Bioaccumulate To increase the concentration of a chemical in biological systems above the concentration in the environment.

Biota All the living organisms of a region.

Biotechnology The practice of making specific modifications to the genome of an organism using techniques based on molecular biology, such as genetic engineering, gene transfer, DNA typing, and cloning of plants and animals.

Biotype A group of plants or animals within a species that possess certain traits or characteristics

	not common to the entire population.
BLS	Bureau of Labor Statistics
BMP	Best management practice
Bolting	The growth of an elongated stalk with flowers grown from within the main stem of a plant.
Breeder's seeds	The initial seeds collected from selected plant varieties prior to distribution for commercial planting.
Breeding	The process of changing the genetics of plants or animals in order to produce desired characteristics.
Burndown	An herbicide application used to kill all vegetation in a field prior to planting.

C

Calendar year	The period of 365 or 366 days from January 1 to December 31.
CAS	See Chemical Abstracts Service
Cation	A positively charged ion.
CDMS	Crop data management system
CEO	Chief executive officer
CEQ	Council on Environmental Quality
Certified seed	Seed of a known variety produced to specific standards to assure purity and absence of weed seeds and seedborne pathogens. Certified seed is typically purchased by growers forfor commercial production of the crop and is usually not used for producing more certified seed.
CFIA	Canadian Food Inspection Agency

CFR	Code of Federal Regulations (U.S.)
CFS	Center for Food Safety
Chard	A beet crop primarily used as a fresh market leafy vegetable.
CHCL	Chronic human carcinogen level
Chemical Abstracts Service	CAS numbers are unique numerical identifiers for chemical elements, compounds, polymers, biological sequences, mixtures, and alloys.
Chlorination	A water purification and disinfection process that uses chlorine.
Chlorotic	The state or condition resulting in yellowing of the plant tissue from low chlorophyll as a result of a plant stress.
Chronic exposure	Repeated, continuous exposure to a substance over an extended period.
Chronic toxicity studies	Studies to examine the toxicity of a substance from repeated continuous exposure over an extended period.
Citric acid	A common food additive used as a preservative and flavor enhancer, commercially produced during the fermentation of sugar beet molasses.
CMS	See Cytoplasmic male sterility
Companion crop	A crop distinct from the primary crop for harvest grown in close physical proximity to the primary crop, on the theory that they assist each other in weed control, nutrient uptake, pest control, pollination, and other factors necessary to increase crop productivity.

Conservation tillage A broad range of soil tillage systems that leave crop residue on the soil surface, substantially reducing the effects of soil erosion from wind and water.

Conventional tillage Full-width tillage that is performed prior to and/or during planting, and generally involves plowing with a moldboard plow and/or other intensive tillage equipment.

CP4 Strain of *Agrobacterium* carrying the *cp4 epsps* gene which confers resistance to glyphosate.

cPAD Chronic population adjusted dose

CRM Crop residue management

Crop rotation Practice of growing a crop in a cycle with other crops in an effort to reduce weed and other pest pressures.

Crop year The time period from one harvest to the next, varying according to the commodity; crop year does not include fallow times when no crop is planted.

Cross-pollination Process that occurs when pollen is delivered to the female structures of the flower from a different plant and results in the formation of a seed.

CRP USDA's Conservation Reserve Program

CSA Community supported agriculture

Curly top A disease of beet caused by the beet curly top virus (BCTV). The young leaves of beet infected by BCTV roll inward, pucker, and thicken; typically, affected young plants die rapidly.

Cytoplasmic male sterility (CMS) A recessive form of genetic male sterility in which plants fail to produce viable pollen but can produce viable seeds. When used in hybrid seed production, CMS plants are the female parent or seed producer.

D

Damping-off	Rot of seedlings caused by soilborne pathogens that attack seed or seedlings before, during, or after germination.
DEFRA	Department for Environment, Food, and Rural Affairs (UK)
DEIS	Draft environmental impact statement
Deoxyribonucleic acid (DNA)	A nucleic acid that carries the genetic information of a cell. The structure of DNA is two long chains, consisting of chemical building blocks (nucleotides), twisted into a double helix. The order of nucleotides determines hereditary characteristics.
Devernalize	Reversing or losing vernalization due to exposure of seeds to high temperature, resulting in failure to flower.
Dicot	A flowering plant with two cotyledons usually having broad leaves and a network of leaf veins.
Direct field method	In hybrid seed production, the practice of directly seeding the male and female parents in blocks in the same field as opposed to transplanting nursery plants.
Disked	Cultivated using a tool (such as a harrow or plow) to turn and loosen the soil with a series of discs.
DNA	See deoxyribonucleic acid
DRES	Dietary risk evaluation system
DSA	Dairy and Sweetener Analysis Group

E

EA	Environmental assessment
EEC	Expected environmental concentration
EFSA	European Food Safety Authority
EIQ	Environmental impact quotient
EIS	Environmental impact statement
Environmental justice	The fair treatment and meaningful involvement of all people regardless of race, color, sex, national origin, or income with respect to the development, implementation and enforcement of environmental laws, regulations, and policies.
EO	Executive order
EPA	U.S. Environmental Protection Agency
EPSPS	An enzyme; 5-enolpyruvylshikimate-3-phosphate synthase
EPTC	Eptam® (herbicide)
ESA	Endangered Species Act
EU	European Union
Event	See transformation event
Expression	The means by which a gene's information stored in DNA (or RNA in some viruses) is turned into biochemical information such as RNA or protein.

F

Fallow	During a crop rotation period the land is rested (no crops are grown) at varying intervals. The traditional fallow is for a period of one year. During the inter-crop fallow, the land is rested in the fall and winter season.
FARE	Foods analysis and residue evaluation
FDA	Food and Drug Administration
Feral	An animal or plant that has escaped from domestication and returned, partly or wholly, to a wild state.
FFDCA	Federal Food, Drug, and Cosmetic Act
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
Fiscal year	A 12-month period at the end of which all accounts are completed to provide a statement of a company's, organization's, or government's financial condition, or for tax purposes.
Fodder beet	Relative of the sugar beet; typically grown for use as livestock feed. Although less common, fodder beet leaves can be consumed by humans.
FONSI	Finding of no significant impact
Forage	Plant material consumed by livestock or other grazing animal species.
Foundation seed	Seed of a particular plant variety that is produced from breeder seed and is then planted to produce certified seed (See also breeder seed and certified seed)
FQPA	Food Quality Protection Act of 1996
FR	Federal register
Furrow irrigation	A method of surface irrigation where farmers

flow water down trenches running through their crops.

FY Fiscal year

G

GE See genetically engineered

Gene The basic unit of heredity transmitted from generation to generation during sexual or asexual reproduction; an ordered sequence of nucleotide bases comprising a segment of DNA. A gene contains the sequence of DNA that encodes an individual RNA or protein.

Gene flow The transfer of genes from one population to another by the movement and establishment of individuals, pollen, seeds, or spores.

Gene insertion The incorporation of one or more copies of a gene into a chromosome.

Gene product An RNA or a protein (e.g., an enzyme), the production of which is directed by the corresponding gene.

GENEEC Generic estimated exposure concentration

Genetic engineering Process by which one or more genes and other genetic elements from one or more organism(s) are inserted into the genetic material of a second organism using recombinant DNA techniques.

Genetically engineered (GE) Modified in genotype and, hence, phenotype, using recombinant DNA techniques.

Genome All of the genetic material in a cell, including DNA present in the cell nucleus and in other locations such as plant chloroplasts and mitochondria.

Genotype A description, usually regarding specific genes or alleles, of the genetic makeup of an individual, dependent on DNA composition.

GHG Greenhouse gases

GM Genetically modified

GMO Genetically modified organism

GPS Global positioning system

GR Glyphosate-resistant

Gramnivorous Feeding primarily on grasses and seeds.

GRAS Generally recognized as safe

Groundkeepers Small roots left behind in sugar beet fields after harvest that produce plants the next growing season.

GT Glyphosate-tolerant

H

H7-1 sugar beet varieties Sugar beet that are genetically engineered to be resistant to the herbicide glyphosate bred from the transformation event designated H7-1.

HA Health advisory

Half-life With regard to an herbicide's persistence; the time (in days) it takes for an herbicide to degrade in soils to 50 percent of its original amount.

Henry's Law Constant The equilibrium level that is reached when the amount of gas dissolved in a liquid is equal to the pressure of the gas over the liquid.

Herbicide A chemical that kills plants.

Herbicide resistance The ability of a plant to remain relatively unaffected by the application of what would otherwise be a highly damaging dose of an herbicide.

Herbicide drift Inadvertent direct overspray, or transport (via

	wind or water flow from rainfall) of soil particles loaded with adsorbed herbicide that contacts non-target terrestrial and aquatic plants (including non-target crops and non-agricultural plants).
Herbivory	The consumption of plants by insects and other animals.
HGT	See horizontal gene transfer
HHS	U.S. Department of Health and Human Services
HIARC	Hazard Identification Assessment Review Committee
Horizontal gene transfer (HGT)	The movement of genetic material between non-sexually compatible, unrelated organisms.
HTS	Harmonized tariff schedule
Human environment	According to the Council on Environmental Quality, the term human environment "shall be interpreted comprehensively to include the natural and physical environment and the relationship of people with that environment" (40 CFR § 1508.14).
Hybrid	The offspring resulting from breeding between two genetically dissimilar organisms.
Hybrid "off-types"	In plant breeding,when offspring possess visually identifiable traits that indicate they were the result of an unintended cross. .
Hybridization	The process by which two individuals interbreed to form hybrid offspring.
Hydrolysis	The process of chemical decomposition by water.
Hydrophilic	Describing or characterizing a substance that bonds with and dissolves in water.

I

IDS Incident data system

Indirect steckling method In hybrid beet seed production,the practice of growing young transplants in nurseries and subsequently transplanting them into seed production fields.

Interfertile Describing two plants or groups of plants capable of breeding and producing offspring.

Interseed Seeding a crop after a crop has already been established.

Interspecific Arising or occurring between individuals of different species.

Intraspecific Arising or occurring between individuals within the same species.

Introgression The introduction and stabilization of genes from one species or population into the gene pool of another via sexual crossing. The process begins with hybridization between the two individuals, followed by repeated sexual crossing (backcrossing) to one of the parent species.

IPA Isopropylamine

IPCC Intergovernmental Panel on Climate Change

ISHRW International Survey of Herbicide-resistant Weeds

Isopropylamine An organic amine. Used in glyphosate herbicides.

L

Lb. a.e.	A unit of measure for pounds acid equivalent, which is the common notation used for measurement of glyphosate herbicide formulations.
LLP	Low-level presence
LOAEC	Lowest-observed-adverse effect concentrations

M

MCL	Maximum contaminant level
Meristem	A tissue in plants consisting of undifferentiated cells (meristematic cells) and found in zones of the plant where growth can take place - the roots and shoots.
Micro-organism	An organism that is microscopic (too small to be seen by the human eye without the use of instruments that significantly magnify the image of the organism).
Microrate application	Common practice of conventional sugar beet growers to frequently apply post-emergent herbicides at low levels to minimize damage to the sugar beet plant.
	Margins of exposure
Monocot	Plants characterized by a single cotyledon, narrow leaves, and parallel veins. Grasses are monocots.
MSG	Monosodium glutamate
MTSA	Monsanto Technology/Stewardship Agreement
Mutagenic	Inducing or increasing the likelihood of mutations.

N

NAAQS	National Ambient Air Quality Standards
NDSU	North Dakota State University
NEPA	National Environmental Policy Act of 1969 and subsequent amendments
NHANES	National Health and Nutrition Examination Survey
NIOSH	National Institute of Occupational Safety and Health
NMFS	National Marine Fisheries Service
No till	A tillage method that leaves previous crop residue undisturbed from harvest to planting except for nutrient injection or narrow strips, and planting or drilling is accomplished in a narrow seedbed or slot.
NOA	Notice of availability
NOAEC	No-observed-adverse-effect concentration
NOAEL	No observed adverse effect level
NOEL	No-observed-effect level
NOI	Notice of intent
Non-target organism	Organisms that are not the target of a pesticide.
NOP	National Organic Program
Notification	As defined by USDA, an administratively-streamlined alternative to a permit. The GE plant must meet specified eligibility criteria, and the introduction must meet certain pre-defined performance standards.

NPCS	National Poison Center System
NPDES	National Pollutant Discharge Elimination System
NPKS	Nitrogen, phosphorus, potassium, and sulfur.
NSC	National Safety Council

O

OAQ	Overall allotment quantity
OECD	Organisation for Economic Co-operation and Development
Oncogenic	Causing the formation of tumors.
OSCS	Oregon Seed Certification Service
OSHA	Occupational Safety and Health Administration
OSH Act	Occupational Safety and Health Act
OSTP	Office of Science and Technology Policy
O-type restorer	A plant line that is genetically identical to a line characterized by cytoplasmic male sterility except that it can produce pollen.
Outcrossing	A term used to describe the movement of plant genes from one plant to another genetically distinct plant via successful pollen movement
Ozonation	A water purification and disinfection process that uses ozone.

P

Packing	A method of planting seeds. Soil packing benefits crop emergence, crop uniformity, soil moisture retention and overall yields in

farming conditions where soil structure and moisture are not ideal for plant growth

PAIRR	Pesticide Active Ingredient Rating Report
PCR	Polymerase chain reaction
Perennial	Plant species that live more than two years. The above ground portion of the plant dies or becomes dormant in the winter, but grows back from root-stock the following spring.
Pesticide	A chemical that kills pests. Pesticides include herbicides, insecticides, and rodenticides.
Petioles	The small stalk that attaches a leaf to the stem of a plant.
PHED	Pesticide Handler Exposure Database
Phenotypic	The observed characteristics produced by the interaction of the genotype and the organism's surrounding environment.
Photolysis	The process of chemical decomposition by light.
Piling	Accumulation and storage of harvested sugar beet root crop for subsequent sugar processing.
Pinning maps	Maps that enable growers to see where sexually compatible crops are being grown so that they can take steps to ensure that required seed isolation distances are met.
Plant pest	Any living stage of any of the following that can directly or indirectly injure, cause damage to, or cause disease in any plant or plant product: protozoan, nonhuman animal, parasitic plant, bacterium, fungus, virus or viroid, infectious agent or other pathogen, or any article similar to or allied with any of the articles specified in the preceding subparagraphs. (7 U.S.C. 7702(14))

PLTP	Plant lipid transfer proteins
PNT	Plant with a novel trait
POEA	Polyethoxylated tallowamine; a surfactant that can be added to herbicide formulations to increase leaf penetration.
Pollen cloud	A dense airborne accumulation of pollen.
Post-emergent	For herbicide applications, this term refers to applications made onto the plant after the seedling emerges from the soil.
PPA	Plant Protection Act
PPE	Personal protective equipment
PPI	Preplant incorporated
PPRA	Plant Pest Risk Assessment
Pre-emergent	Used or occurring before seedling emergence above the ground.
Pre-pile	A period where the processing facility begins to manufacture sugarprior to the full harvest .
Pre-piling	Harvesting a small fraction of sugar beet root crop for initial sugar processing, typically done prior to the full harvest period.
Preplant	Occurring or used before planting a crop.
Protandrous	When anthers release their pollen before the stigma of the same flower is receptive.

R

Recombinant DNA	DNA, including DNA from different organisms, that has been cut apart and recombined using enzymes.
RED	Reregistration eligibility decision

Reduced tillage	A full-width tillage method that usually involves one or more tillage passes over the field prior to and/or during planting, and leaves 15- to 30-percent residue cover after planting.
Regulated article	Subject to APHIS regulation under 7 CFR part 340.
RfD	Reference dose
Risk assessment	A scientifically based process consisting of the following steps: (i) hazard identification; (ii) hazard characterization; (iii) exposure assessment; and (iv) risk characterization.
Rosette	Describing a circular arrangement of leaves at the same height, usually at ground level.
Rotary hoe	A motorized cultivator with revolving blades used for in-row weed control.
Rotation	In crop production, the cycle of crops grown in successive years in the same field.
RPHC	Relative public health concern
RQ	Risk quotient
RR	Relative risk
RRS	Relative risk score
RRSB	Roundup Ready® sugar beet
RR-WTQIs	Relative-risk weighted total quantity indicators
Ruderal	A plant that colonizes and grows in disturbed habitats.

S

Saponins	A class of chemical compounds, one of many

	secondary metabolites found in natural sources. They have a bitter taste and can act as a deterrent to foraging.
Secondary seedling	Seedlings that are not planted directly by the farmer but rather sprout unintentionally.
Self-pollinate	The process of pollination and seed production that results from movement of pollen among flowers on the same plant. The tendency of a plant species to produce offspring that result from a flower pollinating itself. (Also see outcrossing.)
Shattering	An event when the sugar beet seeds break open and release/disperse seeds prior to or during harvest.
Shikimate pathway	Biochemical pathway in plants that produces aromatic amino acids.
Soil compaction	A form of soil degradation typically caused by heavy machinery and livestock trampling.
Soil tilth	A measure of the health of soil. Good tilth refers to soil that has the proper structure and nutrients to grow healthy crops.
SOP	Standard operating procedures
SP	Standards of practice
Steckling	Sugar beet roots that are grown from seed for less than a full season. Stecklings are typically grown for hybrid seed production in nurseries where they are subsequently transplanted into a different location for seed production.
Strip tillage	A field tillage system that combines no till and full tillage to produce row crops.
STRV	Short tons, raw value
Subchronic toxicity studies	Studies of the toxicity effects of a substance

on a small percentage of a subject’s life span.

Sugar beet pulp	A high-quality feed produced from sugar beet that has high energy and high fiber content that is fed to cattle and sheep. Dried beet fiber residue left over from sugar extraction used in plain dried, molasses dried (containing 25 percent molasses), and pelleted forms.
Sugar beet tops	The leaves and petioles of the sugar beet; often used as both fertilizer and animal feed.
Surfactants	Surface-action agents that are soluble in organic solvents and water.

T

Table beet	A beet crop consumed as a vegetable for both the root and leafy greens.
TDN	Total digestible nutrients
TEP	Typical end-use products
Teratogenic	Causing malformation and/or birth defects.
TGAE	Technical grade acid equivalent
TGAI	Technical grade active ingredient
Tilth	A soil structure suitable for seeding.
TMRC	Theoretical maximum residue contribution
Trait	A characteristic of an organism that manifests itself in the phenotype. Traits can be the result of a single gene or can be polygenic, resulting from the simultaneous expression of more than one gene.
Transformation event	An organism produced by the uptake and integration of DNA in a cell’s genome.

Transgene	A foreign gene that is inserted into the genome of a cell via recombinant DNA techniques.
TRQ	Tariff-rate quotas
TSCA	Toxic Substances Control Act
TUG	Monsanto Technology Use Guide

U

U.S. EPA–HED	U.S. Environmental Protection Agency–Health Effects Division
U.S. EPA OPP	U.S. Environmental Protection Agency–Office of Pesticide Programs
U.S.C.	United States code
USD	U. S. dollar
USDA	U.S. Department of Agriculture
USDA–APHIS	See APHIS
USDA–ARS	U.S. Department of Agriculture–Agriculture Research Service
USDA–BRS	U.S. Department of Agriculture–Biotechnology Regulatory Services
USDA–ERS	U.S. Department of Agriculture–Economic Research Service
USDA–FAS	U.S. Department of Agriculture–Foreign Agricultural Service
USDA–FSA	U.S. Department of Agriculture–Farm Service Agency
USDA–FSIS	U.S. Department of Agriculture–Food Safety and Inspection Service

USDA–NASS	U.S. Department of Agriculture–National Agricultural Statistics Service
USDA–NRCS	U.S. Department of Agriculture–Natural Resources Conservation Service
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
USSE	U.S. Soybean Export Council

V

Vector	The agent, such as a plasmid, used by researchers to carry new genes into cells.
Vegetable beet	Beet crops such as table beet, and Swiss chard which are consumed as vegetables as opposed to sugar beet and fodder beet which are used for sugar production and feed, respectively.
Vernalization	The process by which low temperatures induce flowering.
Vigor	A qualitative term used to measure overall health of a plant and its rapidness of growth.
VOC	Volatile organic carbons
Volunteer	Plants resulting from crop seed that escapes harvest and remains in the field until subsequent seasons, where it germinates along with the succeeding crop.

W

Weed shifts	These occur when the local population of weeds changes due to the selective pressures of differing management strategies.
Weediness	The ability of a plant to colonize a disturbed

	habitat and compete with cultivated species.
WIN-PST	Windows pesticide screening tool: A pesticide environmental risk screening tool to evaluate the potential of pesticides to move with water and eroded soil/organic matter and potential to affect non-targeted organisms
WPS	Worker protection standard
WSSA	Weed Science Society of America
WSU	Washington State University
WTO	World Trade Organization
WVSSA	Willamette Valley Specialty Seed Association

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Appendix A. List of Preparers

Name, Project Function	Qualifications
APHIS	
Sidney W. Abel III Assistant Deputy Administrator Reviewer TES Analysis	▪ M.S. Environmental Sciences – Chemistry, The George Washington University ▪ B.S. Special Studies – Environmental Chemistry, University of Maryland ▪ 25 years of professional experience in developing and conducting environmental risk assessments specializing in the fate, transport, and effects of physical, chemical, and biological substances
Patricia K. Beetham Regulatory Biotechnologist Reviewer	▪ Ph.D. Microbiology – Poultry Science, Clemson University ▪ M.S. Microbiology – Food Pathology, Clemson University ▪ B.S. Biology, Appalachian State University ▪ 5 years of professional experience evaluating environmental impacts and 18 years of professional experience in host response to vaccines and environment
David A. Bergsten APHIS Interagency NEPA Contact Project Manager Purpose and Need Reviewer	▪ Ph.D. Environmental Science – Toxicology, University of Texas, School of Public Health, Houston ▪ M.P.H. Disease Control, University of Texas, School of Public Health, Houston ▪ M.S. Entomology, Purdue University, West Lafayette, IN ▪ B.S. Environmental Science, Rutgers University ▪ 30 years of professional experience in environmental toxicology, chemical fate, pesticide research, and environmental protection. ▪ 23 years of experience preparing environmental documentation for APHIS programs.
Michael P. Blanchette Senior Environmental Protection Specialist TES analysis RTC	▪ B.S. Entomology, University of New Hampshire ▪ 22 years of professional experience as an Environmental Protection Specialist with 8 years evaluating plant pest and environmental impacts of genetically engineered crops including effects to threatened and endangered species and critical habitat.
William Doley Biotechnologist Reviewer	▪ Ph.D. Plant Breeding and Genetics, Michigan State University ▪ M.S. Plant Breeding, University of Minnesota ▪ B.S. Plant Science, Pennsylvania State University ▪ 17 years of professional experience developing transgenic crop products ▪ 25 years of professional experience in crop breeding and genetics

Name, Project Function	Qualifications
Samantha Floyd Environmental Protection Specialist Reviewer	▪ M.S. Environmental Science and Policy, Johns Hopkins University, Baltimore, MD ▪ B.S. Biology, James Madison University, Harrisonburg, VA ▪ 7 years of professional experience in environmental documentation for APHIS programs with emphasis on pesticide and drug registration issues
Neil E. Hoffman Science Advisor Project Manager Alternatives Reviewer RTC FEIS	▪ Ph.D. Plant Physiology, University of California, Davis ▪ B.S. Plant Biology, Cornell University ▪ 30 years of professional experience in plant biochemistry and molecular biology ▪ 9 years of professional experience in environmental risk assessment of genetically engineered organisms
Lori L. Kerber Regulatory Specialist Executive Orders and other Environmental Laws	▪ Ph.D. Biochemistry, University of Georgia ▪ J.D., William & Mary Law School ▪ 6 years of experience in molecular biology and genetics, including the development of genetically engineered organisms ▪ 15 years practicing law with specialization in biotechnology patents ▪ 1 year of experience in regulatory compliance of experimental trials of genetically engineered plants
Margaret J. Jones Plant Pest Risk Assessment	▪ Ph.D. Plant Pathology, University of California, Berkeley ▪ M.A. Cell and Molecular Biology, San Francisco State University ▪ B.A. Botany, Humboldt State University ▪ 10 years of professional experience evaluating plant pest and environmental impacts of genetically engineered crops and 16 years of research in plant pathology and molecular biology.
Susan Koehler Supervisory Biotechnologist Reviewer	▪ Ph.D. Plant Biology, Washington University in St. Louis ▪ B.S. Agronomy, University of Kentucky ▪ 16 years of professional experience evaluating plant pest and environmental impacts of genetically engineered crops and 13 years of research in plant biotechnology, plant biochemistry, and molecular biology
Elizabeth Nelson Environmental Protection Specialist Reviewer	▪ B.S. Biology, Bowie State University, Bowie, MD ▪ M.S. Healthcare Administration, University of Maryland, College Park, MD ▪ M.B.A. University of Maryland, College Park, MD ▪ 11 years of professional experience in environmental documentation for APHIS programs with emphasis on veterinary and human health issues

Name, Project Function	Qualifications
Craig Roseland Senior Environmental Protection Specialist Reviewer	▪ Ph.D. Developmental and Cell Biology, University of California, Irvine ▪ B.S. Biological Sciences, University of California, Irvine ▪ 11 years of experience in environmental risk assessment and regulatory analysis
Amy Shalom Environmental Protection Specialist Reviewer	▪ B.A. Foreign Language and Literature, Yale University, New Haven, CT ▪ 7 years of professional experience in preparing and reviewing National Environmental Policy Act analysis and documentation
Rhonda Solomon Environmental Protection Specialist Reviewer	▪ B.S. Biology, George Mason University, Fairfax, VA ▪ Juris Doctorate, Catholic University, Washington, DC ▪ 6 years of professional experience in environmental documentation for APHIS programs with emphasis on National Environmental Policy Act compliance
Rebecca Stankiewicz Gabel Senior Environmental Protection Specialist Project Manager Cumulative Impacts Reviewer RTC FEIS	▪ Ph.D. Genetics, University of Connecticut ▪ M.S. Genetics, University of Connecticut ▪ B.S. Animal Science, University of Connecticut ▪ National Environmental Policy Act Certificate Program – Nicolas School of the Environment, Duke University ▪ 7 years of professional experience in environmental risk assessment of genetically engineered organisms ▪ 10 years of professional experience in molecular biology and genetics, including the development of genetically engineered organisms
Tracy Willard Ecologist Reviewer	▪ Ph.D. Entomology, University of Maryland, College Park, MD ▪ M.S. Entomology, University of Delaware, Newark, DE ▪ B.S. Biology, Eastern University, St. Davids, PA ▪ 11 years of professional experience in environmental documentation for APHIS programs with emphasis on Endangered Species Act compliance

Name, Project Function	Qualifications
ICF International	
Nick Baker Biological Resources – Animals	▪ M.E.M. Conservation Science & Policy, Duke University ▪ B.S. Wildlife Biology, Colorado State University ▪ 5 years of experience in the environmental field
Emily Cella Project Management	▪ Ph.D. (Candidate) Environmental Science and Public Policy, George Mason University ▪ M.S. Environmental Studies, Ohio University ▪ B.S. Biological Sciences - Environmental Biology, Ohio University ▪ 8 years of experience in environmental impact analysis
David Ernst Physical Environment	▪ M.C.R.P. Environmental Policy, Harvard University ▪ B.A. Ethics and Politics, Brown University ▪ B.S. Urban Systems Engineering, Brown University ▪ 30 years of planning, research, analysis, and project management for the air quality and transportation industries
Steve Froggett Biological Resources – Plants	▪ Ph.D. Neuroscience and Behavior, University of Massachusetts ▪ M.S. Biology, University of North Carolina ▪ B.S. Biology and Psychology, Marietta College ▪ 9 years of experience working with government agencies, universities and the private sector on issues related to medical education, health care and food security
Christy Hartmann Project Management	▪ M.E. Environmental Engineering, University of Maryland ▪ B.S. Environmental Engineering, University of Maryland ▪ 9 years of experience in environmental impact assessment, and 6 years of experience in managing and preparing NEPA documents
Audrey Ichida Biological Resources – Plants and Production and Management	▪ Ph.D. Plant Molecular Biology, University of California, San Diego ▪ B.A. Biology, Cornell College ▪ Graduate and post doctoral work in plant molecular biology and 13 years of experience in risk assessment
Kirsten Jaglo Biological Resources – Plants and Production and Management	▪ Ph.D. Crop and Soil Science, Plant Breeding and Genetics, Michigan State University ▪ B.A. Biology (minor in Chemistry) with honors, University of Minnesota 15 years of experience working with federal agencies, universities, and the private sector on issues related to genetic engineering

Name, Project Function	Qualifications
Penny Kellar Document Management	▪ M.S. Ecology, University of California, Davis ▪ B.S. Conservation of Natural Resources, University of California, Berkeley ▪ 24 years of experience working with federal and state agencies, universities, and the private sector in communications about environmental issues and 4 years of experience in NEPA documents
Jim Laurenson Human Health	▪ M.S. Environmental Health Management with Technical Specialty in Risk Assessment, Harvard University School of Public Health ▪ B.S. Animal Science and Pre-veterinary Medicine, University of Massachusetts ▪ 20 years of experience conducting and managing environmental- and human health-related projects
Jason Londo Biological Resources – Plants	▪ Ph.D. Plant Biology, Washington University ▪ B.S. Molecular Biology, Florida Institute of Technology ▪ 3 years of experience in plant population biology and ecology ▪ 6 years of experience in plant population genetics
Bryan Luukinen Human Health	▪ M.S.P.H., Environmental Sciences and Engineering, focus on Environmental Health Sciences, Gillings School of Global Public Health, University of North Carolina-Chapel Hill ▪ B.A. Biology, Willamette University, Salem, OR ▪ 5+ years of experience in technical writing and editing; 3 years experience as a Pesticide Specialist for the National Pesticide Information Center at Oregon State University. Experience in risk assessment, risk communication, and toxicology.
Meg McVey Biological Resources – Animals	▪ NATO Post Doctoral Fellowship, Oxford University, United Kingdom ▪ Ph.D. Animal Behavior and Ecology, The Rockefeller University, New York, NY ▪ B.S. Zoology, University of North Carolina ▪ 30 years of experience in human health and ecological risk assessment
Michael Smith Project Management	▪ Ph.D. Sociology, Utah State University ▪ M.A. Geography, University of Wyoming ▪ B.A. Environmental Studies, University of California, Santa Cruz ▪ 16 years of experience in environmental impact analysis

Name, Project Function	Qualifications
Alex Uriarte Socioeconomics	▪ Ph.D. Development Studies, University of Wisconsin, Madison ▪ M.S. Economics, University of Wisconsin, Madison ▪ M.S. Business Economics, Getúlio Vargas Foundation, São Paulo ▪ B.A. Economics, University of São Paulo ▪ 11 years of experience in socioeconomic assessments and studies, and management and monitoring of economic development projects
Jenna Wallis Project Coordination	▪ M.E.M. Environmental Economics and Policy, Duke University ▪ B.S. Environmental Conservation Studies, University of New Hampshire ▪ 1 year of experience in environmental impact analysis ▪ 3 years of experience in environmental policy
Hova Woods Project Management	▪ M.P.A. Environmental Policy and Management, Indiana University ▪ B.S. Finance, concentration in Science and Technology, Indiana University ▪ 9 years of experience in environmental impact analysis

Appendix B. Distribution List

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Appendix C. Petitioner’s Submission

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or

*http://www.aphis.usda.gov/brs/aphisdocs2/03_32301p_a1.pdf***)**

Appendix D. Sample Compliance Agreement

UNITED STATES DEPARTMENT OF AGRICULTURE ANIMAL AND PLANT HEALTH INSPECTION SERVICE BIOTECHNOLOGY REGULATORY SERVICES	COMPLIANCE AGREEMENT
1. RESPONSIBLE ENTITY NAME AND ADDRESS	2. AUTHORIZED REPRESENTATIVE NAME AND ADDRESS

3. ARTICLE(S)

H7-1 Sugar Beet Root Crop

4. APPLICABLE FEDERAL STATUTES OR REGULATIONS

Plant Protection Act of 2000, as amended

5. I/WE AGREE TO THE FOLLOWING:

This compliance agreement is required as a condition for partial deregulation of the H7-1 sugar beet root crop and is a legally binding and enforceable agreement that authorizes root crop production activities by the Responsible Entity named above and all persons engaging in root crop production activities in association with or on behalf of the Responsible Entity. By signing this compliance agreement, the authorized representative of the Responsible Entity confirms his/her authority to sign the agreement on behalf of the Responsible Entity named above and all persons engaging in root crop production activities in association with or on behalf of the Responsible Entity. The Responsible Entity confirms its understanding of the requirements/conditions set forth in the agreement and confirms that the Responsible Entity and all persons conducting root crop production activities under this compliance agreement will comply with the requirements/conditions of the agreement. The mandatory requirements/conditions under this agreement are outlined and attached as Appendix A and incorporated into this agreement by reference. The Responsible Entity named above designates XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXX as an Authorized Representative and a point of contact in connection with the performance of this agreement.

6. SIGNATURE	7. TITLE	8. DATE SIGNED
The affixing of the signatures below will validate this agreement which shall remain in effect until canceled, but may be revised as necessary or revoked for noncompliance.		9. AGREEMENT NUMBER 10. DATE OF AGREEMENT
11. BRS OFFICIAL (NAME AND TITLE) 13. SIGNATURE		12. ADDRESS
14. US GOVERNMENT/STATE AGENCY 16. SIGNATURE		15. ADDRESS

Appendix A

The following mandatory requirements/conditions apply to the responsible entity and any person conducting root crop production activities (from obtaining/shipping seed for planting to the transportation of the root crop to the processing facility) in association with or on behalf of the responsible entity under this compliance agreement. The term person in this paragraph includes any individual, partnership, corporation, association, joint venture, or other legal entity.

General Administrative Requirements/Conditions:

Information Required: The responsible entity, through its authorized representative, shall submit to APHIS/BRS, no later than 28 days (emailed or postmarked) after the first day of planting under this compliance agreement and every 28 days thereafter until all planting is completed, a planting report (refer to "RRSB _example planting report") that must include the following information: the names and addresses of all growers, the county and state where each release (planting) occurred, at least one GPS coordinate for each release site and the location of the GPS coordinate (e.g., NW corner of the field), confirmation that the release site has been in agricultural production for at least the past three years, the exact planting date(s) for each release site, and the actual acreage planted at each site. Each report shall include plantings occurring during the prior 28 days (to extent such information is reasonably available at the time of the report) and information for plantings occurring in prior reporting periods for which information was not available at the time the prior report was submitted. The reports may be submitted electronically via email at RRSB.BRS@aphis.usda.gov or via mail at: USDA/APHISIBRS Attn. RRSB Planting Reports, 4700 River Road Unit 91, Riverdale, MD 20737; please for an example of a planting report.

The responsible entity through its authorized representative shall notify APHIS/BRS (via email at RRSB.BRS@aphis.usda.gov, via phone at (301) 734-5690), within 48 hours, of any change in the information provided to APHIS/BRS, either upon application for a compliance agreement or at anytime thereafter, regarding planting and/or movement/importation activities (e.g., changes/updates to planting locations, GPS coordinates, shipping addresses for seed and/or root movement).

Reporting of Incidents of Noncompliance: The responsible entity through its authorized representative shall notify APHIS/BRS, verbally (301-734-5690) and in writing via email (RRSB.BRS@aphis.usda.gov), within 24 hours, after becoming aware of unauthorized releases and/or movements. In addition, the responsible entity through its authorized representative shall notify APHIS/BRS, verbally (301-734-5690) and in writing via email (RRSB.BRS@aphis.usda.gov), within 48 hours, after becoming aware of any instance of noncompliance with the conditions of the compliance agreement. In incidents involving unauthorized releases and/or noncompliance, growers shall give notice immediately to the responsible entity so that the responsible entity may notify APHIS/BRS. When contacting APHIS/BRS, the authorized representative shall describe the incident, the date it occurred, the location (including county and state and GPS coordinate(s) of release site), name and address of grower, and field personnel associated with the incident. The authorized representative shall also provide immediate or short term corrective actions and, if necessary and available, long-term plans to return the situation to compliance and prevent similar incidents from occurring in the future. APHIS/BRS will review the information provided by the authorized representative and request additional information, if necessary, within 24 hours of the receipt of the notice. APHIS/BRS may require additional corrective actions if APHIS/BRS deems it necessary. The responsible entity and all persons engaged in root crop production activities in association with or on behalf of the responsible entity must cooperate with APHIS/BRS until the situation is resolved and the incident brought back to compliance. APHIS/BRS will record the incident and submit a response in writing, summarizing the incident and corrective measures, as per APHIS standard procedure in handling noncompliance incidents, to the authorized representative, no later than 10 days of the receipt of the notice.

Third Party Inspections and Audits

Third Party Inspections**:** APHIS/BRS will evaluate the third party inspectors' credentials provided by the responsible entity through its authorized representative in the request for the compliance agreement. The credentials will be evaluated for information such as, prior experience with biotechnology inspections, general experience in conducting inspections, and overall experience/background in agriculture. After evaluating the inspectors' credentials, APHIS will notify the authorized representative which third party inspectors it believes are qualified to conduct H7-1 sugar beet root crop inspections on behalf of the Agency. The responsible entity will have fifteen business days, from the date of the notice, to retain the services of the third party inspector(s). The responsible entity may choose to retain the services of one or more of the APHIS approved inspectors. Upon retaining the services of the third party inspector(s), the authorized representative shall supply the name(s) of the third party inspector(s) to APHIS/BRS. APHIS officials will contact the third party inspectors to schedule inspection training. (APHIS will provide an inspection form to be used by inspectors to capture inspection data.) The third party inspectors will schedule and conduct inspections according to APHIS' instructions. APHIS/BRS will coordinate with a third party inspector to randomly choose a statistically representative sample of fields, from those fields designated by APHIS to inspect, to conduct inspection for bolters (to satisfy condition 5 under Requirements/Conditions for Planting of the Root Crop). The third party inspectors will submit inspection reports directly to APHIS and APHIS will work directly with the inspectors if the reports require additional information. A large number of the root production fields and facilities will be inspected by the third party inspectors, sufficient to give statistically significant conclusions ($p=0.05$) on overall compliance. If the Compliance Agreement only covers seed movements, no third party inspectors are required.

Third Party Audits: APHIS/BRS will evaluate the third party auditors' credentials provided by the responsible entity through its authorized representative in the request for the compliance agreement. The credentials will be evaluated for information such as, prior experience with biotechnology inspections, general experience in conducting inspections, and overall experience/background in agriculture. After evaluating the auditors' credentials, APHIS will notify the authorized representative which third party auditors it believes are qualified to conduct H7-1 sugar beet root crop audits on behalf of the Agency. The responsible entity will have fifteen business days, from the date of the notice, to retain the services of the third party auditor(s). The responsible entity may choose to retain the services of one or more of the APHIS-approved auditors. Upon retaining the services of the third party auditor(s), the authorized representative shall supply the name(s) of the third party auditor(s) to APHIS/BRS. APHIS officials will contact the third party auditors to schedule audit training. APHIS will provide an audit form to be used by auditors to capture audit information. The third party auditors will schedule and conduct audits according to APHIS' instructions. APHIS will require third party auditors to review shipping records and/or grower records and to submit auditing reports directly to APHIS for review. APHIS will work directly with the auditors if the reports require additional information.

All Activities conducted by the responsible entity and any person engaging in root crop production activities in association with or on behalf of the root crop entity to comply with compliance agreement requirements/conditions may be either inspected or audited by APHIS or third party inspectors or auditors or both.

Access to Records, Planting Locations, and Facilities: The responsible entity shall ensure that all persons conducting root crop production activities under this compliance agreement provide access to all records required to be maintained under this compliance agreement and provide access, during regular business hours, to inspect planting locations, facilities, and transport vehicles, upon request by APHIS/BRS or its authorized representative(s).

Training: The responsible entity shall ensure that all persons conducting root crop production activities under this compliance agreement receive a copy of this compliance agreement and are trained in the processes and procedures necessary to comply with the terms of this compliance agreement. In addition, the responsible entity shall ensure that written documentation of the training is maintained and that all training records are maintained for the duration of this compliance agreement.

Duration of Compliance Agreement: This compliance agreement is valid and effective from the date of issuance (i.e. the date signed by APHIS/BRS) until December 31, 2012, unless revoked or superseded by APHIS/BRS. (The December 31, 2012 date does not preclude the responsible entity from ensuring that monitoring for volunteers continues through the end of the three-year monitoring period as set forth in the compliance agreement).

Cancellation or Revocation of Compliance Agreement: A violation of the requirements/conditions of this compliance agreement is a violation of the Plant Protection Act. In the event of a finding of noncompliance or violation of the requirements/conditions of the compliance agreement, APHIS may, at its discretion, revise, suspend, revoke, or otherwise withdraw the compliance agreement. APHIS may also, at its discretion, use the full range of the Plant Protection Act authorities to impose, as appropriate, criminal and/or civil penalties against any person conducting root crop production activities in violation of this agreement and may take remedial measures including seizure, quarantine, and/or destruction of any H7-1 sugar beet root crop production that is found to be in violation of the conditions set forth in the compliance agreement.

Requirements/Conditions for Planting of the Root Crop:

1. Planting of H7-1 sugar beet seed for root production is not allowed in the state of California, and the following counties in Washington State: Clallam, Clark, Cowlitz, Grays Harbor, Island, Jefferson, King, Kitsap, Lewis, Mason, Pacific, Pierce, San Juan, Skagit, Skamania, Snohomish, Thurston, Wahkiakum, and Whatcom.

2. The planting of H7-1 sugar beet seed for root crop production is only allowed in the following states: Arizona, Colorado, Idaho, Michigan, Minnesota, Montana, Nebraska, North Dakota, Oregon, Washington, and Wyoming.

3. The planting of H7-1 sugar beet seed for root production is only allowed in sites that have been in agricultural production for at least three years prior to planting.

4. Root growers shall ensure that root crop fields are surveyed to identify and eliminate any bolters before they produce pollen or set seed. Fields shall be surveyed at least once every 3-4 weeks beginning April 1. Root growers shall ensure that field personnel maintain

records of their field observations and removal of bolters. Reports where bolters are not observed must be maintained as well. If bolters are found, the responsible entity through its authorized representative shall ensure that APHIS/BRS is notified (via email at RRSB.BRS@aphis.usda.gov, via phone at (301) 851-3867), within 48 hours after finding the bolters, and provided a description of the location and action taken by the field personnel to remove them. The responsible entity shall ensure that all records of inspection and bolter removal are maintained for the duration of this compliance agreement.

5. Third party inspectors procured by the responsible entity (see **Third Party Inspections and Audits** above) will coordinate with APHIS/BRS to randomly choose a statistically representative sample of fields, from those fields designated by APHIS to inspect, to conduct inspection for bolters. (This third party inspection is in addition to the requirement in paragraph 4 above that root growers survey their fields at least once every 3-4 weeks.) If bolters are identified, the root grower shall be notified immediately and those bolters must be removed.

6. Planting/cultivating/harvesting equipment that might be used in chard/red beet production shall not be used or shared for regulated GE material in the same growing year.

7. The responsible entity shall ensure root crop fields are monitored for volunteers for three-years (at least twice per year during the growing season) following harvest, and any volunteer plants must be destroyed. If the same land is used for crop cultivation during the volunteer monitoring period, that crop shall be visually distinct from sugar beets or the fields must be left fallow. The responsible entity shall ensure that records of observations are maintained for the volunteer monitoring period.

8. The responsible entity shall ensure that root growers maintain records of all the activities being carried out under the compliance agreements to demonstrate adherence to the mandatory conditions and restrictions.

Requirements/Conditions for Movement of the Seed for Root Crop Production:

1. The responsible entity shall ensure that, during transport of seed for root crop production, chain of custody and records (such as manifests or receipts) are maintained for the duration of this compliance agreement. Sugar beet seeds shall be transported in a sealed plastic bag(s), envelope(s), or other suitable container(s) (primary container) to prevent seed loss.

2. The primary container for transporting seeds shall be placed inside a sealed secondary container that is independently capable of preventing spillage or loss of seed during transport.

3. Each set of containers (primary and secondary) for transporting seeds shall then be enclosed in a sturdy outer shipping container constructed of corrugated fiberboard, corrugated cardboard, wood, or other material of equivalent strength. Each container shall clearly identify that the seed contents within shall only be used for the planting of sugar beet root crop.
4. The shipping containers for transporting seeds shall be transported in enclosed trucks or trailers with closed sides (unless the seed is already packaged with sufficient levels of packaging as described above).

Requirements/Conditions for Movement of the Root Crop for Processing:

1. The responsible entity shall ensure that, during transport of the root crop to a processing facility or any intermediate holding area, chain of custody and records (such as manifests or receipts) are maintained for the duration of this compliance agreement.

2. Trucks used for the movement of root crop from field to storage/processing shall be loaded in a manner to minimize loss of beets during transport or equipped with a retaining device.

Appendix E.

Federally Listed Threatened and Endangered Species

Tables E–1 through E–12 list federally threatened and endangered plant and animal species, and species proposed for listing, in those States where sugar beets could be approved by the U.S. Department of Agriculture’s Animal and Plant Health Inspection Service and grown for seed production and marketable roots. These States include California, Colorado, Idaho, Michigan, Minnesota, Montana, Nebraska, North Dakota, Oregon, South Dakota, Washington, and Wyoming. The lists of species were obtained from the U.S. Fish and Wildlife Service Environmental Conservation Online System accessed on April 24, 2012 (http://www.fws.gov/endangered/species/index.html) (USFWS, 2011).

Table E- 1. Federally Threatened and Endangered Species in California

Status	Species/Listing Name	Critical Habitat
PLANTS		
Plant species listed in this State and that occur in this State – 179 species		
E	Allocarya, Calistoga (*Plagiobothrys strictus*)	N
E	Alopecurus, Sonoma (*Alopecurus aequalis* var. *sonomensis*)	N
E	Ambrosia, San Diego (*Ambrosia pumila*)	Y
T	Amole, purple (*Chlorogalum purpureum*)	Y
T	Baccharis, Encinitas (*Baccharis vanessae*)	N
E	Barberry, island (*Berberis pinnata ssp. insularis*)	N
E	Barberry, Nevin's (*Berberis nevinii*)	Y
E	Bedstraw, El Dorado (*Galium californicum ssp. sierrae*)	N
E	Bedstraw, island (*Galium buxifolium*)	N
E	Bird's beak, palmate-bracted (*Cordylanthus palmatus*)	N
E	Bird's-beak, Pennell's (*Cordylanthus tenuis ssp. capillaris*)	N
E	Bird's-beak, salt marsh (*Cordylanthus maritimus ssp. maritimus*)	N
E	Bird's-beak, soft (*Cordylanthus mollis ssp. mollis*)	Y
E	Bladderpod, San Bernardino Mountains (*Lesquerella kingii ssp. bernardina*)	Y
T	Bluecurls, Hidden Lake (*Trichostema austromontanum ssp. compactum*)	N
E	Bluegrass, Napa (*Poa napensis*)	N
E	Bluegrass, San Bernardino (*Poa atropurpurea*)	Y
T	Brodiaea, Chinese Camp (*Brodiaea pallida*)	N
T	Brodiaea, thread-leaved (*Brodiaea filifolia*)	Y
E	Broom, San Clemente Island (*Lotus dendroideus ssp. traskiae*)	N
E	Buckwheat, cushenbury (*Eriogonum ovalifolium* var. *vineum*)	Y
E	Buckwheat, Ione (incl. Irish Hill) (*Eriogonum apricum (incl.* var. *prostratum)*)	N
E	Bush-mallow, San Clemente Island (*Malacothamnus clementinus*)	N
E	Bush-mallow, Santa Cruz Island (*Malacothamnus fasciculatus* var. *nesioticus*)	N
T	Butterweed, Layne's (*Senecio layneae*)	N
E	Button-celery, San Diego (*Eryngium aristulatum* var. *parishii*)	N
E	Cactus, Bakersfield (*Opuntia treleasei*)	N
E	Ceanothus, coyote (*Ceanothus ferrisae*)	N
E	Ceanothus, Pine Hill (*Ceanothus roderickii*)	N
T	Ceanothus, Vail Lake (*Ceanothus ophiochilus*)	Y
T	Centaury, spring-loving (*Centaurium namophilum*)	Y
E	Checker-mallow, Keck's (*Sidalcea keckii*)	Y
E	Checker-mallow, Kenwood Marsh (*Sidalcea oregana ssp. valida*)	N
E	Checker-mallow, pedate (*Sidalcea pedata*)	N
E	Clarkia, Pismo (*Clarkia speciosa ssp. immaculata*)	N
E	Clarkia, Presidio (*Clarkia franciscana*)	N
T	Clarkia, Springville (*Clarkia springvillensis*)	N
E	Clarkia, Vine Hill (*Clarkia imbricata*)	N
E	Clover, Monterey (*Trifolium trichocalyx*)	N

Table E- 1. Federally Threatened and Endangered Species in California

Status	Species/Listing Name	Critical Habitat
E	Clover, showy Indian (*Trifolium amoenum*)	N
T	Crownbeard, big-leaved (*Verbesina dissita*)	N
E	Crownscale, San Jacinto Valley (*Atriplex coronata* var. *notatior*)	Y
T	Cypress, Gowen (*Cupressus goveniana ssp. goveniana*)	N
E	Cypress, Santa Cruz (*Cupressus abramsiana*)	N
T	Daisy, Parish's (*Erigeron parishii*)	Y
T	Dudleya, Conejo (*Dudleya abramsii* ssp. *parva*)	N
T	Dudleya, marcescent (*Dudleya cymosa* ssp. *marcescens*)	N
E	Dudleya, Santa Clara Valley (*Dudleya setchellii*)	N
T	Dudleya, Santa Cruz Island (*Dudleya nesiotica*)	N
T	Dudleya, Verity's (*Dudleya verityi*)	N
T	Dudleyea, Santa Monica Mountains (*Dudleya cymosa* ssp. *ovatifolia*)	N
T	Dwarf-flax, Marin (*Hesperolinon congestum*)	N
E	Evening-primrose, Antioch Dunes (*Oenothera deltoides* ssp. *howellii*)	Y
E	Evening-primrose, Eureka Valley (*Oenothera avita* ssp. *eurekensis*)	N
T	Evening-primrose, San Benito (*Camissonia benitensis*)	N
E	Fiddleneck, large-flowered (*Amsinckia grandiflora*)	Y
E	Flannelbush, Mexican (*Fremontodendron mexicanum*)	Y
E	Flannelbush, Pine Hill (*Fremontodendron californicum* ssp. *decumbens*)	N
E	Fringepod, Santa Cruz Island (*Thysanocarpus conchuliferus*)	N
E	Gilia, Hoffmann's slender-flowered (*Gilia tenuiflora* ssp. *hoffmannii*)	N
E	Gilia, Monterey (*Gilia tenuiflora* ssp. *arenaria*)	N
E	Goldfields, Burke's (*Lasthenia burkei*)	N
E	Goldfields, Contra Costa (*Lasthenia conjugens*)	Y
T	Grass, Colusa (*Neostapfia colusana*)	Y
E	Grass, Eureka Dune (*Swallenia alexandrae*)	N
E	Grass, Solano (*Tuctoria mucronata*)	Y
T	Gumplant, Ash Meadows (*Grindelia fraxino-pratensis*)	Y
T	Howellia, water (*Howellia aquatilis*)	N
E	Indian paintbrush, San Clemente Island (*Castilleja grisea*)	N
E	Jewelflower, California (*Caulanthus californicus*)	N
E	Jewelflower, Metcalf Canyon (*Streptanthus albidus* ssp. *albidus*)	N
E	Jewelflower, Tiburon (*Streptanthus niger*)	N
E	Larkspur, Baker's (*Delphinium bakeri*)	Y
E	Larkspur, San Clemente Island (*Delphinium variegatum* ssp. *kinkiense*)	N
E	Larkspur, yellow (*Delphinium luteum*)	Y
E	Layia, beach (*Layia carnosa*)	N
E	Lessingia, San Francisco (*Lessingia germanorum (= L.g.* var. *germanorum)*)	N
E	Lily, Pitkin Marsh (*Lilium pardalinum* ssp. *pitkinense*)	N
E	Lily, Western (*Lilium occidentale*)	N
T	Liveforever, Laguna Beach (*Dudleya stolonifera*)	N

Table E- 1. Federally Threatened and Endangered Species in California

Status	Species/Listing Name	Critical Habitat
E	Liveforever, Santa Barbara Island (*Dudleya traskiae*)	N
E	Lupine, clover (*Lupinus tidestromii*)	N
E	Lupine, Nipomo Mesa (*Lupinus nipomensis*)	N
E	Malacothrix, island (*Malacothrix squalida*)	N
E	Malacothrix, Santa Cruz Island (*Malacothrix indecora*)	N
E	Mallow, Kern (*Eremalche kernensis*)	N
E	Manzanita, Del Mar (*Arctostaphylos glandulosa* ssp*. crassifolia*)	N
T	Manzanita, Ione (*Arctostaphylos myrtifolia*)	N
T	Manzanita, Morro (*Arctostaphylos morroensis*)	N
T	Manzanita, pallid (*Arctostaphylos pallida*)	N
E	Manzanita, Presidio (*Arctostaphylos hookeri* var. *ravenii*)	N
E	Manzanita, Santa Rosa Island (*Arctostaphylos confertiflora*)	N
T	Mariposa lily, Tiburon (*Calochortus tiburonensis*)	N
E	Meadowfoam, Butte County (*Limnanthes floccosa* ssp*. californica*)	N
E	Meadowfoam, Sebastopol (*Limnanthes vinculans*)	N
E	Mesa-mint, Otay (*Pogogyne nudiuscula*)	N
E	Mesa-mint, San Diego (*Pogogyne abramsii*)	N
E	Milk-vetch, Braunton's (*Astragalus brauntonii*)	Y
E	Milk-vetch, Clara Hunt's (*Astragalus clarianus*)	N
E	Milk-vetch, Coachella Valley (*Astragalus lentiginosus* var. *coachellae*)	Y
E	Milk-vetch, coastal dunes (*Astragalus tener* var. *titi*)	N
E	Milk-vetch, Cushenbury (*Astragalus albens*)	Y
T	Milk-vetch, Fish Slough (*Astragalus lentiginosus* var. *piscinensis*)	Y
E	Milk-vetch, Lane Mountain (*Astragalus jaegerianus*)	Y
T	Milk-vetch, Peirson's (*Astragalus magdalenae* var. *peirsonii*)	Y
E	Milk-vetch, triple-ribbed (*Astragalus tricarinatus*)	N
E	Milk-vetch, Ventura Marsh (*Astragalus pycnostachyus* var. *lanosissimus*)	Y
E	Monardella, willowy (*Monardella linoides* ssp*. viminea*)	Y
E	Morning-glory, Stebbins' (*Calystegia stebbinsii*)	N
E	Mountain balm, Indian Knob (*Eriodictyon altissimum*)	N
E	Mountain-mahogany, Catalina Island (*Cercocarpus traskiae*)	N
E	Mustard, slender-petaled (*Thelypodium stenopetalum*)	N
E	Navarretia, few-flowered (*Navarretia leucocephala* ssp*. pauciflora (= N. pauciflora)*)	N
E	Navarretia, many-flowered (*Navarretia leucocephala* ssp*. plieantha*)	N
T	Navarretia, spreading (*Navarretia fossalis*)	Y
E	Niterwort, Amargosa (*Nitrophila mohavensis*)	Y
E	Onion, Munz's (*Allium munzii*)	Y
E	Orcutt grass, California (*Orcuttia californica*)	N
E	Orcutt grass, hairy (*Orcuttia pilosa*)	Y
E	Orcutt grass, Sacramento (*Orcuttia viscida*)	Y
T	Orcutt grass, San Joaquin (*Orcuttia inaequalis*)	Y

Table E- 1. Federally Threatened and Endangered Species in California

Status	Species/Listing Name	Critical Habitat
T	Orcutt grass, slender (*Orcuttia tenuis*)	Y
T	Owl's-clover, fleshy (*Castilleja campestris* ssp. *succulenta*)	Y
E	Oxytheca, cushenbury (*Oxytheca parishii* var. *goodmaniana*)	Y
T	Paintbrush, ash-grey (*Castilleja cinerea*)	Y
E	Paintbrush, soft-leaved (*Castilleja mollis*)	N
E	Paintbrush, Tiburon (*Castilleja affinis* ssp. *neglecta*)	N
E	Penny-cress, Kneeland Prairie (*Thlaspi californicum*)	Y
E	Pentachaeta, Lyon's (*Pentachaeta lyonii*)	Y
E	Pentachaeta, white-rayed (*Pentachaeta bellidiflora*)	N
E	Phacelia, island (*Phacelia insularis* ssp. *insularis*)	N
E	Phlox, Yreka (*Phlox hirsuta*)	N
E	Piperia, Yadon's (*Piperia yadonii*)	Y
E	Polygonum, Scotts Valley (*Polygonum hickmanii*)	Y
E	Potentilla, Hickman's (*Potentilla hickmanii*)	N
T	Pussypaws, Mariposa (*Calyptridium pulchellum*)	N
E	Rock-cress, Hoffmann's (*Arabis hoffmannii*)	N
E	Rock-cress, McDonald's (*Arabis macdonaldiana*)	N
E	Rockcress, Santa Cruz Island (*Sibara filifolia*)	N
T	Rush-rose, island (*Helianthemum greenei*)	N
T	Sandwort, Bear Valley (*Arenaria ursina*)	Y
E	Sandwort, Marsh (*Arenaria paludicola*)	N
E	Seablite, California (*Suaeda californica*)	N
E	Sedge, white (*Carex albida*)	N
E	Spineflower, Ben Lomond (*Chorizanthe pungens* var. *hartwegiana*)	N
E	Spineflower, Howell's (*Chorizanthe howellii*)	N
T	Spineflower, Monterey (*Chorizanthe pungens* var. *pungens*)	Y
E	Spineflower, Orcutt's (*Chorizanthe orcuttiana*)	N
E	Spineflower, Robust (incl. Scotts Valley) (*Chorizanthe robusta (incl.* vars. *robusta and hartwegii)*)	Y
E	Spineflower, slender-horned (*Dodecahema leptoceras*)	N
E	Spineflower, Sonoma (*Chorizanthe valida*)	N
T	Spurge, Hoover's (*Chamaesyce hooveri*)	Y
E	Stonecrop, Lake County (*Parvisedum leiocarpum*)	N
E	Sunburst, Hartweg's golden (*Pseudobahia bahiifolia*)	N
T	Sunburst, San Joaquin adobe (*Pseudobahia peirsonii*)	N
E	Sunflower, San Mateo woolly (*Eriophyllum latilobum*)	N
E	Sunshine, Sonoma (*Blennosperma bakeri*)	N
E	Taraxacum, California (*Taraxacum californicum*)	Y
E	Tarplant, Gaviota (*Deinandra increscens* ssp. *villosa*)	Y
T	Tarplant, Otay (*Deinandra (= Hemizonia) conjugens*)	Y
T	Tarplant, Santa Cruz (*Holocarpha macradenia*)	Y

Table E- 1. Federally Threatened and Endangered Species in California

Status	Species/Listing Name	Critical Habitat
E	Thistle, Chorro Creek bog (*Cirsium fontinale* var. *obispoense*)	N
E	Thistle, fountain (*Cirsium fontinale* var. *fontinale*)	N
E	Thistle, La Graciosa (*Cirsium loncholepis*)	Y
E	Thistle, Loch Lomond coyote (*Eryngium constancei*)	N
E	Thistle, Suisun (*Cirsium hydrophilum* var. *hydrophilum*)	Y
T	Thornmint, San Diego (*Acanthomintha ilicifolia*)	Y
E	Thornmint, San Mateo (*Acanthomintha obovata* ssp*. duttonii*)	N
E	Tuctoria, Greene's (*Tuctoria greenei*)	Y
T	Vervain, Red Hills (*Verbena californica*)	N
E	Wallflower, Ben Lomond (*Erysimum teretifolium*)	N
E	Wallflower, Contra Costa (*Erysimum capitatum* var. *angustatum*)	Y
E	Wallflower, Menzies' (*Erysimum menziesii*)	N
E	Watercress, Gambel's (*Rorippa gambellii*)	N
T	Wild-buckwheat, southern mountain (*Eriogonum kennedyi* var. *austromontanum*)	Y
E	Woodland-star, San Clemente Island (*Lithophragma maximum*)	N
E	Woolly-star, Santa Ana River (*Eriastrum densifolium* ssp. *sanctorum*)	N
E	Wooly-threads, San Joaquin (*Monolopia (= Lembertia) congdonii*)	N
E	Yerba santa, Lompoc (*Eriodictyon capitatum*)	Y
Plant listed species occurring in this State that are not listed in this State – 4 species		
E	Fritillary, Gentner's (*Fritillaria gentneri*)	N
T	Ivesia, Ash Meadows (*Ivesia kingie var. eremica*)	Y
T	Milk-vetch, Ash meadows (*Astragalus phoenix*)	Y
T	Sunray, Ash Meadows (*Enceliopsis nudicaulis var. corrugate*)	Y
	Plant species proposed for listing in this State – 1 species	
PE	Manzanita, San Francisco (*Arctostaphylos franciscana*)	N
ANIMALS		
Animal species listed in this State and that occur in this State – 124 species		
E	Abalone, White North America (West Coast from Point Conception, CA, United States, to Punta Abreojos, Baja California, Mexico) (*Haliotis sorenseni*)	N
E	Albatross, short-tailed (*Phoebastria (= Diomedea) albatrus*)	N
T	Beetle, delta green ground (*Elaphrus viridis*)	Y
E	Beetle, Mount Hermon June (*Polyphylla barbata*)	N
T	Beetle, valley elderberry longhorn (*Desmocerus californicus dimorphus*)	Y
T	Butterfly, bay checkerspot (*Euphydryas editha bayensis*)	Y
E	Butterfly, Behren's silverspot (*Speyeria zerene behrensii*)	N
E	Butterfly, callippe silverspot (*Speyeria callippe callippe*)	Y
E	Butterfly, El Segundo blue (*Euphilotes battoides allyni*)	Y
E	Butterfly, Lange's metalmark (*Apodemia mormo langei*)	Y
E	Butterfly, lotis blue (*Lycaeides argyrognomon lotis*)	Y
E	Butterfly, mission blue (*Icaricia icarioides missionensis*)	Y
E	Butterfly, Myrtle's silverspot (*Speyeria zerene myrtleae*)	N

Table E- 1. Federally Threatened and Endangered Species in California

Status	Species/Listing Name	Critical Habitat
T	Butterfly, Oregon silverspot (*Speyeria zerene hippolyta*)	Y
E	Butterfly, Palos Verdes blue (*Glaucopsyche lygdamus palosverdesensis*)	Y
E	Butterfly, Quino checkerspot (*Euphydryas editha quino (= E. e. wrighti)*)	Y
E	Butterfly, San Bruno elfin (*Callophrys mossii bayensis*)	Y
E	Butterfly, Smith's blue (*Euphilotes enoptes smithi*)	Y
E	Chub, bonytail entire (*Gila elegans*)	Y
E	Chub, Mohave tui (*Gila bicolor mohavensis*)	N
E	Chub, Owens tui (*Gila bicolor snyderi*)	Y
E	Condor, California, United States only (*Gymnogyps californianus*)	Y
E	Crayfish, Shasta (*Pacifastacus fortis*)	N
E	Fairy shrimp, Conservancy (*Branchinecta conservatio*)	Y
E	Fairy shrimp, longhorn (*Branchinecta longiantenna*)	Y
E	Fairy shrimp, Riverside (*Streptocephalus woottoni*)	Y
E	Fairy shrimp, San Diego (*Branchinecta sandiegonensis*)	Y
T	Fairy shrimp, vernal pool (*Branchinecta lynchi*)	Y
E	Fly, Delhi Sands flower-loving (*Rhaphiomidas terminatus abdominalis*)	N
E	Flycatcher, southwestern willow (*Empidonax traillii extimus*)	Y
E	Fox, San Joaquin kit (*Vulpes macrotis mutica*)	N
E	Fox, San Miguel Island (*Urocyon littoralis littoralis*)	Y
E	Fox, Santa Catalina Island (*Urocyon littoralis catalinae*)	Y
E	Fox, Santa Cruz Island (*Urocyon littoralis santacruzae*)	Y
E	Fox, Santa Rosa Island (*Urocyon littoralis santarosae*)	Y
T	Frog, California red-legged Entire (*Rana draytonii*)	Y
E	Frog, mountain yellow-legged southern California DPS (*Rana muscosa*)	Y
T	Gnatcatcher, coastal California (*Polioptila californica californica*)	Y
E	Goby, tidewater Entire (*Eucyclogobius newberryi*)	Y
E	Grasshopper, Zayante band-winged (*Trimerotropis infantilis*)	Y
E	June Beetle, Caseys (*Dinacoma caseyi*)	Y
E	Kangaroo rat, Fresno (*Dipodomys nitratoides exilis*)	Y
E	Kangaroo rat, giant (*Dipodomys ingens*)	N
E	Kangaroo rat, Morro Bay (*Dipodomys heermanni morroensis*)	Y
E	Kangaroo rat, San Bernardino Merriam's (*Dipodomys merriami parvus*)	Y
E	Kangaroo rat, Stephens' (*Dipodomys stephensi* (incl. *D. cascus)*)	N
E	Kangaroo rat, Tipton (*Dipodomys nitratoides nitratoides*)	N
E	Lizard, blunt-nosed leopard (*Gambelia silus*)	N
T	Lizard, Coachella Valley fringe-toed (*Uma inornata*)	Y
T	Lizard, Island night (*Xantusia riversiana*)	N
T	Moth, Kern primrose sphinx (*Euproserpinus euterpe*)	Y
E	Mountain beaver, Point Arena (*Aplodontia rufa nigra*)	N
E	Mouse, Pacific pocket (*Perognathus longimembris pacificus*)	N
E	Mouse, salt marsh harvest (*Reithrodontomys raviventris*)	N

Table E- 1. Federally Threatened and Endangered Species in California

Status	Species/Listing Name	Critical Habitat
T	Murrelet, marbled CA, OR, WA (*Brachyramphus marmoratus*)	Y
T	Otter, southern sea except where EXPN (*Enhydra lutris nereis*)	N
T	Owl, northern spotted (*Strix occidentalis caurina*)	Y
E	Pikeminnow (= squawfish), Colorado except Salt and Verde River drainages, AZ (*Ptychocheilus lucius*)	Y
T	Plover, western snowy Pacific coastal pop. (*Charadrius alexandrinus nivosus*)	Y
E	Pupfish, desert (*Cyprinodon macularius*)	Y
E	Pupfish, Owens (*Cyprinodon radiosus*)	N
E	Rabbit, riparian brush (*Sylvilagus bachmani riparius*)	N
E	Rail, California clapper (*Rallus longirostris obsoletus*)	N
E	Rail, light-footed clapper, United States only (*Rallus longirostris levipes*)	N
E	Rail, Yuma clapper, United States only (*Rallus longirostris yumanensis*)	N
E	Salamander, California tiger, United States (CA - Santa Barbara County) (*Ambystoma californiense*)	Y
E	Salamander, California tiger, United States (CA - Sonoma County) (*Ambystoma californiense*)	Y
T	Salamander, California tiger, United States (Central CA DPS) (*Ambystoma californiense*)	Y
E	Salamander, desert slender (*Batrachoseps aridus*)	N
E	Salamander, Santa Cruz long-toed (*Ambystoma macrodactylum croceum*)	Y
T	Salmon, chinook CA Central Valley spring-run (*Oncorhynchus (= Salmo) tshawytscha*)	Y
T	Salmon, chinook CA coastal (*Oncorhynchus (= Salmo) tshawytscha*)	Y
E	Salmon, chinook winter Sacramento River (*Oncorhynchus (= Salmo) tshawytscha*)	Y
T	Salmon, coho OR, CA pop. (*Oncorhynchus (= Salmo) kisutch*)	Y
E	Salmon, coho central CA coast (*Oncorhynchus (= Salmo) kisutch*)	Y
T	Sea turtle, green except where endangered (*Chelonia mydas*)	Y
E	Sea turtle, leatherback (*Dermochelys coriacea*)	Y
T	Sea turtle, loggerhead (*Caretta caretta*)	Y
T	Sea turtle, olive Ridley, except where endangered (*Lepidochelys olivacea*)	N
T	Sea-lion, Steller, eastern pop. (*Eumetopias jubatus*)	Y
T	Seal, Guadalupe fur (*Arctocephalus townsendi*)	N
E	Sheep, Peninsular bighorn, Peninsular CA pop. (*Ovis canadensis nelsoni*)	Y
E	Sheep, Sierra Nevada bighorn, Sierra Nevada (*Ovis canadensis sierrae*)	Y
E	Shrew, Buena Vista Lake ornate (*Sorex ornatus relictus*)	Y
E	Shrike, San Clemente loggerhead (*Lanius ludovicianus mearnsi*)	N
E	Shrimp, California freshwater (*Syncaris pacifica*)	N
E	Skipper, Carson wandering (*Pseudocopaeodes eunus obscurus*)	N
E	Skipper, Laguna Mountains (*Pyrgus ruralis lagunae*)	Y
T	Smelt, delta (*Hypomesus transpacificus*)	Y
E	Snail, Morro shoulderband (= Banded dune) (*Helminthoglypta walkeriana*)	Y
T	Snake, giant garter (*Thamnophis gigas*)	N

Table E- 1. Federally Threatened and Endangered Species in California

Status	Species/Listing Name	Critical Habitat
E	Snake, San Francisco garter (*Thamnophis sirtalis tetrataenia*)	N
T	Sparrow, San Clemente sage (*Amphispiza belli clementeae*)	N
T	Steelhead, Central Valley, CA (*Oncorhynchus (= Salmo) mykiss*)	Y
T	Steelhead, central CA coast (*Oncorhynchus (= Salmo) mykiss*)	Y
T	Steelhead, northern CA (*Oncorhynchus (= Salmo) mykiss*)	Y
T	Steelhead, south central CA coast (*Oncorhynchus (= Salmo) mykiss*)	Y
E	Steelhead, southern CA coast (*Oncorhynchus (= Salmo) mykiss*)	Y
E	Stickleback, unarmored threespine (*Gasterosteus aculeatus williamsoni*)	Y
T	Sturgeon, North American green, United States (CA) Southern Distinct Population Segment (*Acipenser medirostris*)	N
E	Sucker, Lost River (*Deltistes luxatus*)	Y
E	Sucker, Modoc (*Catostomus microps*)	Y
E	Sucker, razorback, entire (*Xyrauchen texanus*)	Y
T	Sucker, Santa Ana, 3 CA river basins (*Catostomus santaanae*)	Y
E	Sucker, shortnose (*Chasmistes brevirostris*)	Y
E	Tadpole shrimp, vernal pool (*Lepidurus packardi*)	Y
E	Tern, California least (*Sterna antillarum browni*)	N
E	Tiger beetle, Ohlone (*Cicindela ohlone*)	N
E	Toad, arroyo (= arroyo southwestern) (*Bufo californicus (= microscaphus)*)	Y
T	Tortoise, desert, United States, except in Sonoran Desert (*Gopherus agassizii*)	Y
T	Towhee, Inyo California (*Pipilo crissalis eremophilus*)	Y
T	Trout, Lahontan cutthroat (*Oncorhynchus clarki henshawi*)	N
T	Trout, Little Kern golden (*Oncorhynchus aguabonita whitei*)	Y
T	Trout, Paiute cutthroat (*Oncorhynchus clarki seleniris*)	N
E	Vireo, least Bell's (*Vireo bellii pusillus*)	Y
E	Vole, Amargosa (*Microtus californicus scirpensis*)	Y
E	Whale, blue (*Balaenoptera musculus*)	N
E	Whale, finback (*Balaenoptera physalus*)	N
E	Whale, humpback (*Megaptera novaeangliae*)	N
E	Whale, killer Southern Resident DPS (*Orcinus orca*)	Y
E	Whale, Sei (*Balaenoptera borealis*)	N
E	Whale, sperm (*Physeter catodon (= macrocephalus)*)	N
T	Whipsnake (= striped racer), Alameda (*Masticophis lateralis euryxanthus*)	Y
E	Woodrat, riparian (= San Joaquin Valley) (*Neotoma fuscipes riparia*)	N
Animal species listed in this State that do not occur in this State – 5 species		
T	Bear, grizzly lower 48 States, except where listed as an experimental population or delisted (*Ursus arctos horribilis*)	Y
E	Jaguar (*Panthera onca*)	N
E	Sea-lion, Steller, western pop. (Eumetopias jubatus)	Y
T	Trout, bull, United States, conterminous, lower 48 States (Salvelinus confluentus)	Y
E	Wolf, gray lower 48 States, except MN and where EXPN. Mexico. (Canis lupus)	Y

Table E- 1. Federally Threatened and Endangered Species in California

Status	Species/Listing Name	Critical Habitat

Source: USFWS, 2011
Notes: T = threatened; E = endangered; EXPN = experimental population, non-essential; DPS = distinct population segment

Table E- 2. Federally Threatened and Endangered Species in Colorado

Status	Species/Listing Name	Critical Habitat
PLANTS		
Plant species listed in this State and that occur in this State – 16 species		
T	Beardtongue, Parachute (*Penstemon debilis*)	N
E	Beardtongue, Penland (*Penstemon penlandii*)	N
T	Bladderpod, Dudley Bluffs (*Lesquerella congesta*)	N
T	Butterfly plant, Colorado (*Gaura neomexicana* var. *coloradensis*)	Y
T	Cactus, Colorado hookless (*Sclerocactus glaucus*)	N
E	Cactus, Knowlton's (*Pediocactus knowltonii*)	N
T	Cactus, Mesa Verde (*Sclerocactus mesae-verdae*)	N
T	Ladies'-tresses, Ute (*Spiranthes diluvialis*)	N
E	Milk-vetch, Mancos (*Astragalus humillimus*)	N
E	Milk-vetch, Osterhout (*Astragalus osterhoutii*)	N
T	Mustard, Penland alpine fen (*Eutrema penlandii*)	N
T	Phacelia, DeBeque (*Phacelia submutica*)	N
E	Phacelia, North Park (*Phacelia formosula*)	N
E	Skyrocket, Pagosa (*Ipomopsis polyantha*)	N
T	Twinpod, Dudley Bluffs (*Physaria obcordata*)	N
E	Wild buckwheat, clay-loving (*Eriogonum pelinophilum*)	Y
ANIMALS		
Animal species listed in this State and that occur in this State – 16 species		
E	Butterfly, Uncompahgre fritillary (*Boloria acrocnema*)	N
E	Chub, bonytail, entire (*Gila elegans*)	Y
E	Chub, humpback, entire (*Gila cypha*)	Y
E	Crane, whooping, except where EXPN (*Grus americana*)	Y
E	Ferret, black-footed, entire population, except where EXPN (*Mustela nigripes*)	N
E	Flycatcher, southwestern willow (*Empidonax traillii extimus*)	Y
T	Lynx, Canada (contiguous United States DPS) (*Lynx canadensis*)	Y
T	Mouse, Preble's meadow jumping, United States, north-central CO (*Zapus hudsonius preblei*)	Y
T	Owl, Mexican spotted (*Strix occidentalis lucida*)	Y
E	Pikeminnow (= squawfish), Colorado except Salt and Verde River drainages, AZ (*Ptychocheilus lucius*)	N
T	Plover, piping except Great Lakes watershed (*Charadrius melodus*)	Y
T	Skipper, Pawnee, montane (*Hesperia leonardus montana*)	Y
E	Sucker, razorback, entire (*Xyrauchen texanus*)	Y

Table E- 2. Federally Threatened and Endangered Species in Colorado

Status	Species/Listing Name	Critical Habitat
E	Tern, least, interior pop. (*Sterna antillarum*)	N
T	Trout, greenback cutthroat (*Oncorhynchus clarki stomias*)	N
E	Wolf, gray, lower 48 States, except MN and where EXPN. Mexico. (*Canis lupus*)	Y
Animal species listed in this State that do not occur in this State – 1 species		
T	Bear, grizzly, lower 48 States, except where listed as an experimental population or delisted (*Ursus arctos horribilis*)	Y
	Plant species proposed for listing in this State – 1 species	
PT	Beardtongue, Graham (*Penstemon grahamii*)	N

Source: USFWS, 2011
Notes: T = threatened; E = endangered; PT = proposed threatened; PE = proposed endangered; EXPN = experimental population, non-essential; DPS = distinct population segment

Table E- 3. Federally Threatened and Endangered Species in Idaho

Status	Species/Listing Name	Critical Habitat
PLANTS		
Plant species listed in this State and that occur in this State – 5 species		
T	Catchfly, Spalding's (*Silene spaldingii*)	N
T	Four-o'clock, MacFarlane's (*Mirabilis macfarlanei*)	N
T	Howellia, water (*Howellia aquatilis*)	N
T	Ladies'-tresses, Ute (*Spiranthes diluvialis*)	N
T	Peppergrass, Slickspot (*Lepidium papilliferum*)	N
ANIMALS		
Animal species listed in this State and that occur in this State – 10 species		
T	Bear, grizzly, lower 48 States, except where listed as an experimental population or delisted (*Ursus arctos horribilis*)	Y
E	Caribou, woodland, Selkirk Mountain population (*Rangifer tarandus caribou*)	N
E	Limpet, Banbury Springs (*Lanx* sp.)	N
T	Lynx, Canada (contiguous United States DPS) (*Lynx canadensis*)	Y
T	Snail, Bliss Rapids (*Taylorconcha serpenticola*)	N
E	Snail, Snake River physa (*Physa natricina*)	N
E	Springsnail, Bruneau Hot (*Pyrgulopsis bruneauensis*)	N
T	Squirrel, northern Idaho ground (*Spermophilus brunneus brunneus*)	N
E	Sturgeon, white, United States, (ID, MT), Canada (B.C.), Kootenai River system (*Acipenser transmontanus*)	Y
T	Trout, bull, United States, conterminous, lower 48 States (*Salvelinus confluentus*)	Y
Animal species listed in this State that do not occur in this State – 6 species		
E	Rabbit, pygmy, Columbia Basin DPS (*Brachylagus idahoensis*)	N
T	Salmon, chinook, fall, Snake River (*Oncorhynchus* (= *Salmo*) *tshawytscha*)	Y
T	Salmon, chinook, spring/summer, Snake River (*Oncorhynchus* (= *Salmo*) *tshawytscha*)	Y
E	Salmon, sockeye, United States (Snake River, ID stock wherever found.) (*Oncorhynchus* (= *Salmo*) *nerka*)	Y

Table E- 3. Federally Threatened and Endangered Species in Idaho

Status	Species/Listing Name	Critical Habitat
T	Steelhead, Snake River Basin (*Oncorhynchus (= Salmo) mykiss*)	Y
E	Wolf, gray, lower 48 States, except MN and where EXPN. Mexico. (*Canis lupus*)	Y

Source: USFWS, 2011
Notes: T = threatened; E = endangered; EXPN = experimental population, non-essential; DPS = distinct population segment

Table E- 4. Federally Threatened and Endangered Species in Michigan

Status	Species/Listing Name	Critical Habitat
PLANTS		
Plant species listed in this State and that occur in this State – 8 species		
E	Bean, rayed (*Villosa fabalis*)	N
T	Daisy, lakeside (*Hymenoxys herbacea*)	N
T	Fern, American hart's-tongue (*Asplenium scolopendrium* var. *americanum*)	N
T	Goldenrod, Houghton's (*Solidago houghtonii*)	N
T	Iris, dwarf lake (*Iris lacustris*)	N
E	Monkey-flower, Michigan (*Mimulus glabratus* var. *michiganensis*)	N
T	Orchid, eastern prairie fringed (*Platanthera leucophaea*)	N
T	Pogonia, small whorled (*Isotria medeoloides*)	N
T	Thistle, Pitcher's (*Cirsium pitcheri*)	N
Plant species listed in this State that do not occur in this State – 1 species		
E	Chaffseed, American (*Schwalbea americana*)	N
ANIMALS		
Animal species listed in this State and that occur in this State – 11 species		
E	Bat, Indiana (*Myotis sodalis*)	Y
E	Bean, rayed (*Villosa fabalis*)	N
E	Beetle, Hungerford's crawling water (*Brychius hungerfordi*)	N
E	Butterfly, Karner blue (*Lycaeides melissa samuelis*)	Y
E	Butterfly, Mitchell's satyr (*Neonympha mitchellii mitchellii*)	N
E	Clubshell, entire range; except where listed as experimental populations (*Pleurobema clava*)	N
T	Lynx, Canada (contiguous United States DPS) (*Lynx canadensis*)	Y
E	Mussel, snuffbox (*Epioblasma triquetra*)	N
E	Plover, piping, Great Lakes watershed (*Charadrius melodus*)	Y
E	Riffleshell, northern (*Epioblasma torulosa rangiana*)	N
T	Snake, copperbelly water, Indiana north of 40 degrees north latitude, Michigan, Ohio (*Nerodia erythrogaster neglecta*)	N
E	Warbler (= wood), Kirtland's (*Dendroica kirtlandii*)	N
E	Wolf, gray, lower 48 States, except MN and where EXPN. Mexico. (*Canis lupus*)	Y
Animal species listed in this State that do not occur in this State – 3 species		
E	Beetle, American burying (*Nicrophorus americanus*)	N
E	Catspaw, white (pearlymussel) (*Epioblasma obliquata perobliqua*)	N
E	Puma (= cougar), eastern (*Puma* (= *Felis*) *concolor couguar*)	N

Table E- 4. Federally Threatened and Endangered Species in Michigan

Status	Species/Listing Name	Critical Habitat
Animal listed species occurring in this State that are not listed in this State – 1 species		
E	Dragonfly, Hine's emerald (*Somatochlora hineana*)	Y

Source: USFWS, 2011
Notes: T = threatened; E = endangered; EXPN = experimental population, non-essential; DPS = distinct population segment

Table E- 5. Federally Threatened and Endangered Species in Minnesota

Status	Species/Listing Name	Critical Habitat
PLANTS		
Plant spcies listed in this State and that occur in this State – 4 species		
T	Bush-clover, prairie (*Lespedeza leptostachya*)	N
E	Lily, Minnesota dwarf trout (*Erythronium propullans*)	N
T	Orchid, western prairie fringed (*Platanthera praeclara*)	N
T	Roseroot, Leedy's (*Sedum integrifolium* ssp. *leedyi*)	N
ANIMALS		
Animal species listed in this State and that occur in this State – 7 species		
E	Butterfly, Karner blue (*Lycaeides melissa samuelis*)	Y
E	Higgins eye (pearlymussel) (*Lampsilis higginsii*)	N
T	Lynx, Canada (contiguous United States DPS) (*Lynx canadensis*)	Y
E	Mapleleaf, winged entire; except where listed as experimental populations (*Quadrula fragosa*)	N
E	Mussel, rayed bean (*Villosa fabalis*)	N
E	Mussel, sheepnose *(Plethobasus cyphyus)*	N
E	Mussel, snuffbox (*Epioblasma triquetra*)	N
T	Plover, piping, Great Lakes watershed (*Charadrius melodus*)	Y
E	Shiner, Topeka (*Notropis topeka* (= *tristis*))	Y
E	Spectaclecase (mussel) (*Cumberlandia monodonta*)	N
Animal species listed in this State that do not occur in this State – 4 species		
E	Beetle, American burying (*Nicrophorus americanus*)	N
E	Mussel, scaleshell (*Leptodea leptodon*)	N
T	Plover, piping, except Great Lakes watershed (*Charadrius melodus*)	Y
T	Wolf, gray, MN (*Canis lupus*)	Y

Source: USFWS, 2011
Notes: T = threatened; E = endangered; EXPN = experimental population, non-essential; DPS = distinct population segment

Table E- 6. Federally Threatened and Endangered Species in Montana

Status	Species/Listing Name	Critical Habitat
PLANTS		
Plant species listed in this State and that occur in this State – 3 species		
T	Catchfly, Spalding's (*Silene spaldingii*)	N
T	Howellia, water (*Howellia aquatilis*)	N

Table E- 6. Federally Threatened and Endangered Species in Montana

Status	Species/Listing Name	Critical Habitat
T	Ladies'-tresses, Ute (*Spiranthes diluvialis*)	N
ANIMALS		
Animal species listed in this State and that occur in this State – 9 species		
T	Bear, grizzly, lower 48 States, except where listed as an experimental population or delisted (*Ursus arctos horribilis*)	Y
E	Crane, whooping, except where EXPN (*Grus americana*)	Y
E	Ferret, black-footed, entire population, except where EXPN (*Mustela nigripes*)	N
T	Lynx, Canada (contiguous United States DPS) (*Lynx canadensis*)	Y
T	Plover, piping, except Great Lakes watershed (*Charadrius melodus*)	Y
E	Sturgeon, pallid (*Scaphirhynchus albus*)	N
E	Sturgeon, white ,United States (ID, MT), Canada (B.C.), Kootenai River system (*Acipenser transmontanus*)	Y
E	Tern, least, interior pop. (*Sterna antillarum*)	N
T	Trout, bull, United States, conterminous, lower 48 States (*Salvelinus confluentus*)	Y
Animal species listed in this State that do not occur in this State – 1 species		
E	Wolf, gray, lower 48 States, except MN and where EXPN. Mexico. (*Canis lupus*)	Y

Source: USFWS, 2011
Notes: EXPN = experimental population, non-essential; DPS = distinct population segment

Table E- 7. Federally Threatened and Endangered Species in Nebraska

Status	Species/Listing Name	Critical Habitat
PLANTS		
Plant species listed in this State and that occur in this State – 4 species		
T	Butterfly plant, Colorado (*Gaura neomexicana* var. *coloradensis*)	Y
T	Ladies'-tresses, Ute (*Spiranthes diluvialis*)	N
T	Orchid, western prairie fringed (*Platanthera praeclara*)	N
E	Penstemon, blowout (*Penstemon haydenii*)	N
Plant species listed in this State that do not occur in this State – 1 species		
T	Orchid, eastern prairie fringed *(Platanthera leucophaea)*	N
ANIMALS		
Animal species listed in this State and that occur in this State – 8 species		
E	Beetle, American burying (*Nicrophorus americanus*)	N
E	Crane, whooping, except where EXPN (*Grus americana*)	Y
T	Plover, piping, except Great Lakes watershed (*Charadrius melodus*)	Y
E	Shiner, Topeka (*Notropis topeka* (= *tristis*))	Y
E	Sturgeon, pallid (*Scaphirhynchus albus*)	N
E	Tern, least, interior pop. (*Sterna antillarum*)	N
E	Tiger beetle, Salt Creek (*Cicindela nevadica lincolniana*)	Y
E	Wolf, gray, lower 48 States, except MN and where EXPN. Mexico. (*Canis lupus*)	Y
Animal species listed in this State that do not occur in this State – 2 species		
E	Higgins eye (pearlymussel) (*Lampsilis higginsii*)	N

Table E- 7. Federally Threatened and Endangered Species in Nebraska

Status	Species/Listing Name	Critical Habitat
E	Mapleleaf, winged, entire; except where listed as experimental populations (*Quadrula fragosa*)	N
E	Spectaclecase (mussel) (*Cumberlandia monodonta*)	N
Animal listed species occurring in this State but not listed in this State – 3 species		
E	Curlew, Eskimo (*Numenius borealis*)	N
E	Ferret, black-footed, entire population, except where EXPN (*Mustela nigripes*)	N
E	Mussel, scaleshell (*Lepodea leptodon*)	N

Source: USFWS, 2011
Notes: T = threatened; E = endangered; EXPN = experimental population, non-essential

Table E- 8. Federally Threatened and Endangered Species in North Dakota

Status	Species/Listing Name	Critical Habitat
PLANTS		
Plant species listed in this State and that occur in this State – 1 species		
T	Orchid, western prairie fringed (*Platanthera praeclara*)	N
ANIMALS		
Animal species listed in this State and that occur in this State – 6 species		
E	Crane, whooping, except where EXPN (*Grus americana*)	Y
E	Ferret, black-footed, entire population, except where EXPN (*Mustela nigripes*)	N
T	Plover, piping, except Great Lakes watershed (*Charadrius melodus*)	Y
E	Sturgeon, pallid (*Scaphirhynchus albus*)	N
E	Tern, least, interior pop. (*Sterna antillarum*)	N
E	Wolf, gray, lower 48 States, except MN and where EXPN. Mexico. (*Canis lupus*)	Y
Animal species listed in this State that do not occur in this State – 1 species		
E	Beetle, American burying (*Nicrophorus americanus*)	N

Source: USFWS, 2011
Notes: T = threatened; E = endangered; EXPN = experimental population, non-essential

Table E- 9. Federally Threatened and Endangered Species in Oregon

Status	Species/Listing Name	Critical Habitat
PLANTS		
Plant species listed in this State and that occur in this State – 15 species		
T	Catchfly, Spalding's (*Silene spaldingii*)	N
T	Checker-mallow, Nelson's (*Sidalcea nelsoniana*)	N
E	Daisy, Willamette (*Erigeron decumbens* var. *decumbens*)	Y
E	Desert-parsley, Bradshaw's (*Lomatium bradshawii*)	N
T	Four-o'clock, MacFarlane's (*Mirabilis macfarlanei*)	N
E	Fritillary, Gentner's (*Fritillaria gentneri*)	N
T	Howellia, water (*Howellia aquatilis*)	N

Table E- 9. Federally Threatened and Endangered Species in Oregon

Status	Species/Listing Name	Critical Habitat
E	Lily, western (*Lilium occidentale*)	N
E	Lomatium, Cook's (*Lomatium cookii*)	Y
T	Lupine, Kincaid's (*Lupinus sulphureus* (= *oreganus*) ssp. *kincaidii* (= var. *kincaidii*))	Y
E	Meadowfoam, large-flowered woolly (*Limnanthes floccosa* ssp. *grandiflora*)	Y
E	Milk-vetch, Applegate's (*Astragalus applegatei*)	N
E	Popcornflower, rough (*Plagiobothrys hirtus*)	N
T	Thelypody, Howell's spectacular (*Thelypodium howellii spectabilis*)	N
E	Wire-lettuce, Malheur (*Stephanomeria malheurensis*)	Y
Plant listed species occurring in this State but not listed in this State – 2 species		
T	Paintbrush, golden (*Castilleja levisecta*)	N
E	Rock-cress, McDonald's (*Arabis macdonaldiana*)	N
ANIMALS		
Animal species listed in this State and that occur in this State – 35 species		
E	Albatross, short-tailed (*Phoebastria* (= *Diomedea*) *albatrus*)	N
E	Butterfly, Fender's blue (*Icaricia icarioides fenderi*)	Y
T	Butterfly, Oregon silverspot (*Speyeria zerene hippolyta*)	Y
E	Chub, Borax Lake (*Gila boraxobius*)	Y
T	Chub, Hutton tui Hutton (*Gila bicolor* ssp.)	N
T	Chub, Oregon (*Oregonichthys crameri*)	Y
T	Dace, Foskett speckled Foskett (*Rhinichthys osculus* ssp.)	N
E	Deer, Columbian white-tailed, Columbia River DPS (*Odocoileus virginianus leucurus*)	N
T	Fairy shrimp, vernal pool (*Branchinecta lynchi*)	Y
T	Lynx, Canada (contiguous United States DPS) (*Lynx canadensis*)	Y
T	Murrelet, marbled, CA, OR, WA (*Brachyramphus marmoratus*)	Y
T	Owl, northern spotted (*Strix occidentalis caurina*)	Y
T	Plover, western snowy, Pacific coastal pop. (*Charadrius alexandrinus nivosus*)	Y
T	Salmon, chinook, fall, Snake River (*Oncorhynchus* (= *Salmo*) *tshawytscha*)	Y
T	Salmon, chinook, lower Columbia River (*Oncorhynchus* (= *Salmo*) *tshawytscha*)	Y
T	Salmon, chinook, spring/summer, Snake River (*Oncorhynchus* (= *Salmo*) *tshawytscha*)	Y
T	Salmon, chinook, upper Willamette River (*Oncorhynchus* (= *Salmo*) *tshawytscha*)	Y
T	Salmon, chum, Columbia River (*Oncorhynchus* (= *Salmo*) *keta*)	Y
T	Salmon, coho, Oregon coast (*Oncorhynchus* (= *Salmo*) *kisutch*)	Y
T	Salmon, coho, OR, CA pop. (*Oncorhynchus* (= *Salmo*) *kisutch*)	Y
T	Sea turtle, green, except where endangered (*Chelonia mydas*)	Y
E	Sea turtle, leatherback (*Dermochelys coriacea*)	Y
T	Sea turtle, loggerhead (*Caretta caretta*)	Y
T	Sea-lion, Steller, eastern pop. (*Eumetopias jubatus*)	Y
T	Steelhead, Snake River Basin (*Oncorhynchus* (= *Salmo*) *mykiss*)	Y
T	Steelhead, middle Columbia River (*Oncorhynchus* (= *Salmo*) *mykiss*)	Y
T	Steelhead, upper Willamette River (*Oncorhynchus* (= *Salmo*) *mykiss*)	Y

Table E- 9. Federally Threatened and Endangered Species in Oregon

Status	Species/Listing Name	Critical Habitat
E	Sucker, Lost River (*Deltistes luxatus*)	Y
E	Sucker, Modoc (*Catostomus microps*)	Y
E	Sucker, shortnose (*Chasmistes brevirostris*)	Y
T	Sucker, Warner (*Catostomus warnerensis*)	Y
T	Trout, bull, United States, conterminous, lower 48 States (*Salvelinus confluentus*)	Y
T	Trout, Lahontan cutthroat (*Oncorhynchus clarki henshawi*)	N
E	Whale, humpback (*Megaptera novaeangliae*)	N
E	Whale, killer, southern resident DPS (*Orcinus orca*)	Y
E	Wolf, gray, lower 48 States, except MN and where EXPN. Mexico. (*Canis lupus*)	Y
Animal species listed in this State that do not occur in this State – 6 species		
T	Bear, grizzly, lower 48 States, except where listed as an experimental population or delisted (*Ursus arctos horribilis*)	Y
E	Condor, California, United States only (*Gymnogyps californianus*)	Y
T	Otter, southern sea, except where EXPN (*Enhydra lutris nereis*)	N
E	Rabbit, pygmy, Columbia Basin DPS (*Brachylagus idahoensis*)	N
T	Salmon, coho, lower Columbia River (*Oncorhynchus* (= *Salmo*) *kisutch*)	Y
E	Sea-lion, Steller, western pop. (*Eumetopias jubatus*)	Y
Animal listed species occurring in this State but not listed in this State – 3 species		
E	Salmon, sockeye, United States (Snake River, ID stock wherever found.) (*Oncorhynchus (= Salmo) nerka*)	Y
T	Steelhead, lower Columbia River (*Oncorhynchus (= Salmo) mykiss*)	Y
T	Sturgeon, North American green, United States (CA) Southern Distinct Population Segment (*Acipenser medirostris*)	N
Animal species proposed for listing in this State – 1 species		

Source: USFWS, 2011
Notes: T = threatened; E = endangered; PT = proposed threatened; EXPN = experimental population, non-essential; DPS = distinct population segment

Table E- 10. Federally Threatened and Endangered Species in South Dakota

Status	Species/Listing Name	Critical Habitat?
PLANTS		
Plant species listed in this State and that occur in this State – 1 species		
T	Orchid, western prairie fringed (*Platanthera praeclara*)	N
ANIMALS		
Animal species listed in this State and that occur in this State – 9 species		
E	Beetle, American burying (*Nicrophorus americanus*)	N
E	Crane, whooping, except where EXPN (*Grus americana*)	Y
E	Ferret, black-footed, entire population, except where EXPN (*Mustela nigripes*)	N
E	Mussel, scaleshell (*Leptodea leptodon*)	N
T	Plover, piping except Great Lakes watershed (*Charadrius melodus*)	Y
E	Shiner, Topeka (*Notropis topeka (= tristis)*)	Y

Table E- 10. Federally Threatened and Endangered Species in South Dakota

Status	Species/Listing Name	Critical Habitat?
E	Sturgeon, pallid (*Scaphirhynchus albus*)	N
E	Tern, least, interior pop. (*Sterna antillarum*)	N
E	Wolf, gray lower 48 States, except MN and where EXPN. Mexico. (*Canis lupus*)	Y
Animal listed species occurring in this State but not listed in this State – 2 species		
E	Curlew, Eskimo (*Numenius borealis*)	N
E	Higgins eye (pearlymussel) (*Lampsilis higginsii*)	N

Source: USFWS, 2011
Notes: T = threatened; E = endangered; EXPN = experimental population, non-essential

Table E- 11. Federally Threatened and Endangered Species in Washington

Status	Species/Listing Name	Critical Habitat?
PLANTS		
Plant species listed in this State and that occur in this State – 9 species		
	Catchfly, Spalding's (*Silene spaldingii*)	N
	Checker-mallow, Nelson's (*Sidalcea nelsoniana*)	N
	Checkermallow, Wenatchee Mountains (*Sidalcea oregana* var. *calva*)	Y
	Desert-parsley, Bradshaw's (*Lomatium bradshawii*)	N
	Howellia, water (*Howellia aquatilis*)	N
	Ladies'-tresses, Ute (*Spiranthes diluvialis*)	N
	Lupine, Kincaid's (*Lupinus sulphureus* (= *oreganus*) ssp. *kincaidii* (= var. *kincaidii*))	Y
	Paintbrush, golden (*Castilleja levisecta*)	N
	Stickseed, showy (*Hackelia venusta*)	N
ANIMALS		
Animal species listed in this State and that occur in this State – 28 species		
E	Albatross, short-tailed (*Phoebastria* (= *Diomedea*) *albatrus*)	N
T	Bear, grizzly lower 48 States, except where listed as an experimental population or delisted (*Ursus arctos horribilis*)	Y
E	Caribou, woodland, Selkirk Mountain population (*Rangifer tarandus caribou*)	N
E	Deer, Columbian white-tailed, Columbia River DPS (*Odocoileus virginianus leucurus*)	N
T	Lynx, Canada (contiguous United States DPS) (*Lynx canadensis*)	Y
T	Murrelet, marbled, CA, OR, WA (*Brachyramphus marmoratus*)	Y
T	Owl, northern spotted (*Strix occidentalis caurina*)	Y
T	Plover, western snowy, Pacific coastal pop. (*Charadrius alexandrinus nivosus*)	Y
E	Rabbit, pygmy, Columbia Basin DPS (*Brachylagus idahoensis*)	N
T	Salmon, chinook, Puget Sound (*Oncorhynchus* (= *Salmo*) *tshawytscha*)	Y
T	Salmon, chinook, fall, Snake River (*Oncorhynchus* (= *Salmo*) *tshawytscha*)	Y
T	Salmon, chinook, lower Columbia River (*Oncorhynchus* (= *Salmo*) *tshawytscha*)	Y
E	Salmon, chinook, spring, upper Columbia River (*Oncorhynchus* (= *Salmo*) *tshawytscha*)	Y

Table E- 11. Federally Threatened and Endangered Species in Washington

T	Salmon, chinook, spring/summer, Snake River (*Oncorhynchus* (= *Salmo*) *tshawytscha*)	Y
T	Salmon, chum, Columbia River (*Oncorhynchus* (= *Salmo*) *keta*)	Y
T	Salmon, chum, summer-run Hood Canal (*Oncorhynchus* (= *Salmo*) *keta*)	Y
T	Salmon, sockeye, United States (Ozette Lake, WA) (*Oncorhynchus* (= *Salmo*) *nerka*)	Y
T	Sea turtle, green, except where endangered (*Chelonia mydas*)	Y
E	Sea turtle, leatherback (*Dermochelys coriacea*)	Y
T	Sea-lion, Steller, eastern pop. (*Eumetopias jubatus*)	Y
T	Steelhead, Puget Sound DPS (*Oncorhynchus* (= *Salmo*) *mykiss*)	Y
T	Steelhead, Snake River Basin (*Oncorhynchus* (= *Salmo*) *mykiss*)	Y
T	Steelhead, lower Columbia River (*Oncorhynchus* (= *Salmo*) *mykiss*)	Y
T	Steelhead, upper Columbia River Basin (*Oncorhynchus* (= *Salmo*) *mykiss*)	Y
T	Trout, bull, United States, conterminous, lower 48 States (*Salvelinus confluentus*)	Y
E	Whale, humpback (*Megaptera novaeangliae*)	N
E	Whale, killer, southern resident DPS (*Orcinus orca*)	Y
E	Wolf, gray, lower 48 States, except MN and where EXPN. Mexico. (*Canis lupus*)	Y
Animal species listed in this State that do not occur in this State – 5 species		
T	Butterfly, Oregon silverspot (*Speyeria zerene hippolyta*)	Y
T	Otter, southern sea, except where EXPN (*Enhydra lutris nereis*)	N
T	Salmon, coho, lower Columbia River (*Oncorhynchus* (= *Salmo*) *kisutch*)	Y
E	Sea-lion, Steller, western pop. (*Eumetopias jubatus*)	Y
T	Steelhead middle Columbia River (*Oncorhynchus* (= *Salmo*) *mykiss*)	Y
Animal listed species occurring in this State but not listed in this State – 3 species		
E	Salmon, sockeye, United States (Snake River, ID stock wherever found.) (*Oncorhynchus (= Salmo) nerka*)	Y
T	Steelhead, upper Willamette River (*Oncorhynchus (= Salmo) mykiss*)	Y
T	Sturgeon, North American green, United States (CA) Southern Distinct Population Segment (*Acipenser medirostris*)	N

Source: USFWS, 2011
Notes: T = threatened; E = endangered; EXPN = experimental population, non-essential; DPS = distinct population segment

Table E- 12. Federally Threatened and Endangered Species in Wyoming

Status	Species/Listing Name	Critical Habitat
PLANTS		
Plant species listed in this State and that occur in this State – 4 species		
T	Butterfly plant, Colorado (*Gaura neomexicana* var. *coloradensis*)	Y
T	Ladies'-tresses, Ute (*Spiranthes diluvialis*)	N
E	Penstemon, blowout (*Penstemon haydenii*)	N
T	Yellowhead, desert (*Yermo xanthocephalus*)	Y
ANIMALS		
Animal species listed in this State and that occur in this State – 5 species		

Table E- 12. Federally Threatened and Endangered Species in Wyoming

Status	Species/Listing Name	Critical Habitat
T	Bear, grizzly, lower 48 States, except where listed as an experimental population or delisted (*Ursus arctos horribilis*)	Y
E	Dace, Kendall Warm Springs (*Rhinichthys osculus thermalis*)	N
E	Ferret, black-footed, entire population, except where EXPN (*Mustela nigripes*)	N
T	Lynx, Canada (contiguous United States DPS) (*Lynx canadensis*)	Y
E	Toad, Wyoming (*Bufo baxteri (=hemiophrys*)	N
Animal species listed in this State that do not occur in this State – 6 species		
E	Chub, bonytail, entire (*Gila elegans*)	Y
E	Chub, humpback, entire (*Gila cypha*)	Y
E	Crane, whooping, except where EXPN (*Grus americana*)	Y
E	Pikeminnow (= squawfish), Colorado except Salt and Verde River drainages, AZ (*Ptychocheilus lucius*)	N
E	Sucker, razorback, entire (*Xyrauchen texanus*)	Y
E	Wolf, gray, lower 48 States, except MN and where EXPN. Mexico. (*Canis lupus*)	Y
	Animal listed species occurring in this state that are not listed in this state – 1 species	
T	Mouse, Preble's meadow jumping, United States, north-central CO (*Zapus hudsonius preblei*)	Y

Source: USFWS, 2011

Notes: T = threatened; E = endangered; PT = proposed threatened; PE = proposed endangered; EXPN = experimental population, non-essential; DPS = distinct population segment

Appendix F. APHIS Threatened and Endangered Species Analysis and Decision Tree for U.S. Fish and Wildlife Service Consultations

Threatened and Endangered Species Analysis

Congress passed the Endangered Species Act (ESA) of 1973, as amended, to prevent extinctions facing many species of fish, wildlife, and plants. The purpose of the ESA is to conserve threatened and endangered species (TES) and the ecosystems on which they depend as key components of America's heritage. To implement the ESA, the U.S. Fish & Wildlife Service (USFWS) works in cooperation with the National Marine Fisheries Service (NMFS); other Federal, State, and local agencies; tribes; non-governmental organizations; and private citizens. Before a plant or animal species can receive the protection provided by the ESA, it must first be added to the Federal list of threatened and endangered wildlife and plants.

A species is added to the list when the USFWS and NMFS determined it to be endangered or threatened because of any of the following factors:

- The present or threatened destruction, modification, or curtailment of its habitat or range;
- Overutilization for commercial, recreational, scientific, or educational purposes;
- Disease or predation;
- The inadequacy of existing regulatory mechanisms; or
- Natural or manmade factors affecting its survival.

In accordance with the ESA, once an animal or plant is added to the list, protective measures apply to the species and its habitat. These measures include protection from adverse effects of Federal activities.

Section 7 (a)(2) of the ESA requires that a Federal agency, in consultation with the USFWS or NMFS, ensures that any action the agency authorizes, funds, or carries out is not likely to jeopardize the continued existence of a listed species or result in the destruction or adverse modification of designated critical habitat. It is the responsibility of the Federal agency taking the action to assess the effects of the agency's action and to consult with the USFWS or NMFS if it is determined that the action "may affect" listed species or critical habitat. To facilitate APHIS' ESA consultation process, the agency met with the USFWS from 1999 to 2003 to discuss factors relevant to APHIS' regulatory authority and effects analysis for petitions for nonregulated status, and developed a process for conducting an effects determination consistent with the Plant Protection Act (PPA) of 2000 (title IV of Public Law 106-224). This process is described in a decision tree document presented at the end of this appendix. APHIS uses this process to help fulfill its obligations and responsibilities under section 7 of the ESA for biotechnology regulatory actions.

APHIS' regulatory authority over genetically engineered (GE) organisms under the PPA is limited to those GE organisms for which it has reason to believe might be a plant pest or those for which APHIS does not have sufficient information to determine that the GE organism is unlikely to pose a plant pest risk (title 7, part 340.1 of the Code of Federal Regulations (CFR)). APHIS does not have authority to regulate the use of any herbicide, including glyphosate. After completing a plant pest risk analysis, if APHIS determines that H7-1 sugar beet does not pose a plant pest risk, then H7-1 sugar beet would no longer be subject to the plant pest provisions of the PPA or to the regulatory requirements of 7 CFR part 340 and, therefore, APHIS must grant it nonregulated status. As part of its Environmental Impact Statement (EIS) analysis, APHIS is analyzing the potential effects of H7-1 sugar beets on the environment, including any potential effects to TES and critical habitat. As part of this process, APHIS thoroughly reviews GE product information and data related to the organism (generally a plant species, but may also be other GE organisms). For each transgene(s)/transgenic plant, APHIS considers the following information, data, and questions:

- A review of the biology and taxonomy of the crop plant and its sexually compatible relatives;
- Characterization of each transgene with respect to its structure and function and the nature of the organism from which it was obtained;
- A determination of where the new transgene and its products (if any) are produced in the plant and their quantity;
- A review of the agronomic performance of the plant, including disease and pest susceptibilities, weediness potential, and agronomic and environmental impacts;
- Determination of the concentrations of known plant toxicants (if any are known in the plant);
- Analysis to determine if the transgenic plant is sexually compatible with any threatened or endangered plant species or a host of any threatened or endangered plant or animal species; and
- Any other information that may inform the potential for an organism to pose a plant pest risk.

In following this review process, APHIS has evaluated the potential effects that a determination of nonregulated status of H7-1 sugar beet plants for both seed and root production may have, if any, on federally listed TES, species proposed for listing, designated critical habitat, and habitat proposed for designation. Based upon the scope of the EIS and production areas identified in section III.B.1.c(1), APHIS reviewed the list of TES (listed and proposed) for each state where sugar beet are commercially produced in the USFWS Environmental Conservation Online System (ECOS`; as accessed 4/24/2012 at http://ecos.fws.gov/tess_public/pub/stateListingAndOccurrence.jsp\,). Prior to this review, APHIS considered the potential for H7-1 sugar beets to extend the range of sugar beet production and expand agricultural production into new natural areas. H7-1 sugar beets were extensively commercialized when they had nonregulated status from 2005 to 2010. Currently, they account for approximately 95 percent of the sugar beet production in the United States. Considering that H7-1 sugar beets account for such a high percentage of the total area planted with sugar beets, it is reasonable to expect that a second decision to grant nonregulated status would result in H7-1 sugar beets being planted in areas similar to where they were planted prior to the 2010 court order vacating the previous decision to grant nonregulated status. The genetic transformation does not impart any phenotypic characteristic that would allow for the planting of H7-1 sugar beets in areas unsuitable to sugar beet varieties currently available. In addition, as described in detail in section III.D.1.b, even when granted nonregulated status, sugar beet production requires close coordination under contractual agreements between the grower and the processor. All sugar beets are shipped to a processor to efficiently extract the sugar from the beet. All sugar beet processors in the United States are now structured as cooperatives, with the exception of Wyoming Sugar Beet Company, LLC, who is also owned primarily by sugar beet producers. The cooperatives own the processing facilities, and the sugar beet farmers are members of the cooperatives. To contain shipping costs, sugar beet production is effectively limited to areas typically within 60 miles of a processing facility, although some fields may be located up to 100 miles away (Western Sugar Cooperative,2006). Because of the high costs associated with constructing a processing facility, and the required coordination with potential growers, expansion of production into new areas is not anticipated in the foreseeable future.

Potential Effects of H7-1 Sugar Beet Plants and Plant Products on TES

To identify any potential effects of H7-1 sugar beets on threatened and endangered plant species, APHIS evaluated the potential of H7-1 sugar beets to cross with a listed species. Sugar beets are in the genus *Beta* and have the ability to cross with several species of wild beets in the same genus, but are not known to cross with any other plant species without human assistance (OECD,2001). After reviewing the list of threatened and endangered plant species in the States where sugar beets are grown, APHIS determined that H7-1 sugar beets would not be sexually compatible with any listed threatened or endangered plant species or plants proposed for listing as none of these listed plants are in the same genus or known to cross pollinate with species of the genus *Beta* (see appendix E).

To identify potential effects on threatened and endangered animal species, APHIS evaluated the risks to threatened and endangered animals from consuming H7-1 sugar beets. As discussed in section III.F.1.a(4), there is no difference in the composition and nutritional quality of H7-1 sugar beets compared with conventional sugar beets. APHIS also examined the allergenicity and toxicity of H7-1 sugar beets' CP4 EPSPS protein and, based on the research summarized and referenced in section III.F.1.a(5), concluded that no differences exist compared to conventional sugar beets' EPSPS protein. Both types of proteins are ubiquitous in nature and normally present in food and feeds derived from these plant and microbial sources. In addition, when used to impart tolerance to glyphosate in corn, cotton, and soybean plants, the CP4 EPSPS protein has not resulted in any adverse human health effects despite being grown on hundreds of millions of acres across the United States over the past decade. Finally, the research cited and summarized in section III.F.1.a(5) also finds no difference in allergenicity between conventional and H7-1 sugar beet pollen. Therefore, based on these analyses, APHIS concluded that consumption of H7-1 sugar beet plant parts (seeds, leaves, stems, pollen, or roots) would have no effect on any listed threatened or endangered animal species or animal species proposed for listing.

APHIS considered the possibility that H7-1 sugar beets could serve as a host plant for TES. A review of the species list revealed that there are no members of the genus *Beta* that serve as a host plant for any TES.

As part of the analysis for TES and critical habitat, APHIS considered if the new phenotype imparted to H7-1 sugar beets may allow the plant to naturalize in the environment and potentially have an effect on TES. In doing so, APHIS assessed whether H7-1 sugar beets are any more likely to become a weed than the non-transgenic recipient sugar beet line or other currently cultivated sugar beets. Weediness could potentially affect TES or critical habitat if H7-1 sugar beets were to become naturalized in the environment. The assessment considers the basic biology of sugar beets and an evaluation of unique characteristics of H7-1 sugar beets. As discussed in section III.C.3.c, no *Beta* species are listed as weeds on any of the 12 weed lists from the USDA PLANTS database (USDA-NRCS,2010). Sugar beets possess few of the characteristics of plants that are notable as successful weeds. APHIS considered data on plant vigor, bolting, seedling emergence, seed germination, seed dormancy, and other characteristics that might relate to increased weediness (USDA-APHIS,2012) During field trials, no differences were observed between H7-1 lines and non-transgenic lines with respect to the plants' ability to persist or to compete as a weed (Monsanto and KWS SAAT AG,2004) No unusual characteristics were noted that would suggest increased weediness of H7-1 plants. In addition, no characteristics relating to disease or insect resistance that might affect weediness were noted that were consistent over all trial locations. H7-1 sugar beets are still susceptible to the typical insect and disease pests of sugar beets. Collectively, this information indicates that H7-1 sugar beets are unlikely to naturalize and persist in the environment.

After reviewing potential effects on the environment that could result from a determination of nonregulated status of H7-1 sugar beets, APHIS has not identified any stressor that could affect the reproduction, numbers, or distribution of a listed TES or species proposed for listing. As a result, a detailed site-specific (or spatially explicit) exposure analysis for individually listed TES is not necessary for APHIS to reach a determination of nonregulated status for H7-1 sugar beets. APHIS considered the effect of H7-1 sugar beet production on designated critical habitat or habitat proposed for designation and could identify no difference from effects that would occur from the production of other sugar beet varieties. Sugar beets are not considered a particularly competitive plant species, are ecologically limited due to susceptibility to plant pathogens and herbivores, and are not typically described as weeds outside of agricultural fields (Bartsch et al.,2001). Sugar beets are not considered weedy, and feral populations of sugar beets have not been identified in the United States. H7-1 sugar beets are not sexually compatible with, nor do they serve as a host species for, any listed species or species proposed for listing. Consumption of H7-1 sugar beets by any listed species or species proposed for listing will not result in a toxic or allergic reaction. Based on these factors, APHIS has determined that H7-1 sugar beets would have no effect on listed threatened or endangered plant or animal species or such species proposed for listing and would not affect listed threatened or endangered plant or animal species' designated critical habitat or habitat proposed for designation. Because of this no effect determination, consultation under section 7(a)(2) of the ESA or the concurrence of the USFWS or NMFS is not required.

Potential Impacts of Glyphosate Use on TES

As part of the EIS process, APHIS met with USFWS officials on June 15, 2011 to discuss whether APHIS has any obligations under the ESA to analyze the impacts of herbicide use associated with all GE crops on TES. As a result of these joint discussions, the USFWS and APHIS have agreed that it is not necessary for APHIS to perform an ESA effects analysis on herbicide use associated either with H7-1 sugar beets or other currently planted GE crops. APHIS has no statutory authority to authorize or regulate the use of glyphosate, or any other herbicide, by sugar beet growers. Under 7 CFR 340, APHIS only has the authority to regulate H7-1 sugar beets or any GE organism if the agency believes it may pose a plant pest risk. APHIS has no regulatory jurisdiction over any other risks associated with GE organisms, including risks resulting from the use of herbicides or other pesticides on those organisms. Nevertheless, APHIS is aware that there may be potential environmental impacts resulting from the use of glyphosate on H7-1 sugar beets, including potential impacts on TES and critical habitat, based on assessments provided by the EPA and in peer reviewed scientific literature. APHIS is providing the available information of potential environmental impacts resulting from glyphosate use on H7-1 sugar beet below. APHIS has provided the draft EIS to the NMFS for their review and comment. After review, the NMFS has not provided comments on the EIS.

It is important to note that the use of herbicides in the production of sugar beets is not unique to the production of H7-1 sugar beets and that H7-1 sugar beets are not dependent on the use of glyphosate for their production lifecycle. Non-glyphosate herbicides are typically used to control weeds during production of conventional sugar beet varieties, and these herbicides could presumably be used in production of H7-1 sugar beet. An analysis of herbicide use in H7-1 and conventional sugar beets and the risks associated with them is thoroughly described in section IV. In summary, because of their toxicity, many of the herbicides historically used in conventional sugar beet production potentially pose greater impacts to non-target organisms than the use of glyphosate and would also potentially pose greater impacts to TES.

Conservation tillage and no-till practices have a positive impact on wildlife (Towery and Werblow,2010). Benefits include decreased soil erosion and improved water quality in receiving waters, retention of cover, availability of waste grain on the soil surface for feed, and increased populations of invertebrates as a food source (Sharpe,2010). As described in section III.B.1.c(2), the use of glyphosate in a H7-1 sugar beet production system facilitates the use of conservation tillage practices, whereas conservation tillage is far more difficult in conventional sugar beet production. Therefore, if H7-1 sugar beets are replacing fields of conventional varieties that are not currently utilizing conservation tillage practices and where TES species are present, the production of H7-1 sugar beets could improve baseline conditions and have a beneficial impact on TES. However, any beneficial impact may have already been realized following the 2005 granting of nonregulated status of H7-1 sugar beets and their rapid adoption. In addition, it would be difficult to assess those impacts retrospectively.

EPA Endangered Species Protection Program (ESPP)

On October 7, 1988, Congress enacted Public Law 100-478 to in part address the relationship between ESA and the Environmental Protection Agency's (EPA) pesticide labeling program (section 1010) by requiring EPA to conduct a study, and report to Congress, on ways to implement its endangered species pesticide labeling program in a manner that both complies with ESA and allows people to continue production of agricultural food and fiber. This law provided a clear sense that Congress wanted EPA to fulfill its obligation to conserve listed species, while at the same time consider the needs of agriculture and other pesticide users (70 FR 211 2005-11-02).

In 1988, EPA established the ESPP to meet its obligations under the ESA. The EPA's ESPP Web site[1] describes its assessment process for endangered species. Some of the elements of that process are summarized below. The goal of EPA's ESPP is to carry out its responsibilities under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) in compliance with the ESA without placing unnecessary burden on agriculture and other pesticide users consistent with Congress' intent. EPA is responsible for reviewing pesticide information and data to determine whether a pesticide product may be registered for a particular use, including those uses associated with the approval of biotechnology products. As part of that determination, the Agency assesses whether listed TES or their designated critical habitat may be affected by use of the pesticide product. All pesticide products that EPA determines "may affect" a listed species or its designated critical habitat may be subject to the ESPP. If limitations on pesticide use are necessary to protect listed species in areas where a pesticide may be used, the information is related through Endangered Species Protection Bulletins. Bulletins identify the species of concern and the pesticide active ingredient that may affect the listed species. They also provide a description of the measures necessary to protect the species, and contain a county-level map showing the geographic area(s) associated with the protection measures, depending on the susceptibility of the species. Bulletins are enforceable as part of the product label (http://www.epa.gov/oppfead1/endanger/basic-info.htm).

EPA's TES Evaluation Process

EPA evaluates the potential for effects of pesticides to listed species and their critical habitat concerns in connection with its actions under FIFRA.

EPA's review of the pesticide under FIFRA is independent of APHIS' review and regulatory decisions under 7 CFR 340. EPA does not require data or analyses conducted by APHIS to complete its reviews. EPA evaluates extensive toxicity, ecological effects data, environmental fate, and transport and behavior data, most of which are mandated under FIFRA data requirements, to assess and determine how a pesticide will move through and break down in the environment. Risks to various taxa (e.g., birds, fish, invertebrates, plants and mammals) are routinely assessed and used in EPA's determinations of whether a pesticide may be licensed for use in the United States.

EPA's core pesticide risk assessment and regulatory processes address non-target species, not just TES. EPA has developed a comprehensive risk assessment process modeled after, and consistent with, its numerous guidelines for environmental assessments (http://www.epa.gov/oppfead1/endanger/consultation/ecorisk-overview.pdf). The result of an assessment, which may go through several refinements, is to determine whether the potential effects of a pesticide's registration to a listed species will result in either a "no effect" or "may affect" determination. EPA consults with the USFWS and/or NMFS on determinations that

[1] http://www.epa.gov/espp/

“may affect” a listed species or adversely modify its critical habitat (http://www.epa.gov/oppfead1/endanger). As a result of either an assessment or consultation, EPA may seek to require changes to the use conditions specified on the label of the product. When such changes are necessary only in specific geographic areas rather than nationwide to ensure protection of the listed species, EPA implements these changes through geographically specific Endangered Species Protection Bulletins. Otherwise, these changes are applied to the label for all uses of the pesticide.

Ecological Risks of Glyphosate

The ecological risks associated with use of glyphosate as an herbicide have been assessed several times since 1974 when it was first registered for use in the United States. In addition, EPA has consulted with the USFWS on the effects of glyphosate on listed species and critical habitat. Findings from relevant ecological risk assessments and the results and status of consultations are summarized below.

- In the June 1986 Registration Standard for glyphosate, EPA discussed consultations with the USFWS on hazards to crops, rangeland, silvicultural sites, and the Houston toad that may result from the use of glyphosate. Because a jeopardy opinion resulted from these consultations, the agency imposed endangered species labeling requirements in the Registration Standard to mitigate the risk to endangered species.

- In 1993, glyphosate was assessed by EPA for the Reregistration Eligibility Decision (RED) (U.S. EPA 1993) The RED concluded that direct risks to birds, mammals, invertebrates, and fish would be minimal. Under certain conditions, aquatic plants were expected to be at risk from glyphosate use. Additional data, including incident data and vegetative vigor testing, were needed on non-target terrestrial plants. The assessment stated that many endangered plants may be at risk from use of glyphosate with the registered use patterns. In addition, it was determined that the Houston toad may be at risk from use of glyphosate on alfalfa. The RED resulted in label changes to provide protection of aquatic organisms.

- In 2003, USDA’s Forest Service had a risk assessment conducted for glyphosate uses in its vegetation management programs (USDA-FS,2003). For forestry uses, all commercial formulations of glyphosate contained the isopropylamine salt of glyphosate. Application rates ranged from 0.5 pounds acid equivalent per acre (lbs. ae/acre) to 7 lbs. ae/acre with the most typical at 2 lbs. ae/acre. Based on the available data, USDA concluded that the risks were minimal to mammals, birds, fish, amphibians, invertebrates, and aquatic plants. Risks to fish following application of the more toxic formulations were not considered to be high; however, the assessment did state that at an application rate of 7 lbs. ae/acre, the acute exposures slightly exceeded the acute median lethal concentration for a more tolerant freshwater fish and exceeded it by a factor of 2 for the less tolerant fish. These values were estimated from a worst-case scenario where there was a severe rainfall of about 7 inches over a 24-hour period in an area where runoff is favored. USDA did not conduct a separate assessment for amphibians. The document concluded that the amphibian data indicated that glyphosate is no more toxic to amphibians than it is to fish. For terrestrial plants, the assessment concluded that for relatively tolerant plants, when a low-boom spray is utilized as the method of application, there is no indication that glyphosate would result in damage from spray drift at distances from the application site of 25 feet or greater. For more sensitive plants, the distance increased to approximately 100 feet. For applications requiring the use of backpack-directed spray, the distances would be less. No risks to terrestrial plants from runoff were expected.

- In 2004, EPA issued a report entitled Glyphosate Analysis of Risks to Endangered and Threatened Salmon and Steelhead. The analysis within the report included 11 evolutionary significant units (ESU)—a population that is considered distinct for purposes of conservation—in California, with one unit extending into southern Oregon. Much of the quantitative information presented and used was derived from the 1993 RED Ecological Risk Assessment. Testing was performed with formulated products, in addition to glyphosate alone, and included acute and chronic toxicity. Testing of the pure product indicated that pure glyphosate is practically non-toxic to the species examined. Glyphosate was moderately toxic to practically non-toxic in formulated products. Since this is somewhat increased over results with the pure chemical, the report concluded that it appears likely due to the added agents, generally surfactants. EPA uses a variety of chemical fate and transport data to develop "estimated environmental concentrations" (EECs) from a suite of established models. The EECs were used with toxicity for the most sensitive species from technical grade testing of the active ingredient to develop acute risk quotients (RQ). The RQ analysis indicated that glyphosate applied at 5.062 lbs. active ingredient per acre (ai/acre) does not present an acute risk to endangered and threatened salmonids from direct effects because the calculated RQ is less than the level of concern (LOC). The primary indirect effect of concern would be for the food source for listed fish. The report concluded that this rate of application does not present indirect effects from loss of food or loss of cover, as the RQ for invertebrates and plants is less than the LOC. However, the assessment determined that use of glyphosate "may affect, but is not likely to adversely affect" the species based on acute toxicity to fish for uses with application rates above 5 lbs. ai/acre. For uses with application rates below 5 lbs. ai/acre, the agency determined glyphosate would have no effect on the 11 ESU.

- In 2006, the EPA assessed glyphosate for a new use on bentgrass (U.S. EPA 2006d; U.S. EPA 2006a); and for new uses on Indian mulberry (noni), dry peas, lentils, garbanzo (U.S. EPA 2006b); as well as safflower and sunflower (U.S. EPA 2006c), with the highest proposed ground application rate of 3.73 lbs. ae/acre. For all proposed new uses, the EPA concluded that there was minimal risk of direct acute effects to terrestrial animals (birds and mammals) and aquatic animals (fish, amphibians, and invertebrates) and minimal risk to terrestrial plants (both non-target and endangered plant species), aquatic non-vascular (algae and diatoms), and vascular (duckweed) plants from off-target spray drift and runoff from ground-based applications. In addition, there were no chronic risks to animals.

- In 2008, as a part of EPA's TES effects assessment for the California red-legged frog, EPA evaluated the effect of glyphosate use at rates up to 7.95 lbs. ae/acre on fish, amphibians, aquatic invertebrates, aquatic plants, birds, mammals, and terrestrial invertebrates (U.S. EPA 2008). This assessment determined that at the maximum application rate for in-crop applications of glyphosate to glyphosate-tolerant sugar beets (1.125 lbs. ae/acre), there would be no effects of glyphosate use on fish, amphibians, birds, and mammals. The EPA assessment was uncertain of the effects on terrestrial invertebrates, citing the potential to affect small insects at all application rates and large insects at the 7.95 lbs. ae/acre rate, which is above the maximum rate for glyphosate tolerant sugar beets.

- In 2010, EPA issued a memorandum entitled Assessment of Ecological Risk for Glyphosate, potassium salt (PC Code 103613; CAS# 70901-12-1) for Label Supplement to Add Uses on Roundup Ready Sweet Corn. Because of the potential risk from surfactants, a conservative estimation of risk to aquatic organisms was conducted on a formulation basis and a glyphosate acid equivalent basis. The names and Chemical Abstracts Service (CAS) numbers of the surfactant are proprietary and are not provided in the assessment. Instead, the surfactant polyoxyethylene alkylamine mixture (POEA, CAS # 61791-26-2) was used because it has been used in glyphosate products and is known to be considerably more toxic to aquatic organisms than technical glyphosate. The assessment was completed with the assumption that the proposed surfactants are similar to POEA. Based on the proposed labels, the maximum application rate on a glyphosate acid equivalent basis is 3.71 lbs. ae/acre glyphosate and on a formulation basis is 9.35 lbs. formulation per acre.

  The risk to fish, aquatic phase amphibians, aquatic invertebrates, aquatic plants, birds, reptiles, terrestrial phase amphibians, mammals, terrestrial invertebrates, and terrestrial plants was analyzed. The assessment concluded that there was no risk to fish, aquatic phase amphibians, aquatic invertebrates, aquatic plants, and mammals because the RQ did not exceed the LOC for any of these groups. Because of the lack of toxicity studies for reptiles and terrestrial phase amphibians, birds are used as a surrogate. None of the available acute and subacute avian studies showed mortality, so RQ were not calculated for birds. All of the terrestrial EEC values are lower than the highest dose/concentration tested (3.71 lbs. ae/acre glyphosate), but many of the EECs for 20 gram birds were greater than one-tenth of that dose. For 100 gram birds, several EECs were greater than one-tenth of the highest dose with the 1.15 lbs. ae/acre dose applied 4 times per season. Therefore, there is uncertainty associated with the effect to listed birds, reptiles, and terrestrial phase amphibians. The chronic LOC for birds (LOC = 1) was exceeded for application to short grasses at the highest dose (3.71 lbs. ae/acre glyphosate and RQ = 1.07). However, because there were no effects at the highest concentrations in the bird studies and the RQ was only slightly greater than the LOC, the risk following chronic exposure is expected to be minimal. The assessment concluded that the risk to terrestrial invertebrates is negligible based on glyphosate's classification as practically non-toxic to honeybees. Lastly, for listed terrestrial plants, the RQ is lower than the LOC at the highest application rate when applied via ground applications, but are exceeded for listed and non-listed monocots and dicots when aerially applied at the 3.71 lbs. ae/acre glyphosate rate.

EPA's pesticide registration process considers the potential for risk to non-target organisms, and label use restrictions are required when necessary to avoid unreasonable adverse effects to the environment. Through registration review, EPA is reviewing each registered pesticide every 15 years to determine whether it still meets the FIFRA standard for registration. In this way, EPA is ensuring that all registered pesticides do not cause unreasonable risks to human health, workers, or the environment when used as directed on product labeling. EPA intends to meet its responsibility under the ESA in the registration review program. Glyphosate is scheduled to complete registration review in 2015, at which time EPA will complete its national endangered species assessment of all registered uses of the herbicide.

Potential Impacts of Glyphosate Use in the Production of Sugar Beets

In 2009, Stachler et al. (Stachler et al.,2009a; Stachler et al.,2009b)surveyed sugar beet growers in Minnesota, North Dakota, and Montana regarding weed control and production practices. The results showed that glyphosate is nearly always broadcast-applied to glyphosate tolerant sugar beets with a ground sprayer and aerial spraying is only used for 3 percent of applications. In Minnesota and eastern North Dakota, the most common herbicide treatment was glyphosate applied at 0.75 lb. ae/acre (Stachler et al.,2009b). The average total seasonal rate of glyphosate applied to glyphosate tolerant sugar beets was 1.85 lbs. ae/acre in 2009, compared to 1.95 lbs. ae/acre in 2008 in the same region (Stachler et al.,2009b). Similarly, in 2009, in western North Dakota and eastern Montana, the most common herbicide treatment was glyphosate applied at 1.0 lb. ae/acre (Stachler et al.,2009a). The average total seasonal rate of glyphosate application was 2.4 lbs. ae/acre (Stachler et al.,2009a).

In general, States have primary authority for compliance monitoring and enforcing the use of pesticides by the label requirements. Violators of the regulations are liable for all negative consequences of their actions (7 U.S. Code 136j (a)(2)(G)). Therefore, growers that use glyphosate are very likely to follow its label restrictions. To facilitate pesticide applicators adherence to EPA label use restrictions for glyphosate when applied to glyphosate tolerant crops, Monsanto designed a Web-based program (Pre-Serve[2]). The purpose of Pre-Serve is to "protect threatened and endangered plant species from potential impacts resulting from the agricultural use of herbicides that contain glyphosate." Pre-Serve instructs growers to observe specific precautions, including buffer zones, when spraying glyphosate herbicides on glyphosate-tolerant crops near threatened and endangered plant species that may be at risk. In addition, label requirements for Monsanto's Roundup® formulations and glyphosate formulations marketed by other manufacturers prohibit application in conditions or locations where adverse impact on federally designated threatened or endangered plants or aquatic species is likely.

In summary, glyphosate use in the production of sugar beet is nearly always broadcast-applied with a ground sprayer, the typical application rate on H7-1 sugar beets is below the maximum allowed by the label, the RQ for all effects is below the LOC for the maximum allowable rate, Monsanto instructs growers to observe specific precautions with the Pre-Serve program, and the pesticide label requires precautions to protect TES. Additionally, it is APHIS' understanding that EPA will be evaluating the effect of glyphosate application on H7-1 sugar beets and consult with the USFWS and/or NMFS if necessary. Accordingly, the available information suggests

[2] http://www.pre-serve.org/

that the glyphosate use resulting from granting nonregulated status to H7-1 sugar beets does not present an increase in potential impacts to TES.

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APHIS Threatened and Endangered Species Decision Tree for U.S. Fish and Wildlife Service Consultations

Decision Tree on Whether Section 7 Consultation with the U.S. Fish and Wildlife Service (USFWS) is Triggered for Petitions of Transgenic Plants

This decision tree document is based on the phenotypes (traits) that have been permitted for environmental releases under Animal and Plant Health Inspection Service (APHIS) oversight (for a list of approved notifications and environmental releases, visit Information Systems for Biotechnology). APHIS will re-evaluate and update this decision document as it receives new applications for environmental releases of new traits that are genetically engineered into plants.

BACKGROUND

For each transgene(s)/transgenic plant, the following information, data, and questions are addressed by APHIS, and the environmental analysis (e.g., environmental assessment [EA] or environmental impact statement [EIS]) for each petition will be publicly available. The APHIS review encompasses:

- A review of the biology, taxonomy, and weediness potential of the crop plant and its sexually compatible relatives;
- Characterization of each transgene with respect to its structure and function and the nature of the organism from which it was obtained;
- A determination of where the new transgene and its products (if any) are produced in the plant and their quantity;
- A review of the agronomic performance of the plant including disease and pest susceptibilities, weediness potential, and agronomic and environmental impact;
- Determination of the concentrations of known plant toxicants (if any are known in the plant); and
- Analysis to determine if the transgenic plant is sexually compatible with any threatened or endangered plant species or a host of any threatened or endangered plant species.

The U.S. Food and Drug Administration (FDA) published a policy in 1992 on foods derived from new plant varieties, including those derived from transgenic plants (see http://www.fda.gov/food/biotechnology/default.htm). Under this policy, FDA considers its existing statutory authorities to be “fully adequate to ensure the safety of new ingredients and foods derived from new varieties of plants, regardless of the process by which such foods and ingredients are produced (U.S. FDA, 1992). Thus, genetically engineered foods must meet the same rigorous safety standards as are required of all other foods. Many of the food crops currently being developed using biotechnology do not contain substances that are significantly different from those already consumed by humans and so may be less likely to require pre-market approval. FDA expects developers to consult with the agency on safety and regulatory questions. A list of consultations is available at http://www.fda.gov/Food/Biotechnology/Submissions/default.htm. APHIS considers the status and conclusion of the FDA consultations in its EAs and EISs.

Below is the description of the APHIS review process to determine if consultation with USFWS is necessary. If the answer to any of the questions below is "yes," APHIS contacts USFWS to determine if consultation is required.

1. Is the transgenic plant sexually compatible with a threatened or endangered plant[3] without human intervention?
2. Are naturally occurring plant toxins (toxicants) or allelochemicals increased over the normal concentration range in parental plant species?
3. Does the transgene product or its metabolites have any significant similarities to known toxins[4])?
4. Will the new phenotype(s) imparted to the transgenic plant allow the plant to be grown or employed in new habitats (e.g., outside the agro-ecosystem)[5]?
5. Does the pest resistance[6] gene act by one of the mechanisms listed below? If the answer is "yes," then consultation with USFWS is NOT necessary.

A. The transgene acts only in one or more of the following ways:

i. As a structural barrier to either the attachment of the pest to the host, to penetration of the host by the pest, to the spread of the pest in the host plant (e.g., the production of lignin, callose, thickened cuticles);
ii. In the plant by inactivating or resisting toxins or other disease causing substances produced by the pest;
iii. By creating a deficiency in the host of a component required for growth of the pest (such as with fungi and bacteria);
iv. By initiating, enhancing, or potentiating the endogenous host hypersensitive disease resistance response found in the plant; or
v. In an indirect manner that does not result in killing or interfering with normal growth, development, or behavior of the pest;

B. A pest derived transgene is expressed in the plant to confer resistance to that pest (such as with coat protein, replicase, and pathogen virulence genes).

For the biotechnologist:

[3] APHIS will provide USFWS a draft EA that addresses the impacts, if any, of gene movement to the threatened or endangered plant.
[4] Via a comparison of the amino acid sequence of the transgene's protein with those found in the protein databases like PIR, Swiss-Port, and HIV amino acid databases.
[5] Such phenotypes might include tolerance to environmental stress such as drought, salt, frost, and aluminum or heavy metals.
[6] Pest resistance would include any toxin or allelochemical that prevents, destroys, repels, or mitigates a pest or affects any vertebrate or invertebrate animal, plant, or micro-organism.

Depending on the outcome of the decision tree, initial the appropriate decision below and incorporate its language into the EA or EIS. Retain a hard copy of this decision document in the petition's file.

__________ BRS has reviewed the data in accordance with a process mutually agreed upon with the U.S. Fish and Wildlife Service to determine when a consultation, as required under Section 7 of the Endangered Species Act, is needed. APHIS has reached a determination that the release following a determination of nonregulated status would have no effects on listed threatened or endangered species and consequently, a written concurrence or formal consultation with the U.S. Fish and Wildlife Service is not required for this EA or EIS.

__________ BRS has reviewed the data in accordance with a process mutually agreed upon with the U.S. Fish and Wildlife Service to determine when a consultation, as required under Section 7 of the Endangered Species Act, is needed. APHIS reached a determination that the release following a determination of nonregulated status is not likely to adversely affect any listed threatened or endangered species and consequently obtained written concurrence from the U.S. Fish and Wildlife Service.

__________ BRS has reviewed the data in accordance with a process mutually agreed upon with the U.S. Fish and Wildlife Service to determine when a consultation, as required under Section 7 of the Endangered Species Act, is needed. APHIS reached a determination that the release following a determination of nonregulated status is likely to adversely affect one or more listed threatened or endangered species and has initiated formal consultation with the U.S. Fish and Wildlife Service.

Appendix G. Herbicide Applications in Conventional Sugar Beets

Tables G–1 through G–11 present herbicide use by State, in conventional sugar beets, for 2000. These herbicide use data were gathered from the USDA Agricultural Chemical Use Database (USDA, 2008). The data for acres planted were obtained from the USDA 2000 Crop Production Survey (USDA, 2001). Data are presented for the 11 sugar beet production States in 5 regions: Imperial Valley (California); Great Lakes (Michigan); Great Plains (Colorado, Montana, Nebraska, Wyoming); Midwest (Minnesota and North Dakota); and Northwest (Idaho, Oregon, Washington). These data provide a regional perspective on sugar beet herbicide use and represent the most current regional herbicide use data in sugar beets for the entire United States. Further discussion of herbicide use by region, including a regional summary table is presented in section III.B.1.d.

Table G- 1. Herbicide Applications to Conventional Sugar Beet Acres in California (Imperial Valley Region), 2000

Agricultural Chemical (Herbicide)	Trade Name (typical)	WSSA Mechanism of Action Group No.[1]	Acreage Treated (%)	No. of Applications per Year	Rate per Application (lb/app./acre)	Rate per Acre (lb/acre)	Total Applied per Year (lb)
Clethodim	Select®	1	7%	1	0.09	0.08	ND[2]
Desmedipham	Betanex®	1	69%	1.5	0.17	0.11	11,000
Ethofumesate	Nortron®	8	6%	1.2	0.53	0.44	3,000
Glyphosate	(Several)	9	15%	1	0.6	0.6	9,000
Phenmedipham	Betamix®	5	69%	1.5	0.17	0.11	11,000
Sethoxydim	Poast®	1	51%	1.5	0.51	0.33	25,000
Trifluralin	Treflan® HFP	3	9%	1	0.72	0.72	7,000
Triflusulfuron-methyl	Upbeet®	2	26%	1.1	0.01	0.01	ND

Pesticide Usage Source: National Agriculture Statistics Service, Agricultural Chemical Use Database (http://www.pestmanagement.info/nass/app_usage.cfm).

[1] Source: Heap, 2011; WSSA, 2007.

[2] ND = No data were reported for total herbicide applied per year (lb), although the available data indicated that the herbicide was applied in California (Imperial Valley Region).

Table G- 2. Herbicide Applications to Conventional Sugar Beet Acres in Michigan (Great Lakes Region), 2000

Agricultural Chemical (Herbicide)	Trade Name (typical)	WSSA Mechanism of Action Group No.[1]	Acreage Treated (%)	No. of Applications per Year	Rate per Application (lb/app./acre)	Rate per Acre (lb/acre)	Total Applied per Year (lb)
Clopyralid	Stinger®	4	78%	2.5	0.07	0.03	10,000
Cycloate	Ro-Neet™	8	3%	1	3.03	3.03	16,000
Desmedipham	Betanex®	5	92%	2	0.12	0.06	21,000
Ethofumesate	Nortron®	8	14%	1.5	0.13	0.08	3,000
Phenmedipham	Betamix®	5	90%	2	0.11	0.06	19,000
Pyrazon	Pyramin®	5	35%	1	0.99	0.97	66,000
Quizalofop-p-ethyl	Assure® II	1	12%	1.3	0.07	0.05	2,000
Triflusulfuron-methyl	Upbeet®	2	87%	2	0.01	0.01	2,000

Pesticide Usage Source: National Agriculture Statistics Service, Agricultural Chemical Use Database (http://www.pestmanagement.info/nass/app_usage.cfm).

[1] Source: Heap, 2011; WSSA, 2007.

Table G- 3. Herbicide Applications to Conventional Sugar Beet Acres in Colorado (Great Plains Region), 2000

Agricultural Chemical (Herbicide)	Trade Name (typical)	WSSA Mechanism of Action Group No.[1]	Acreage Treated (%)	No. of Applications per Year	Rate per Application (lb/app./acre)	Rate per Acre (lb/acre)	Total Applied per Year (lb)
Clethodim	Select®	1	36%	1	0.02	0.02	1,000
Clopyralid	Stinger®	4	46%	1.2	0.07	0.05	2,000
Cycloate	Ro-Neet™	8	8%	1	1.31	1.31	7,000
Desmedipham	Betanex®	5	83%	1.2	0.06	0.05	3,000
Ethofumesate	Nortron®	8	65%	1	0.14	0.13	7,000
Phenmedipham	Betamix®	5	83%	1.2	0.06	0.05	3,000
Quizalofop-p-ethyl	Assure® II	1	12%	1	0.05	0.05	ND[2]
Triflusulfuron-methyl	Upbeet®	2	80%	1.2	0.01	0.009	ND

Pesticide Usage Source: National Agriculture Statistics Service, Agricultural Chemical Use Database (http://www.pestmanagement.info/nass/app_usage.cfm).
[1] Source: Heap, 2011; WSSA, 2007.
[2] ND = No data were reported for total herbicide applied per year (lb), although the available data indicated that the herbicide was applied in Colorado (Great Plains Region).

Table G- 4. Herbicide Applications to Conventional Sugar Beet Acres in Montana (Great Plains Region), 2000

Agricultural Chemical (Herbicide)	Trade Name (typical)	WSSA Mechanism of Action Group No.[1]	Acreage Treated (%)	No. of Applications per Year	Rate per Application (lb/app./acre)	Rate per Acre (lb/acre)	Total Applied per Year (lb)
Clethodim	Select®	1	65%	2.6	0.12	0.04	5,000
Clopyralid	Stinger®	4	92%	2.5	0.08	0.03	5,000
Desmedipham	Betanex®	8	99%	2.7	0.15	0.05	9,000
Ethofumesate	Nortron®	5	41%	2.3	0.17	0.07	4,000
Glyphosate	(Several)	8	67%	1	0.42	0.42	17,000
Phenmedipham	Betamix®	5	97%	2.7	0.13	0.05	8,000
Quizalofop-p-ethyl	Assure® II	1	5%	2	0.04	0.02	ND[2]
Triflusulfuron-methyl	Upbeet®	2	91%	2.6	0.03	0.01	2,000

Pesticide Usage Source: National Agriculture Statistics Service, Agricultural Chemical Use Database (http://www.pestmanagement.info/nass/app_usage.cfm).
[1] Source: Heap, 2011; WSSA, 2007.
[2] ND = No data were reported for total herbicide applied per year (lb), although the available data indicated that the herbicide was applied in Montana (Great Plains).

Table G- 5. Herbicide Applications to Conventional Sugar Beet Acres in Nebraska (Great Plains Region), 2000

Agricultural Chemical (Herbicide)	Trade Name (typical)	WSSA Mechanism of Action Group No.[1]	Acreage Treated (%)	No. of Applications per Year	Rate per Application (lb/app./acre)	Rate per Acre (lb/acre)	Total Applied per Year (lb)
Clethodim	Select®	1	41%	1	0.09	0.09	3,000
Clopyralid	Stinger®	4	66%	1.8	0.08	0.04	4,000
Cycloate	Ro-Neet™	8	17%	1	1.72	1.72	23,000
Desmedipham	Betanex®	5	90%	2	0.15	0.08	11,000
Ethofumesate	Nortron®	8	70%	1.2	0.22	0.18	12,000
Phenmedipham	Betamix®	5	86%	2	0.15	0.07	10,000
Sethoxydim	Poast® II	1	3%	1	0.16	0.16	ND[2]
Triflusulfuron-methyl	Upbeet®	2	70%	2	0.02	0.01	1,000

Pesticide Usage Source: National Agriculture Statistics Service, Agricultural Chemical Use Database (http://www.pestmanagement.info/nass/app_usage.cfm).

1 Source: Heap, 2011; WSSA, 2007.

2 ND = No data were reported for total herbicide applied per year (lb), although the available data indicated that the herbicide was applied in Nebraska (Great Plains Region).

Table G- 6. Herbicide Applications to Conventional Sugar Beet Acres in Wyoming (Great Plains Region), 2000

Agricultural Chemical (Herbicide)	Trade Name (typical)	WSSA Mechanism of Action Group No.[1]	Acreage Treated (%)	No. of Applications per Year	Rate per Application (lb/app./acre)	Rate per Acre (lb/acre)	Total Applied per Year (lb)
Clethodim	Select®	1	35%	1.7	0.11	0.06	2,000
Clopyralid	Stinger®	4	71%	2.1	0.07	0.03	3,000
Cycloate	Ro-Neet™	8	15%	1	0.79	0.78	7,000
Desmedipham	Betanex®	5	86%	2.1	0.1	0.05	5,000
EPTC	Eptam®	8	12%	1	2.15	2.15	15,000
Ethofumesate	Nortron®	8	37%	1.1	0.17	0.15	4,000
Phenmedipham	Betamix®	5	78%	2.2	0.09	0.04	4,000
Triflusulfuron-methyl	Upbeet®	2	79%	2.1	0.02	0.009	1,000

Pesticide Usage Source: National Agriculture Statistics Service, Agricultural Chemical Use Database (http://www.pestmanagement.info/nass/app_usage.cfm).

1 Source: Heap, 2011; WSSA, 2007.

Table G- 7. Herbicide Applications to Conventional Sugar Beet Acres in North Dakota1 (Midwest Region), 2000

Agricultural Chemical (Herbicide)	Trade Name (typical)	WSSA Mechanism of Action Group No.[2]	Acreage Treated (%)	No. of Applications per Year	Rate per Application (lb/app./acre)	Rate per Acre (lb/acre)	Total Applied per Year (lb)
Clethodim	Select®	1	83%	2.9	0.11	0.04	24,000
Clopyralid	Stinger®	4	85%	3.1	0.1	0.03	22,000
Desmedipham	Betanex®	5	98%	3.3	0.21	0.06	54,000
Ethofumesate	Nortron®	8	32%	2.5	0.12	0.05	10,000
Glyphosate	(Several)	9	9%	1	0.67	0.64	16,000
Phenmedipham	Betamix®	5	75%	3	0.14	0.05	28,000
Quizalofop-p-ethyl	Assure® II	1	8%	1.4	0.06	0.04	1,000
Sethoxydim	Poast®	1	4%	3.4	0.21	0.06	2,000
Triflusulfuron-methyl	Upbeet®	2	87%	3.2	0.02	0.006	4,000

Pesticide Usage Source: National Agriculture Statistics Service, Agricultural Chemical Use Database (http://www.pestmanagement.info/nass/app_usage.cfm).

[1] For North Dakota in 2000, 242,400 acres of sugar beets were planted in eastern North Dakota and 15,600 acres were planted in the two western counties (Williams and McKenzie). The NASS herbicide usage database does not break out by county, so North Dakota data were grouped with the Midwest region.

[2] Source: www.weedscience.org; www.hracglobalcom.

Table G- 8. Herbicide Applications to Conventional Sugar Beet Acres in Minnesota (Midwest Region), 2000

Agricultural Chemical (Herbicide)	Trade Name (typical)	WSSA Mechanism of Action Group No.[1]	Acreage Treated (%)	No. of Applications per Year	Rate per Application (lb/app./acre)	Rate per Acre (lb/acre)	Total Applied per Year (lb)
Clethodim	Select®	1	75%	2.6	0.04	0.1	38,000
Clopyralid	Stinger®	4	95%	3.2	0.03	0.1	46,000
Desmedipham	Betanex®	5	100%	3.3	0.07	0.25	121,000
Ethofumesate	Nortron®	8	20%	2.1	0.04	0.08	8,000
Glyphosate	(Several)	9	4%	1	0.5	0.5	10,000
Phenmedipham	Betamix®	5	70%	3	0.05	0.15	52,000
Quizalofop-p-ethyl	Assure® II	1	9%	1.4	0.04	0.06	3,000
Sethoxydim	Poast®	1	16%	1.7	0.16	0.28	21,000
Trifluralin	Treflan® HFP	3	6%	1	0.84	0.84	23,000
Triflusulfuron-methyl	Upbeet®	2	94%	3.3	0.007	0.02	10,000

Pesticide Usage Source: National Agriculture Statistics Service, Agricultural Chemical Use Database (http://www.pestmanagement.info/nass/app_usage.cfm).

[1] Source: www.weedscience.org; www.hracglobalcom.

Table G- 9. Herbicide Applications to Conventional Sugar Beet Acres in Idaho (Northwest Region), 2000

Agricultural Chemical (Herbicide)	Trade Name (typical)	WSSA Mechanism of Action Group No.[1]	Acreage Treated (%)	No. of Applications per Year	Rate per Application (lb/app./acre)	Rate per Acre (lb/acre)	Total Applied per Year (lb)
Clopyralid	Stinger®	4	62%	2.2	0.07	0.03	9,000
Cycloate	Ro-Neet™	8	13%	1	2.39	2.39	65,000
Desmedipham	Betanex®	5	100%	2.9	0.13	0.04	28,000
EPTC	Eptam®	8	20%	1	2.93	2.93	125,000
Ethofumesate	Nortron®	8	94%	2.7	0.12	0.05	25,000
Glyphosate	(Several)	9	24%	1	0.4	0.39	20,000
Phenmedipham	Betamix®	5	100%	2.9	0.13	0.04	28,000
Quizalofop-p-ethyl	Assure® II	1	23%	2	0.07	0.03	3,000
Sethoxydim	Poast®	1	13%	1	0.26	0.24	7,000
Trifluralin	Treflan® HFP	3	9%	1	0.5	0.5	10,000
Triflusulfuron-methyl	Upbeet®	2	84%	2.6	0.04	0.02	7,000

Pesticide Usage Source: National Agriculture Statistics Service, Agricultural Chemical Use Database (http://www.pestmanagement.info/nass/app_usage.cfm).
1 Source: www.weedscience.org; www.hracglobalcom.

Table G- 10. Herbicide Applications to Conventional Sugar Beet Acres in Oregon (Northwest Region), 2000

Agricultural Chemical (Herbicide)	Trade Name (typical)	WSSA Mechanism of Action Group No.[1]	Acreage Treated (%)	No. of Applications per Year	Rate per Application (lb/app./acre)	Rate per Acre (lb/acre)	Total Applied per Year (lb)
Clopyralid	Stinger®	4	58%	2.6	0.09	0.03	1,000
Desmedipham	Betanex®	5	89%	2.8	0.15	0.05	2,000
EPTC	Eptam®	8	15%	1.3	3.79	2.75	9,000
Ethofumesate	Nortron®	8	31%	2.9	0.2	0.07	1,000
Glyphosate	(Several)	9	39%	1	0.45	0.45	3,000
Phenmedipham	Betamix®	5	89%	2.8	0.15	0.05	2,000
Quizalofop-p-ethyl	Assure® II	1	10%	1	0.07	0.07	ND[2]
Trifluralin	Treflan® HFP	3	27%	1	0.55	0.55	2,000
Triflusulfuron-methyl	Upbeet®	2	88%	2.6	0.03	0.01	ND

Pesticide Usage Source: National Agriculture Statistics Service, Agricultural Chemical Use Database (http://www.pestmanagement.info/nass/app_usage.cfm).
1 Source: www.weedscience.org; www.hracglobalcom.
2 ND = No data were reported for total herbicide applied per year (lb), although the available data indicated that the herbicide was applied in Oregon (Northwest).

Table G- 11. Herbicide Applications to Conventional Sugar Beet Acres in Washington (Northwest Region), 2000

Agricultural Chemical (Herbicide)	Trade Name (typical)	WSSA Mechanism of Action Group No.[1]	Acreage Treated (%)	No. of Applications per Year	Rate per Application (lb/app./acre)	Rate per Acre (lb/acre)	Total Applied per Year (lb)
Clethodim	Select®	1	41%	1.9	0.24	0.12	3,000
Cycloate	Ro-Neet™	8	32%	1	1.57	1.57	14,000
Desmedipham	Betanex®	5	83%	2.6	0.21	0.08	5,000
EPTC	Eptam®	8	38%	1	2.11	2.11	22,000
Ethofumesate	Nortron®	8	57%	1.5	0.28	0.17	5,000
Phenmedipham	Betamix®	5	83%	2.6	0.2	0.07	5,000
Triflusulfuron-methyl	Upbeet®	2	80%	2.4	0.03	0.01	1,000

Pesticide Usage Source: National Agriculture Statistics Service, Agricultural Chemical Use Database (http://www.pestmanagement.info/nass/app_usage.cfm).
[1] Source: www.weedscience.org; www.hracglobalcom.

Appendix H
Response to Comments

Contents

I Summary

APHIS received 1,293 submissions that supported the use of Roundup Ready® sugar beet (RRSB) and 94 submissions that did not support their use. APHIS also received 9,186 letters that were nearly identical in content and a petition from an organization with 14,592 signatures and associated comments opposed to the use of RRSB. APHIS received 68 submissions from commenters that attached 578 supporting documents. Of the attached documents, 23 were cited in the final environmental impact statement (FEIS), 150 were not cited in the FEIS, and the remaining were court documents related to litigation associated with RRSB or other genetically engineered (GE) crops or duplicate submissions of attachments.

In addition, APHIS conducted 3 public meetings, at which a total of 63 people provided comments.

The text of the form letter submissions (APHIS-2010-0047-4251[1], APHIS-2010-0047-4252, APHIS-2010-0047-4288, APHIS-2010-0047-4292, and APHIS-2010-0047-4293) is included below. Among these form letters, some individuals included additional or alternate text. In instances where the additional or alternate text related to a substantive issue, APHIS' responses are in the subject-related areas of this document.

The text of the form letter with APHIS' response to each issue:

Comment: I am writing to strongly oppose USDA's proposal to allow the deregulation and commercialization of Monsanto's genetically engineered, "Roundup Ready" sugar beets (Docket No. APHIS-2010-0047-3179).

Transgenic contamination is not only likely, but certain, under a full deregulation, and in fact has already occurred. USDA's preferred alternative to fully deregulate GE sugar beets will lead to transgenic contamination of conventional sugar beet seed and conventional and organic table beet and Swiss chard seed. With no mandatory measures in place to keep GE and non-GE fields distant enough to prevent contamination, there will be an increased level of gene flow from GE to non-GE fields resulting in contaminated seed.

This contamination burdens organic and conventional farmers with the cost of testing their product, externalizing a cost of production that should be borne by the producers of the technology. While USDA recognizes that full deregulation of the GE sugar beet seeds will result in increased testing costs for non-GE growers, even forcing some to leave their land because of the costs associated with the threat and likelihood of contamination, the Agency proposes no mitigating measures to protect conventional and organic farmers from this harm, opting instead to promote it by proposing full deregulation of GE sugar beets. This is unacceptable.

Response: APHIS examined the likelihood of gene flow between conventional, organic, and GE beets if the agency were to grant nonregulated status to RRSB; the results can be found in section IV.B.5 of the FEIS. APHIS concluded that under normal growing practices in areas where these crops are typically grown, the probability of gene flow between the crops is very small. In seed-growing areas where there is geographic overlap between sugar beet, table beet, and chard seed production, the probability of gene flow is less than 1 in 10,000 if current isolation practices are

[1] These citations are to public comments submitted to regulations.gov docket APHIS-2010-0047 http://www.regulations.gov/#!searchResults;rpp=25;po=0;s=APHIS-2010-0047.

used. If growers choose to use different practices, the probability of gene flow may increase or decrease. APHIS acknowledges that the H7-1 trait was detected in some vegetable beet seed produced in 2007 and 2008. However, vegetable beet seed that has been tested in subsequent years has tested negative for the H7-1 trait. APHIS has concluded that overall it is unlikely that gene flow will occur between vegetable beet and sugar beet root production.

APHIS examined the potential harm to non-GE beet seed growers (see secs. IV.D.3 and IV.D.4 of the FEIS). While APHIS did not conclude that any non-GE beet seed growers would be forced to leave their land, the agency did conclude that some non-GE growers may be unable to grow beet seed at some locations if their specific growing contracts required certain isolation distances longer than what local practices normally require. In addition, APHIS found that some non-GE growers may opt to grow seeds other than beet seeds if they are at a competitive disadvantage to beet seed producers in other locales (see sec. IV.D.4). In addition, APHIS examines the cost of testing in section IV.D.4.

As APHIS describes in the FEIS, growers who wish to produce crops for GE-sensitive markets are growing specialty crops to attain a market premium. It is the responsibility of the grower who enters into a specific contract to grow a specialty crop to take steps to meet the specialty crop contract's obligations. Restricting the activities of other growers who are not obligated under the specialty crop contract so that the specialty growers can meet their self-imposed obligated market specifications is outside of APHIS' authority under the Plant Protection Act (PPA). APHIS has no legal authority to impose any regulatory requirements, including mandatory isolation distances on H7-1 sugar beet growers, unless APHIS determines that H7-1 sugar beet presents a plant pest risk that can be mitigated by those isolation distances or other regulatory requirements.

Comment: USDA also refuses to seriously analyze other adverse environmental impacts stemming from full deregulation of Roundup Ready sugar beets. USDA's biased assessment touts the advantage of glyphosate displacing other herbicides, but ignores, denies or downplays a range of adverse impacts, including a 20-fold increase in the use of glyphosate, a twofold rise in overall herbicide use on sugar beets, rapid evolution of glyphosate-resistant weeds, and the acquisition of glyphosate resistance by weeds already resistant to other herbicides.

USDA recommends increased use of more toxic herbicides as a mitigating measure for the anticipated emergence of glyphosate-resistant weeds caused by the huge rise in glyphosate use on sugar beet fields, but fails to assess the impacts. Contrary to USDA's bogus claim that resistant weeds require at least five years to develop, two populations of glyphosate-resistant weeds infesting sugar beets have been documented in just the last year, only the 4th year of widespread RR sugar beet cultivation. USDA's cumulative impacts assessment essentially dismisses problems caused by RR sugar beets on the grounds that these problems are not as great as those caused by more widely-planted RR crops that USDA unconditionally approved. By this logic, the Army Corps of Engineers could justify allowing a small town to be inundated on the grounds that it forms a small proportion of the many other towns it had previously failed to protect from the rising floodwaters.

Response: First, APHIS believes that it has analyzed the potential impacts that may result from the full deregulation of H7-1 sugar beet. Second, APHIS has clearly analyzed the effects of changes in herbicide use that are associated with the adoption of H7-1 sugar beet (see sec.

IV.B.1). APHIS has updated the analysis of total changes in herbicide use based on the most recent herbicide use surveys for sugar beet in the Red River Valley (Stachler, Carlson et al., 2012, where more than half of U.S. sugar beet production occurs. The updated analysis compares herbicide use on H7-1 sugar beet with herbicide use on conventional sugar beet, both grown in the Red River Valley. Glyphosate use on H7-1 sugar beets increased about sevenfold over herbicide use on conventional sugar beet. Ethofumesate use as a preplant-incorporated herbicide decreased about 25-fold; clethodim and clopyralid use decreased about 43-fold; quizalofop decreased fifteenfold; and desmedipham, dimetheneamid-p, ethofumesate (as a post emergent herbicide), phenmedipham, and trisulfuron-methyl were no longer used. Overall pounds of herbicide applied decreased about 22 percent on H7-1 sugar beet. Third, APHIS analyzed the selection of glyphosate-resistant (GR) weeds, including those resistant to multiple herbicides. While this comment disagrees with APHIS' analyses, it does not offer any data to support its opposition or its particular claims with regard to quantities of herbicides used on sugar beet.

In addition, with regard to the cumulative impacts analysis, APHIS has updated that analysis to make it clearer that on a national level the changes in production practices associated with the adoption of H7-1 sugar beet do not contribute measurably to the cumulative effects that the sum total of agricultural crops and systems have on the environment. In addition, APHIS has examined the cumulative impacts at the regional and local levels and has concluded that the adoption of H7-1 sugar beet could increase beneficial practices associated with conservation management programs run by USDA's National Resources Conservation Service (NRCS) in some regions, such as the Northwest and Great Plains. In certain areas, the adoption of H7-1 sugar beet may also incrementally contribute to the development and spread of GR weeds in GR cropping systems.

APHIS disagrees with the commenter's characterization that the agency falsely claimed that it takes 5 years for GR weeds to develop when in just 4 years GR weeds are now infesting sugar beet fields. These weeds did not develop from 4 years of herbicide use in sugar beet fields; rather, they developed from at least 15 years of herbicide use in soybean and corn fields that have been rotated into sugar beet. Consequently, the selection of these weeds would occur under any of the three alternatives because of the widespread adoption of GR corn and soybean over the landscape in the Midwest. Models describing how long selection needs to be applied before resistance appears in a population are consistent among several sources and are supported by the observation that GR weeds have not been selected in sugar beet fields in the Great Plains and Northwest after 4 years of H7-1 adoption.

Comment: As a consumer I am harmed by the loss of my right to choose non-GE foods. As concerns about the contamination of conventional foods have grown, consumers are turning to organics as a safe alternative. But under USDA's deregulation proposal, organics are threatened with contamination as well. USDA claims that consumers accept transgenic contamination of organic foods, basing these claims on a thriving organic industry despite the known contamination of organic soy and corn. But there is no tolerance for transgenic contamination in the organic standard or in the market. Allowing commercialization will eliminate my choice to choose non-GE food and threaten vital organic markets and farmers.

Response: APHIS analyzes consumer preference in section IV.D.4 of the FEIS. The commenter has not offered any evidence to contradict that analysis. APHIS does not agree that consumers will lose the right to choose non-GE food. Almost half of the sugar produced in the United States is derived from sugar cane that is non-GE. Non-GE swiss chard and table beets will continue to be available, allowing consumers to choose non-GE vegetables.

Comment: USDA should prohibit the commercial use and planting of Roundup Ready Sugar Beets, until and unless it can fully protect the environment, farmers, and consumers from its harms.

Response: APHIS has been asked to make a decision on a petition to grant nonregulated status to H7-1 sugar beet. Under title 7, part 340 of the Code of Federal Regulations (CFR), APHIS must base it decision on whether H7-1 sugar beet poses a plant pest risk. APHIS has not found a greater plant pest risk associated with the production of H7-1 sugar beet than other sugar beet. Therefore, APHIS' preferred alternative is to approve the petition. If APHIS determines there is no plant pest risk and grants the petition, there is no basis under 7 CFR 340 to place restrictions on the use and planting of H7-1 sugar beets. The commenter has provided no evidence that H7-1 is likely to be a plant pest.

Comment: The following represents my position in strong disagreement with the draft Environmental Impact Statement (EIS) for RoundUp Ready Sugar Beets, which identifies full deregulation as the preferred alternative.

The EIS acknowledges that the threat of contamination to organic seed and crops is real, and risks compromising livelihoods, genetic integrity, and faith in the organic label. This requires the USDA to reject Monsanto's petition seeking a determination of nonregulated status.[2]

Response: In the FEIS, APHIS fully analyzes the effects of three different alternatives on the likelihood of gene flow from H7-1 sugar beet to other *Beta vulgaris* crops; the analysis is in section IV.B.5. APHIS also examined the economic impact of gene flow to growers of other *B. vulgaris* crops (see sec. IV.D.4). The analysis does not identify any plant pest risks that are associated with gene flow between H7-1 and other beet crops. Accordingly, the analysis does not support the commenter's conclusion that APHIS must reject the petition for nonregulated status for H7-1 sugar beet. The commenter has not provided any evidence that H7-1 sugar beet is likely to be a plant pest.

Comment: Sugar beets are wind pollinated and easily cross with vegetable relatives. The species at issue (Beta vulgaris) is one of the few vegetable crop species that is wind pollinated. Some insect pollination occurs in beets, but wind accounts for most pollination events. Furthermore, beets are self-incompatible, meaning each plant must have pollen from a genetically different individual to produce viable seed.

Table beets and chard have large numbers of flowers per plant and produce large amounts of pollen. Crops within the Beta vulgaris species (table beets, chard, and sugar beets) are fully sexually compatible and mating between any two of these crops will occur if they flower in proximity to one another, as pollen from one will readily fertilize any of the

[2] Comment number APHIS-2010-0047-4383 contained a petition that included names as well as individual comments in the field designated "letter." Exactly 7,498 people submitted comments in this field. The majority of the comments consisted of two different form letters and variations of these form letters. APHIS' response to the issues raised in these form letters is in this section. Some individuals made additional comments; APHIS' responses to those comments are included in the subject-specific response sections of this document.

other's flowers, resulting in viable offspring that produce viable seed. Research shows that beet pollen can travel over 12 miles. There's no realistic distance that completely isolates two cross-pollinating crops 100 percent of the time, especially in a highly concentrated seed production location like the Willamette Valley.

Response: APHIS acknowledges the comment and has considered these facts in the FEIS. The FEIS fully discusses the pollination biology of *B. vulgaris*, the different varieties of *B. vulgaris* and cross-pollination between them, and the effect that distance has on the probability of cross-pollination (see sec. III.B.5). APHIS is not aware of any data that shows that a successful cross-pollination between beet species occurs over 12 miles. The greatest distance over which cross-pollination occurs that APHIS is aware of is 6 miles, as described in (Fénart *et al.*, 2007).

Contracts may set thresholds for a maximum allowable percentage of off-types. Growers in areas with highly concentrated seed industries, such as the Willamette Valley, have developed organizations like the Willamette Valley Specialty Seed Association (WVSSA) to cooperatively set standards to help growers meet contract-mandated thresholds for off-types.

Comment: Complete segregation is not possible. Once contamination occurs, farmers can neither detect the presence of a transgenic trait without testing, nor can they remove the foreign DNA sequence from the crop. If contaminated seed is planted unknowingly, contamination will spread. For example: The contaminated seed could be used as stock for a subsequent seed crop. As soon as contaminated seed is in the hands of farmers or gardeners scattered geographically, it could cause a wider distribution of GE contamination, especially if they are in or near seed production areas for any of the Beta vulgaris crops.

Contamination can also spread through unintentional flowering when crops encounter stress - called "bolting" - releasing pollen to other Beta vulgaris populations within pollination proximity. When seed crops from this species are grown during the first year of the biennial cycle they can flower prematurely if exposed to excessive cold temperatures, producing pollen from plots that are not normally considered in calculating isolation distances. "Weedy" sugar beets growing in roadside ditches and other areas not under cultivation can spread pollen with GE traits and further contamination events.
Human error is also a factor, as mistakes regarding the physical mixing of roots in breeding programs spreads genetic traits from one seed lot to another.

Response: The FEIS discusses methods for detecting the 5-enolpyruvylshikimate-3-phosphate synthase (*epsps*) transgene in crops as well as vegetable beet/sugar beet hybrids, methods employed by seed producers to maintain the purity of varieties of beets, and the biology of sugar beets including bolting. Farmers can detect whether vegetable beet seed has the H7-1 transgene when they grow their crop because the only seed with the transgene will be half vegetable beet and half sugar beet and will have a distinct appearance. Such hybrid off-types can be culled to remove the "DNA sequence from the crop." This is a practical remedy for those growing vegetables as they are normally harvested by hand and are typically inspected at that point. In the case of growing salad mixes that are harvested at a young stage before off-types have developed distinguishing characteristics, seed would need to be tested for the presence of the H7-1 transgene. Weedy sugar beets have not been identified as a problem in roadside ditches, especially in most areas of sugar beet production, because beets do not overwinter in freezing temperatures. While sugar beets can bolt, they rarely do and generally are not grown in proximity to a flowering vegetable beet crop. APHIS has not identified any information in this section of the comment that requires a change to the FEIS.

Comment: The unwanted spread of GE traits threatens markets and livelihoods. Maintaining the genetic purity and proper isolation distances with these crops is difficult as it is without introducing a novel, engineered trait that is outright rejected by various markets. Cross-pollination between a GE crop and a non-GE crop of the same species causes a number of problems. Contaminated seed will not be acceptable for many farmers' use because:
The contaminated seed cannot be sold into countries that do not allow GE crops or products, regardless of how it was grown.
The contaminated seed will not comply with USDA standards for organic certification, which does not permit GE content in organic seed. It can therefore not be sold as organically certified seed in the U.S. or into any international organic seed market that adheres to the standards established by the International Foundation of Organic Agricultural Movements.

Response: APHIS examined the impacts of each of the three alternatives on markets. When growers choose to produce a crop for a specialty market or a particular buyer, they must determine whether or not they can meet the market or contract demands. Growers within specific areas may agree to keep certain production practices, such as isolation distances, to aid in the production of crops with market-driven standards.

Other countries have their own regulations regarding the use of GE crops, which may include restrictions on the use of GE crops that are not approved for use in their country. They may also require testing of crops. It is exporters' obligation to understand the regulations of the importing country. Section III.B.1 of the FEIS states which countries have approved H7-1 sugar beet.

Detection of H7-1 DNA or the modified EPSPS protein does not necessarily constitute a violation of the National Organic Program (NOP). The preamble to NOP's final rule states: "When we are considering [genetic] drift issues, it is particularly important to remember that organic standards are process based. Certifying agents attest to the ability of organic operations to follow a set of production standards and practices that meet the requirements of the Act and the regulations. This regulation prohibits the use of excluded methods in organic operations. The presence of a detectable residue of a product of excluded methods alone does not necessarily constitute a violation of this regulation. As long as an organic operation has not used excluded methods and takes reasonable steps to avoid contact with the products of excluded methods as detailed in their approved organic system plan, the unintentional presence of the products of excluded methods should not affect the status of an organic product or operation" (65 FR 80556).

Furthermore, NOP's final rule states: "…these regulations do not establish a 'zero tolerance' standard. As with other substances not approved for use in organic production systems, a positive detection of a product of excluded methods would trigger an investigation by the certifying agent to determine if a violation of organic production or handling standards occurred. The presence of a detectable residue alone does not necessarily indicate use of a product of excluded methods that would constitute a violation of the standards" (65 FR 80632).

Comment: GE sugar beets put chard and table beet seed at risk. The integrity of organic seed and food crops and products are at risk. The quality of organic seed is dependent on its genetic purity, including being free of GE contamination. This is particularly a concern

for table beets and chard that are relatives to sugar beets and grown in the same region. Washington and Oregon account for over 80 percent of U.S. chard and table beet seed production, and 50 percent of world chard and table seed production. These crops are valued at millions of dollars. It's not just organic markets that will reject seed with GE contamination. This valley is home to a high value specialty seed trade with buyers in the Pacific Rim and European Union who will also reject contaminated seed. Companies are already looking to produce seed elsewhere, in different U.S. regions and abroad, because of contamination concerns.

Response: APHIS acknowledges the comment. The seed purity of vegetable beets grown in the Willamette Valley was considered in the FEIS, and the likelihood and impacts were fully analyzed. APHIS examined the geographic distribution of the vegetable beet and sugar beet seed growing areas. Traditionally, table beet seeds are grown in western Washington, and sugar beet seeds are grown in the Willamette Valley. Chard seeds are a smaller market and are grown in both areas. Beet seed growers in the Willamette Valley often participate in the WVSSA's pinning program to establish isolation between sexually compatible varieties, which allows them to meet their contractual requirements. Under this system, individual growers may be unable to grow the variety of their choosing in a particular field if another grower has priority under the system for planting his or her variety in a nearby field or if they are unable to meet the contract's growing requirements. However, while individual growers might lose certain contracts, other growers can obtain them. Accordingly, APHIS concludes in the FEIS that there is little effect on the integrity of the organic seed market of the vegetable beet seed industry as a whole under any of the alternatives.

Comment: Organic farmers shoulder the burden of protecting the integrity of organic seed.

The burden of protecting the integrity of organic seeds, agricultural products, and markets is solely on the shoulders of organic farmers. This is an imbalanced and unfair burden. In the event contamination occurs, farmers have no recourse to recoup damages because the question of who is liable has not been determined. They are left with the economic and agronomic costs of detecting and eradicating GE material; losing the genetic integrity of seed on which they rely; taking measures to avoid future contamination; and selling contaminated products into the conventional market, losing a premium for organically produced products.

Response: APHIS fully analyzes the effects of three alternatives on organic, conventional vegetable beet seed, and sugar beet producers in section IV.D of the FEIS. USDA supports the use of all types of agriculture, including organic, conventional, and GE. The decision to grow a crop for a specialty market is an individual choice. Growers consider the risks and the returns when making those decisions. There is a risk to producing an identity-preserved product whether organic, conventional, or GE. The burden of protecting one's product is upon the person growing the seed, regardless of the type of seed.

Comment: Please revise the draft EIS to bring the recommendation in line with the evidence. The only way to prevent genetically engineered sugar beet production from destroying the organic seed market for related crops is to reject Monsanto's petition for deregulation.

Response: The commenter has not provided any evidence that supports revising the FEIS. The FEIS analyzes the impacts of three different alternatives on the human environment. The comment has provided no evidence to support the assertion that the organic seed market for *B. vulgaris* varieties would be destroyed under any of the alternatives. Further, the commenter points to no basis under 7 CFR 340 for denying the petition based on a plant pest risk.

Comment: I am writing to strongly oppose the USDA's proposal to allow the commercial planting and sale of genetically engineered, "Roundup Ready" sugar beets before the agency has completed the court-ordered review of that crop's impacts (Docket No. APHIS-2010-0047).

The USDA's proposal violates environmental laws that are meant to ensure that agencies analyze potential environmental and socioeconomic impacts before they take action, not allow those activities to continue under another name while they undertake that analysis. The proposal also violates the law because it allows commercialization under provisions meant only for research, making an end-run around actually making a commercial approval decision.

Response: APHIS will make a determination on the petition for nonregulated status after completing the FEIS, namely the court ordered review referenced by the commenter, and publishing the record of decision (ROD). APHIS is not taking an action on the petition for nonregulated status in the absence of completing this FEIS.

The commenter appears to be referring to the interim measures imposed by APHIS while the FEIS has been conducted. This comment more appropriately refers to the action APHIS took in response to the request for partial deregulation of H7-1 sugar beet submitted by Monsanto and KWS on August 9, 2010, not the action APHIS plans to take in response to the petition for nonregulated status that is the subject of the FEIS. Nevertheless, in responding to the earlier action, APHIS has not violated the National Environmental Policy Act (NEPA) or any other environmental law. In a similar case involving Roundup Ready® alfalfa, the Supreme Court ruled that “if the agency found, on the basis of a new EA, that a limited and temporary deregulation satisfied applicable statutory and regulatory requirements, it could proceed with such a deregulation even if it had not yet finished the onerous EIS required for complete deregulation” (United States Supreme Court, 2010) [pg. 17]. Clearly the agency acted within the law when it imposed specific conditions for the partial deregulation of H7-1 sugar beet during the preparation of the EIS.

We presume that the commenter’s statement claiming that APHIS has somehow violated the “law prohibiting commercialization under provisions meant only for research” is referring to APHIS’ part 340 regulations. We certainly disagree with the commenter’s interpretation of our part 340 regulations. Our part 340 regulations do not make any reference to or distinction between field trial tests for “research” or “commercialization.” Thus, we disagree with the commenter’s inference that the part 340 regulations are for the approval of research-only field tests.

In reference to making its determination regarding that petition for nonregulated status, APHIS has appropriately complied with NEPA and the District Court’s order specifically requiring APHIS to prepare an environmental impact statement (EIS) that fully considers the potential effects on the human environment that may result from that determination prior to making its final determination on that petition. Consistent with 7 CFR 340.6, a GE organism is no longer subject to the regulatory requirements of 7 CFR 340 when APHIS determines that it is unlikely to pose a plant pest risk. Accordingly, APHIS would have no regulatory jurisdiction or basis to place any restrictions on the production of H7-1 sugar beet if the agency determines that it does not pose a plant pest risk. Once APHIS determines that H7-1 sugar beet does not pose a plant pest risk after a full plant pest risk analysis, the agency would make the determination that it would be appropriate for H7-1 sugar beet to have nonregulated status.

Comment: As a consumer I am harmed by the loss of my right to choose non-GE foods. The harm to me happens because the sugar made from biotech beets is made by a production system that I know is harmful to the environment and farmers, regardless of the differences between biotech-derived sugar and other sugars. These harms include the risk of transgenic contamination of organic and non-GE crops, the creation of resistant "super weeds" from the overuse of Roundup, and the impacts of Roundup on biodiversity and protected species. Allowing commercialization to continue will not only eliminate my choice to choose non-GE food, but it will prejudge the agency's forgone conclusion to eventually commercialize again.

Response: The FEIS provides an analysis of consumer preferences in section IV.D.4, which does not support the assertion that consumers will lose the right to choose non-GE foods from the production of H7-1 sugar beet. The FEIS also analyzes the impacts of the adoption of H7-1 sugar beet on the environment, including the risks of gene flow and the indirect effects of gene flow on growers; the development of herbicide-resistant weeds; and the effects of changes in herbicide use on the environment (see secs. IV.B.5, IV.D, and IV.C.3). The analysis in the FEIS does not support the assertion that the use of H7-1 sugar beet is more harmful to the environment than conventional sugar beet production.

Comment: The USDA has proposed an unprecedented scheme with measures it claims will ensure harm such as transgenic contamination won't happen. But those measures have never been analyzed by our government for any biotech crop. They are the same measures that the Federal Court refused to adopt in August of this year. These measures should not be adopted now, at least not without a full Environmental Impact Statement analyzing their efficacy.

Response: The commenter appears to be referring to the interim measures imposed by APHIS while the FEIS has been conducted. This comment more appropriately refers to the action APHIS took in response to the request for partial deregulation of H7-1 sugar beet submitted by Monsanto and KWS on August 9, 2010, not the action APHIS plans to take in response to the petition for nonregulated status that is the subject of the FEIS. Nevertheless, in responding to the earlier action, APHIS has not violated NEPA or any other environmental law. In a similar case involving Roundup Ready® alfalfa, the Supreme Court ruled that "if the agency found, on the basis of a new EA, that a limited and temporary deregulation satisfied applicable statutory and regulatory requirements, it could proceed with such a deregulation even if it had not yet finished the onerous EIS required for complete deregulation" (United States Supreme Court, 2010) [pg. 17]. Clearly the agency acted within the law when it imposed specific conditions for the partial deregulation of H7-1 sugar beet during the preparation of the EIS.

The EIS considers and analyzes three alternatives in detail. It is unclear which scheme or measures the comment is referencing. The preferred alternative, to approve the petition, would not place restrictions on the cultivation of H7-1 sugar beet.

Comment: Additionally, the USDA's track record at overseeing biotech crops in field trials is abysmal, as numerous government reports have concluded (GAO 2008, USDA IG 2005). The failings of the USDA's field trial oversight have led to dozens of contamination episodes and billions of dollars in lost markets and businesses, such as with genetically engineered rice and corn. The USDA's actions belie its rhetoric of concern for non-GE crop growers, and continue to undermine its credibility. The USDA refused to disclose to the public a major contamination episode that came to light just a few weeks ago when GE bentgrass was discovered to have contaminated at least 20 square miles in eastern Oregon. GE bentgrass is not commercially approved and the contamination is believed to have spread from a field trial that ended more than five years ago. Congress even required USDA to improve its oversight of field trials in the 2008 farm bill, an order USDA has ignored.

Response: The comment does not raise any issue with any of APHIS' analyses of environmental impacts or other topics covered in the draft environmental impact statement (DEIS). Nevertheless, we will address the comment. APHIS strongly disagrees with the commenter's assertion that APHIS' oversight of field trials of biotech crops is abysmal. Quite the contrary, APHIS believes it has had and continues to have a very longstanding, reliable, and effective regulatory oversight of thousands of biotech field trials under its jurisdiction. APHIS has conscientiously taken into account the 28 recommendations from USDA's Office of Inspector General (OIG) 2005 audit report and reached management decisions with OIG on all 28 of the recommendations. APHIS reached closure on all but 3 recommendations with the Office of the Chief Financial Officer (OCFO). Of the remaining three recommendations, one pertaining to shipping requirements is with the OCFO for closure, and the remaining two recommendations were to be incorporated into APHIS' 7 CFR 340 regulations, which have not been finalized at present.

The General Accounting Office (GAO) had two primary recommendations for action that were applicable to APHIS in its 2008 report. The recommendation relevant to sugar beet is as follows: "USDA, EPA, and FDA should develop a coordinated strategy for risk-based monitoring of (deregulated) GE crops that are marketed, which should identify crops that warrant monitoring, such as those that produce pharmaceutical or industrial compounds, and include criteria for determining when monitoring is no longer needed." In situations where a GE crop plant is partially deregulated, APHIS has the legal authority to consider the plant pest risk of the partially deregulated GE crop and to determine what would be the appropriate mitigation conditions and monitoring of the GE crop in reference to the potential plant pest risk. Under Alternative 3, which is the partial deregulation alternative, APHIS would require growers to force sprouting of seed remaining after harvest and continue monitoring sites where H7-1 sugar beet had been planted for 3 years. Any crops planted at the site would need to be visually distinct from sugar beet during the monitoring period to avoid facilitating persistence of H7-1 sugar beet.

In addition, APHIS disagrees with the commenter's assertion that it had ignored the 2008 Farm Bill. APHIS has by no means ignored the 2008 Farm Bill. Under the Farm Bill, APHIS was given new authority to subpoena evidence, including samples of GE crops, and increase penalties for willful violations of permit conditions and performance standards applicable to avoiding unintended releases into the environment. In response, APHIS initiated numerous affirmative processes and actions to comply with the mandates and recommendations of the 2008 Farm Bill.

APHIS amended its guidelines for civil penalties for violations of its part 340 regulations. The Farm Bill also encouraged design of an electronic database for permits to facilitate tracking, and APHIS implemented the ePermits system to accomplish this request. In addition, the Farm Bill directed APHIS to enhance its protocols for conducting molecular forensics. In a memorandum of understanding with the Agricultural Marketing Service and the Grain Inspection, Packers and Stockyards Administration, APHIS addressed how it would secure sampling and testing of crops when necessary. Congress also asked APHIS to ensure that its separation distances for confined field trials reflect the latest science for appropriate separation distances. As such, APHIS has worked with the industry standard-setting organization, the Association of Official Seed Certifying Agencies, to develop these. Standards for audits of compliance were mandated, and APHIS has begun a Biotechnology Quality Management System pilot program with technology developers to implement them. In addition, APHIS addressed a number of the Farm Bill's points by revising and proposing new biotechnology regulations. The revision of 7 CFR 340, which was published as a proposed rule but has not been promulgated, contains provisions addressing many of Congress' concerns, including those regarding the quality and completeness of records, the maintenance of identity and control in the event of an unauthorized release, corrective actions in the event of an unauthorized release, clarity in contractual agreements, and the need for a system of risk-based categories to classify each regulated article. Finally, the Farm Bill asked APHIS to impose certain requirements on permit holders, including requiring them to maintain a positive chain of custody, maintain records, conduct periodic audits, and provide contingency and corrective action plans. APHIS addressed these concerns in the provisions of its proposed rule and continues to develop management plans for technology providers and to require better performance in the specified areas.

Comment: Now the USDA is claiming that its system of field trials is sufficient to contain an entire industry across the country. The measures should not be adopted at least without a full EIS.

Response: APHIS will make a determination on the petition for nonregulated status of H7-1 sugar beet after completing the FEIS and publishing the ROD for the FEIS. APHIS will not issue its final determination on the petition for nonregulated status of H7-1 sugar beet until after it has issued the FEIS and its ROD is effective.

Comment: The companies claiming economic harm from the failure to plant biotech beets in 2011 - Monsanto, Syngenta, and other agro-chemical giants - have not disclosed what conventional seed stock they have to plant if they cannot plant biotech beets. Any claims of economic harm to them are speculative and a result of their own gambling, since these companies have known since 2008 that they should plan to revert to conventional beets since it was likely biotech beets would again be illegal.

Response: APHIS used information obtained from the 2011 growing season to update the analysis in the FEIS. Based on public comment and herbicide use surveys, it appears that 10 to 15 percent of sugar beet growers in some regions decided to plant conventional sugar beet during the 2011 growing season. The FEIS analyzes the difference in costs between growing H7-1 sugar beet and conventional sugar beet, the availability of seed for the 2013 growing season and beyond under the different alternatives, and the loss of investment into research and development under Alternative 1 (see sec. IV.D).

Comment: Biotech beets are illegal and they threaten the environment through transgenic contamination and weed resistance, and consumers by inhibiting the fundamental right to choose.

Response: APHIS acknowledges the commenters allegations of harm. APHIS has fully considered and analyzed issues such as cross-pollination, weed resistance, and consumer choice. At the time that the DEIS was published, the importation, interstate movement, and release into the environment of H7-1 sugar beet was regulated under 7 CFR 340 and partially deregulated under the PPA. The sugar beet themselves are not illegal.

Comment: Of those that support the use of the technology, the majority (828) were growers that currently use RRSB or plan to use it in the future. Those who currently use the technology cited the use of less cultivation, use of less herbicide applications, and good weed control as their primary reasons for adopting and continuing the use of the product. Some commenters mentioned improved quality of life as a reason to use the technology. These individuals felt that fewer applications of herbicides and fewer cultivations to remove weeds benefited their family life. Others cited reduced petroleum fuel use, less fertilizer use, and less water use as advantages. Many growers provided anecdotes about their particular experiences with RRSB. Some told of improved yields; others wrote about the poor weather and late planting that resulted in 2011. They explained that using RRSB offered them more flexibility in weed management because glyphosate could be applied at times that other herbicides could not. Some growers who planted conventional beets wrote to tell of the difficulty in hiring workers to hand-weed fields. They cited both the expense and reliability of the workers as issues.

Several growers and extension agents also explained that the requirements in alternative 3 created a burden, but did not give specific examples of the additional costs. Several growers were also concerned that the unavailability of RRSB would make the growing of sugar beet less profitable because the use of H7-1 sugar beet reduced the overall cost of beet production for these growers. Some of these growers suggested that if H7-1 sugar beet was not available, they would no long grow sugar beet because they could not make a profit growing conventional sugar beet.

Response: The analysis in the EIS is consistent with these comments.

Comment: Nine state and local government officials also commented in support of Alternative two. These officials cited the importance of sugar beet to their economies and the high adoption of RRSB among their constituents as reasons for supporting the adoption of Alternative two. Several also cited the use of agricultural production practices that reduce wind and water erosion as benefits to their local environments.

Response: The analysis in the EIS is consistent with these comments.

Comment: Eight academic scientists and extension agents wrote in support of Alternative two. Some cited a safe history of use of GE organisms in agriculture and the need for good weed control in sugar beet. Some presented specific comments about weed control and isolation distances.

Response: The specific details of those comments and APHIS' response are provided in the appropriate subject-related sections below.

II Purpose and Need for Agency Action

Comment: APHIS also ignores the agency's noxious weed mandate under the PPA. APHIS must undertake its statutorily mandated obligation to investigate whether RRSB poses noxious weed risks, and consider whether or how to address noxious weed harms resulting from the agency's approval action. The PPA imposes on APHIS the duty to consider whether plants under its authority create "noxious weed" or "plant pest" harms, and grants it the authority to address these harms.

The agency has broad statutory power to prohibit or regulate plant pest harms, as well as noxious weed harms. The statutory definition of "noxious weed" is very broad, and include many of the types of harms noted in these comments including transgenic contamination to other crops from RRSB and the resulting public health risks, damage to crops, the environment, and the interests of agriculture, for example.

Exercising APHIS's noxious weed authority is particularly important here because the approval of RRSB and the glyphosate use associated with the Roundup Ready crop system will promote the rapid evolution and spread of noxious weeds tolerant of or resistant to glyphosate herbicide, in violation of the PPA's noxious weed provisions. Glyphosate-resistant weeds are noxious because of their manifold negative impacts on the interests of agriculture, human health, the environment, and farmers' welfare. Because RRSB will directly and indirectly foster and cause these significant negative noxious weed impacts, APHIS must apply its noxious weed authority to RRSB.

APHIS's overly narrow application of its statutory authority here violates the PPA, and is an arbitrary and capricious abdication of authority. APHIS should at a minimum delay any decision on RRSB and any other GE crop until it revises its admittedly outdated regulations to make clear that its noxious weed mandate applies to GE crops.

Response: APHIS disagrees with the commenter's statement that APHIS has arbitrarily and capriciously abdicated its noxious weed authority under the PPA as well as the commenter's claim that APHIS applies and uses its PPA statutory authorities narrowly. The PPA provides APHIS with the authority to regulate both plant pests and noxious weeds under two distinct mechanisms and procedures. Section 7711 of the PPA covers plant pests and prohibits any unauthorized movement (e.g., importing, exporting, moving interstate, mailing, shipping, and releasing into the environment) of plant pests without specific regulatory permission under general or specific permits unless APHIS determines that no permit is necessary. Section 7712 of the PPA covers noxious weeds, plants, plant products, and biological control organisms and provides APHIS with the authority to prohibit or restrict their movement. Section 7712(f)(1) specifically allows APHIS to publish, by regulation, a list of noxious weeds that are prohibited or restricted from entering the United States or subject to restrictions on interstate movement.

Pursuant to these different PPA authorities, APHIS has promulgated specific and distinct regulations for plant pests and noxious weeds. While there are numerous APHIS regulations concerning the importation or interstate movement of plant pests and/or articles that can transmit or carry plant pests, 7 CFR 340 specifically concerns only those GE organisms that are plant pests or for which there is reason to believe that those GE organisms are or may be plant pests. APHIS' regulation of GE organisms under 7 CFR 340 derives from section 7711 of the PPA. APHIS does not regulate noxious weeds pursuant to the plant pest regulations including 7 CFR

340; rather, APHIS regulates noxious weeds under separate regulations, namely 7 CFR 360. APHIS' authority to regulate noxious weeds under 7 CFR 360 derives from section 7112(f) of the PPA. In accordance with those part 360 regulations, a party may petition APHIS to designate a plant or plant product as a noxious weed.

Pursuant to 7 CFR 340, a petition for nonregulated status for RRSB was submitted to APHIS, and the developer of RRSB based its petition for nonregulated status on the claim that RRSB does not pose a plant pest risk. Therefore, APHIS must evaluate RRSB and determine whether it should be granted nonregulated status based on its potential plant pest risk. APHIS conducts a thorough plant pest risk assessment (PPRA) in order to make its scientific and regulatory determination on whether or not RRSB poses a plant pest risk. APHIS does not need to evaluate whether or not RRSB is a noxious weed because part 340 does not evaluate a GE organism based on whether or not it poses a noxious weed risk; the part 340 regulations only require APHIS to evaluate a GE organism solely based on its potential to pose a plant pest risk. It is very important to note that APHIS' long history and experience of regulating noxious weeds has never considered any typical agricultural crop—whether conventional, organic, or GE—to be a weed, much less a noxious weed. Thus, APHIS would not consider H7-1 sugar beet a weed, much less a noxious weed. Moreover, APHIS is fully aware of the fact that neither RRSB nor any other GE or non-GE cultivar of sugar beet, nor any other GE crop that APHIS has regulated or deregulated, has ever been included on APHIS' regulatory list of noxious weeds in part 360. Additionally, no one has ever petitioned APHIS to include RRSB or any other GE or non-GE cultivar of sugar beet on the noxious weed list.

As APHIS described in its proposed rule for the revision of 7 CFR 340 "federally listed noxious weeds are plants that are likely to be aggressively invasive, have significant negative impacts, and are extremely difficult to manage or control once established" (USDA-APHIS, 2008). Clearly, H7-1 sugar beet has none of these characteristics. Contrary to the commenter's assertion that APHIS must regulate H7-1 sugar beet under the noxious weed provisions of the PPA because it will promote the rapid evolution and spread of noxious weeds tolerant of or resistant to glyphosate herbicide, it should be noted that herbicides have been widely used on crops for over 70 years, herbicide-resistant weeds have been selected over this entire period, and the agency has never interpreted its noxious weed authority to cover herbicide use on crops. Furthermore, in considering what constitutes a noxious weed, APHIS has never designated a weed a noxious weed solely because it is GR (or resistant to any other herbicide).

Regarding the commenter's assertion that APHIS needs to make clear that its part 340 regulations should include the agency's noxious weed authority, APHIS wants to emphasize that as of now it has not made a final decision on whether or not it will in fact use its PPA noxious weed authority to regulate GE organisms that are regulated currently only in regards to a plant pest risk under part 340.

Comment: Although NEPA does not mandate any particular results, its main purpose is to foster informed decision-making by agencies. See 42 USC 4321; 40 CFR 1501.1(c). Here, the decision to deregulate RRSB has already been determined. APHIS has concluded, based on its 10-page PPRA, that it must deregulate RRSB. APHIS has the process backwards: the NEPA process is meant to inform agency action, not create paperwork after a decision is made. APHIS cannot use the already finished PPRA to short-circuit and prejudge the NEPA analysis.

Response: APHIS disagrees with this comment because it has not in any manner short-circuited or prejudged its NEPA analysis for the petition for nonregulated status for H7-1 sugar beet. Pursuant to 7 CFR 340, a petition for nonregulated status for H7-1 sugar beet was submitted to APHIS, and the developer of H7-1 sugar beet based its petition on the claim that this sugar beet does not pose a plant pest risk. Thus, once the petition was submitted, APHIS is required to evaluate the petition; however, clearly APHIS has not yet made its full and final determination regarding the submitted petition. APHIS must scientifically evaluate H7-1 sugar beet to determine whether it poses a plant pest risk before the agency can make a final regulatory decision regarding whether or not it is appropriate that H7-1 sugar beet has nonregulated status.

In evaluating whether or not RRSB poses a plant pest risk, the scientific analyses in the PPRA provides APHIS with information about the biological aspects and characteristics of H7-1 sugar beet. While APHIS' part 340 regulations require the agency to conduct a PPRA in order to have a sound scientific analysis of whether or not H7-1 sugar beet poses a plant pest risk, the scientific analyses in the PPRA do not in any manner short-circuit or prejudge APHIS' analysis under NEPA regarding potential environmental impacts that may result from the reasonable alternatives for making a determination on the petition for nonregulated status that were fully evaluated and analyzed in the DEIS and FEIS.

Accordingly, both types of analyses and data (the regulatory PPRA plant pest risk analyses and the potential environmental impact analyses in the DEIS and FEIS) are and must be prepared to inform the APHIS decisionmaker in order to reach a full and final determination regarding the submitted petition. The PPRA is the scientific plant pest risk assessment and evaluation that will be used in order to make APHIS' ultimate and final regulatory decision on whether or not H7-1 sugar beet poses a plant pest risk. The DEIS and the FEIS are the environmental analyses on the reasonable and viable alternatives for APHIS' ultimate and final regulatory decision on the petition. The ROD constitutes the Agency's decision on the FEIS. The PPRA, DEIS, and FEIS have their own specific and distinct purposes, goals, topics and scope. None of them undermine or prejudice the others. Rather, all of them are necessary and required in order to properly inform and provide the APHIS decisionmaker (as well as the public) with the required regulatory, scientific, and environmental analyses and information needed to make a final determination on the petition for nonregulated status. The APHIS decisionmaker cannot make the final determination on the petition for nonregulated status of RRSB until after he has reviewed, evaluated, and considered all of the information, analyses, and conclusions presented by the PPRA, DEIS, and FEIS.

The final regulatory decision on the petition is issued by the APHIS decisionmaker in the form of the agency's determination of the appropriate regulatory status of H7-1 sugar beet, as requested by the submitted petition for full deregulation of it. Thus, the APHIS decisionmaker has to make the final regulatory determination either that H7-1 sugar beet has to continue to be regulated under part 340 or that H7-1 sugar beet should have full nonregulated status and no longer be subject to the regulatory requirements of part 340 or the PPA.

III Alternatives

Comment: In conducting this assessment, weed susceptibility to glyphosate should be regarded as the resource to be conserved. If glyphosate offers the benefits claimed for it by APHIS, and conventional sugar beet herbicides are as toxic as APHIS says, then loss of glyphosate's benefits is contrary to the interests of agriculture, while conserving them fosters those interests. The EPA has taken a similar approach to that recommended here with the insect-resistant Bt crops under its jurisdiction. EPA regards Bt toxins as less toxic than chemical insecticides, and therefore regulates to preserve their efficacy and forestall the increased use of chemical insecticides that would be entailed by evolution of Bt resistance in insects. The longer-term environmental benefit of conserving insect susceptibility to Bt toxins is "paid" for by modest restraints on the use of Bt crops in the short-term, via mandated "refuge" of non-Bt crops that forestall insect pest resistance to Bt toxins. APHIS should formulate an alternative that similarly places reasonable restraints on RRSB cultivation.

Resistance is not, as APHIS has it, an inevitability – an "unavoidable impact." To the extent that it is likely in APHIS's three alternatives, this merely underscores the need for APHIS to formulate another alternative with conditions designed to prevent weed resistance.

Response: The proposed alternative does not meet the purpose and need as defined in the FEIS. In accordance with 7 CFR 340, APHIS is and must make a regulatory decision on a petition for nonregulated status based on the plant pest risk, if any, associated with the regulated article for which the petition is requesting nonregulated status. Maintaining the long-term efficacy of glyphosate or any other herbicide is both outside the scope of the FEIS and outside the legal jurisdiction of APHIS. The U.S. Environmental Protection Agency (EPA) regulates the use of pesticides and specifically defines the amounts of each pesticide that can be applied to sugar beet and other crops during the growing season. In addition, it should be noted that herbicide resistance is often a dominant trait, so maintaining a refuge would not achieve the desired result. APHIS discusses agricultural practices that can contribute to resistance management in the FEIS (see sec. IV.C.3).

Comment: As explained above, the DEIS fails to meaningfully consider any alternative other than the Preferred Alternative because the decision is predetermined: in the agency's (erroneous) view, the plant pest assessment for RRSB precludes any action other than full deregulation; thus any other alternative is illusory rather than meaningful. However, APHIS must meaningfully consider the "no action" alternative, as well as all reasonable alternatives.

Response: APHIS disagrees with this comment because the agency has meaningfully included and considered the "no action" and all other reasonable, viable alternatives in the DEIS and FEIS; appropriately defined the "purpose and need" of the DEIS and FEIS; and correctly explained to the public APHIS' regulatory options as determined by applicable statutory and regulatory authorities. The commenter fails to understand that the DEIS and FEIS are used to evaluate the potential environmental impacts resulting from the reasonable and appropriate regulatory options that APHIS has to respond to in order to make a determination regarding the submitted petition requesting full deregulation of H7-1 sugar beet. APHIS' regulatory options to make a determination on the submitted petition for nonregulated status for H7-1 sugar beet are limited, and our NEPA analysis and evaluation do not expand our statutory and regulatory authorities to regulate H7-1 sugar beet. Thus, APHIS prepares its NEPA analyses and evaluations to inform the agency's decisionmaker of the potential environmental impacts resulting from the reasonable and appropriate regulatory options available to the agency to respond to the petition for nonregulated status for H7-1 sugar beet. However, such NEPA analyses and evaluations do not add or subtract from the part 340 regulations and the PPA authorities that APHIS must use to make a final determination on the petition for nonregulated status.

One of NEPA's primary purposes includes informing the agency's decisionmaker and the public. APHIS' DEIS and FEIS for the H7-1 sugar beet petition carefully consider and provide a full and fair discussion of the potential environmental impacts that may result from the reasonable alternatives, which will inform APHIS' final determination regarding the petition for nonregulated status. Namely, APHIS must make a scientific determination on whether or not H7-1 sugar beet poses a plant pest risk before the agency can make its final regulatory decision regarding whether it should or should not designate H7-1 as having nonregulated status. APHIS must prepare a PPRA in order to determine H7-1 sugar beet's potential plant risk, but the PPRA by itself is not the agency's final determination regarding the regulatory status of H7-1 sugar beet. The PPRA is absolutely necessary and required to inform the APHIS decisionmaker of the potential, if any, that H7-1 sugar beet has for posing a plant pest risk and of what regulatory determination is appropriate for the request for nonregulated status.

At the same time, as part of APHIS' process to make a final determination on the petition for nonregulated status, APHIS must prepare the appropriate NEPA analyses and evaluation. Thus, APHIS' NEPA review process—like every other Federal agency's—is integrated with its decisionmaking process related to the proposed action (in this case, APHIS' regulatory determination of whether or not H7-1 sugar beet should have nonregulated status pursuant to the requirements of part 340).

For the NEPA environmental analyses and evaluations that APHIS provided in the DEIS and FEIS, the agency determined the reasonable and viable alternatives that were appropriate to be analyzed in order to make its regulatory determination on whether or not H7-1 sugar beet should have nonregulated status. As with any NEPA analysis, APHIS considered many different factors—including environmental, aesthetic, socioeconomic, technical, and other factors as well as the agency's legal ability to fulfill its statutory mission and responsibilities—to determine the reasonable and viable alternatives. In an effort to be transparent to the public, APHIS has identified and explained in many of its responses to different comments what its regulatory authorities are, their limitations, and how its statutory and regulatory authorities would and could be carried out under the DEIS' and FEIS' alternatives.

APHIS fully understands its NEPA responsibilities. The environmental analyses APHIS has prepared and provided in its DEIS and FEIS thoroughly analyze the potential environmental impacts that are likely to result from the reasonable alternatives considered for its regulatory determination. APHIS' regulatory and scientific analyses—and ultimately its final determination—of the RRSB petition are specifically and legally pursuant to the PPA and part 340, and thus are limited by APHIS' statutory authorities and jurisdiction.

The PPA and the NEPA are separate Federal statutes with different legal obligations and responsibilities, and each has its own specific purposes and goals. Pursuant to part 340, APHIS must determine whether RRSB is or is not likely to pose a plant pest risk. Once APHIS has completed both its PPRA and its NEPA analyses with its respective decision, the agency can and must make a final regulatory decision on the RRSB petition for nonregulated status.

Comment: The DEIS acknowledges in several places that the environmental risks of RRSB are more acute in certain regions than in others. For example, risks stemming from the presence of feral beet populations—including, but not limited to, transmission of the H7-1 trait to wild beets from RRSB bolter pollen—are higher in California's Imperial Valley than elsewhere. Also, in light of the known contamination incidents in the Willamette Valley—where most sugar beet seed production occurs and where RRSB and other *Beta* crop growers are in close proximity—it would be reasonable to consider a deregulation alternative that placed geographical restrictions on RRSB planting. Such an alternative could otherwise resemble APHIS's Preferred Alternative (i.e., complete deregulation). However, such an alternative is not mentioned anywhere in the DEIS, much less rigorously analyzed.

Response: Alternative 3 is similar to the alternative described by the commenter because Alternative 3 proposes to impose geographic restrictions on RRSB planting.

Comment: There are other alternatives the agency should consider to limit the likelihood of contamination. For instance, the DEIS fails to consider, much less rigorously analyze, any alternative that would require use of RRSB seed crop pollinators not carrying the H7-1 transgene (i.e., "male sterile" technology). Consideration of this alternative is reasonable in light of APHIS's previous admission that it would reduce the risk of contamination. Nor does the DEIS consider a partial deregulation alternative with any isolation distances other than the 4-miles already in use by industry. Although the effectiveness of a 4-mile isolation distance is at best controversial (and contradicted by the evidence discussed *infra*), the DEIS fails to consider requiring any other isolation distance.

Response: APHIS disagrees with the commenter's suggestion that a 4-mile isolation distance is ineffective. APHIS chose the 4-mile isolation distance based on its demonstrated ability to meet market standards. Distances greater than 4 miles would decrease the number of people that could grow any type of *Beta* seed crop in an area without creating greater protections for growers, as there is no evidence that greater isolation distances would decrease the extremely rare cross-pollination events that may occur under current conditions. APHIS did not consider an alternative that only allowed male-sterile plants because breeding scenarios typically require some male fertile plants to carry the trait during the multigenerational breeding programs needed to create new varieties. Therefore, this restriction is not practical or realistic, and such an alternative would not be a viable, appropriate alternative to consider in the EIS. In addition, APHIS has not found any plant pest risk associated with the natural process of cross-pollination between H7-1 sugar beet plants and other varieties, so restricting breeding programs by prohibiting male fertile lines from carrying the GE trait and possibly even delaying the development of improved or disease-resistant lines would be imposing a mandatory regulatory requirement even though APHIS finds no potential whatsoever for any plant pest risk.

Comment: Nor does the DEIS consider an alternative that would require monitoring of commercial RRSB production, but otherwise resembled the Preferred Alternative. Such

an alternative would be reasonable given the paucity of data regarding transgenic contamination incidents and the myriad disincentives to reporting contamination incidents (including, but not limited to, retaliation by state/local authorities and harassment of the type documented in *Monsanto vs. U.S. Farmers*).

Response: At no time and under no circumstances does APHIS have any regulatory or statutory authority to impose monitoring and testing on growers of non-GE vegetable beet in order to determine if they have cross-pollinated with H7-1 sugar beet. Growers can and may choose their production methods based on their tolerance of off-types. APHIS did not identify any plant pest risks associated with cross-pollination between H7-1 sugar beet and other *Beta* varieties. If individuals growing non-GE *Beta* varieties are concerned about the amount of cross-pollination taking place with H7-1 sugar beet, they are free to take steps to ensure prevention of any cross-pollination. For example, they can use longer isolation distances between their crops and H7-1 sugar beet crops and/or to test for any potential cross-pollination. However, APHIS has no legal authority to impose any regulatory requirements on any grower of any type of crop, whether GE or non-GE, when there is no plant pest risk associated with cross-pollination resulting from the growing of the crop. Cross-pollination is a natural process, and the biological and physiological aspects of that process do not in themselves create or establish any plant pest risk. Moreover, there are extensive data and well-established methods for limiting and reducing the potential for any cross-pollination. Isolation distances utilized by beet seed growers are established based on this information.

Comment: Finally, as noted above, the DEIS fails to consider any alternatives that regulated RRSB pursuant to the agency's broader statutory authority under the PPA.

The unconditional deregulation of RRSB poses significant risks to the quality of the human environment. For example, the significant likelihood of gene flow from RRSB to non-RR sugar beets poses risks to the livelihood of organic and conventional farmers as well as the environment. The potential for APHIS to reduce these significant impacts by adopting one or more of these ignored alternatives must be fully and meaningfully analyzed. APHIS's nominal (and illusory) consideration of *some* alternatives does not satisfy NEPA.

Response: APHIS disagrees with this comment. Once APHIS has determined that H7-1 sugar beet root and seed crops do not pose any plant pest risk, completes its environmental analyses related to its final determination regarding the nonregulated status of H7-1 sugar beet, and makes its final determination that H7-1 sugar beet should have nonregulated status, then the agency does not have any regulatory authority to impose any mandatory requirements on H7-1 sugar beet. Thus, APHIS has no legal authority to impose an alternative on growers of H7-1 sugar beet that would require mandatory regulatory conditions to be met in order to be allowed to grow H7-1 sugar beet. In its DEIS and FEIS, APHIS has thoroughly analyzed the impacts of H7-1 sugar beet on conventional and organic sugar beet growers as well as vegetable beet growers (see secs. IV.D.3 and IV.D.4). In addition, APHIS has fully and meaningfully considered and analyzed the three reasonable and appropriate alternatives in reference to it making a determination of the petition for nonregulated status, including one alternative that does specifically put restrictions on where and under what conditions H7-1sugar beet can be grown. This alternative has geographic restrictions and mandatory isolation distances pursuant to APHIS' regulatory and statutory authorities.

IV Agronomic practices

Comment: Weed control was the most important problem for sugarbeet growers since beets were first grown in Europe and later in the United States. An annual sugarbeet survey conducted for North Dakota and Minnesota showed that weeds were considered as the most important problem from the 70s until 2008 (when Roundup Ready sugarbeet planting became widespread). In 2009 through 2011, weed control was not considered as a major problem. Instead, Rhizoctonia and Aphanomyces root rot were considered as the major problem. Should USDA/APHIS decide on 'Alternative 1', growers will have to contend with managing weeds using conventional herbicides, which are not as effective as glyphosate, use tillage to assist in weed control which will likely lead to more Rhizoctonia root rot (as a result of throwing infected soil into crowns of plants), and the sugarbeet industry will not have the opportunity to utilize genetic engineering to help manage diseases such as Rhizoctonia and Aphanomyces root rot. In addition, timely application of a fungicide such as Quadris (azoxystrobin) for control of Rhizoctonia root rot will be hindered since it cannot be mixed with conventional herbicides and must be applied three or more days prior to or after conventional herbicide application. One grower in Minnesota successfully produced no-tilled Roundup Ready sugar beet in a rocky field that would not have been economically feasible with conventional sugar beet. In Nebraska, many farms with sprinkler irrigation have successfully adopted no-till or reduced tillage using Roundup Ready sugar beet. Reduced tillage will help to conserve wildlife, reduce erosion, and improve the economics of sugar beet production. (APHIS-2010-0047-3259)

Response: APHIS has updated the FEIS to incorporate the information in this comment regarding root rot and its management. The FEIS is consistent with the conclusion that tillage for weed control would be higher under Alternative 1.

Comment: A major thrust of the work of this Committee was to establish isolation maps for the numerous specialty crop species grown in the Willamette and Tualatin River valleys. Large, detailed wall maps were posted at the county offices of Linn and Marion counties where the great majority of these crops were grown. Postings of plantings and intentional plantings followed a long establish procedure agreed to by the fieldmen group and were made twice a year (spring and fall) by certain deadlines. This provided an orderly method of preventing contamination by insect or wind cross pollination.

The Committee also established an arbitration procedure by which disputes could be resolved, if intended plantings, or established plantings were discovered which might have resulted in contamination and if the seed companies involved were not able to resolve the dispute among themselves.

The Committee was also involved in providing educational meetings to their growers about seed production dealing with issues about pollination, weed, insect and disease control, good practices in transportation of seed crops and disposal of seed cleaning waste so as not to create contamination problems. They conducted research to develop pesticide registration for weed control in some crops.

Isolation issues in the production of sugar beets, table beets (red and yellow beets) and various types of chard as well as heirloom cultivars have been worked out over the years. This same protection from genetic contamination has been afforded these small-

acreage crops as is afforded to the predominantly grown large-acreage commercial crops. Production of organic chard or organic table beets (or any other seed crop for the organic crop market) can similarly be easily resolved among willing cooperators, so long as the historically established field isolation mapping procedures are adhered to. The Willamette Valley is a large production area and can easily accommodate various types of production.

Seed companies in the Willamette Valley are proud of the quality of specialty seeds being produced and have even published a pamphlet advertising the attributes of the Willamette Valley and its producers as a quality seed production area. As a result a number of European and Japanese seed companies produce specialty seed in the Willamette Valley through local seed companies.

Genetically modified Roundup Ready sugar beets have been produced without problems since they were cleared for production by the U.S. Department of Agriculture in 2005. To my knowledge, there have been no known incidents of contamination of conventional table beets or chard, nor organically produced table beets or chard or other crops for the organic specialty crop market. There is no reason to believe this would change, provided producers of these crops work cooperatively in the future and maintain the Willamette Valley as a unique and quality seed production area. (APHIS-2010-0047-3217)

Response: APHIS acknowledges your comment regarding the role of the WVSSA Fieldman Committee. While the description does not change the analysis presented in the FEIS, it does provide information about the role of this committee in an area that grows a diverse variety of seeds.

Comment: If roundup had not been available for weed control for the 2011 crop I would have lost 30% of my production due to weeds. Because of wet conditions my crop was planted late and the application of conventional herbicides would not have been able to have taken place in the window of time that they need to be applied. My crop was only 2/3 of my 10 year average with the use of roundup, but 30% of my acerage would not of been harvestable without roundup. (APHIS-2010-0047-3709)

Response: APHIS understands based on public comment that many sugar beet growers value access to H7-1 sugar beet and feel that it is an important part of their sugar beet operations. The comment is consistent with the analysis in the FEIS.

Comment: Simply put, compared to conventional sugarbeets, RRSB are better for the environment, public, and farmer.

I have experienced these benefits first hand. Weeds are the most difficult factor in producing a viable sugarbeet crop in our region. In Amalgamated's region and on my own growing acres, we have to irrigate. Irrigation exacerbates weed problems because weed seeds are always getting reintroduced through irrigation. Prior to using RRSB, I had a labor intensive herbicide regimen that required using a number of more toxic herbicides. Before planting, my farm would spray with either RoNeet or Nortron. Before the sugarbeets emerged, I would spray Roundup. After the sugarbeet crop emerged, I sprayed Betamix once and a mix of Progress, UpBeet, Stinger, and grass herbicide up to four times thereafter. Manual hand labor, which became increasingly scarce and very expensive, was then needed to remove any remaining weeds. In contrast, with RRSB, I spray the fields twice and obtain near-complete weed control.

RRSB provides my farm with other benefits. Unlike conventional seed, RRSB growth is not stunted by its herbicidal regimen, and my other crops suffer less damage. I obtain better yields, quality, and storage in the pile with RRSB. I till my fields less, which saves labor and time. I run machines less, leading to less wear and tear, uses less natural resources, and generates fewer emissions. (APHIS-2010-0047-3874)

Response: APHIS understands based on public comment that many sugar beet growers value access to H7-1 sugar beet and feel that it is an important part of their sugar beet operations. The comment is consistent with the analysis in the FEIS.

Comment: Herbicide application under a conventional chemical regimen was a managerial balancing act. Too heavy of a chemical rate damaged beets and cut into yields incredibly, but to light of a rate didn't get the weeds killed. On the average acre we would come in with a pre-plant herbicide like Nortron during bedding. Then once the beets emerged we would hit them with a tank mix of Betamix and Upbeet, followed five days later with a tank mix of Betamix, Upbeet, and Stinger, followed by a spraying of Select a week later for grasses, and then we would cultivate them twice and, if it was flood irrigated, we would have to re-make the corrugations. If they were under sprinkler irrigation we would chemigate on some Outlook (Pre-emergence broadleaf herbicide) to get us to canopy closure where the beets could try to shade out the late germinating weeds. Now the hand labor would come in and try to keep us clean enough to allow for a fairly clean harvest. It was an incredible amount of work, money, fuel, and chemical to get only marginal weed control. It was the highest hurdle of the sugar beet race.With Roundup Ready Sugarbeets we have and effective affordable method to broadcast spray for weeds. Equally important, now we can Strip-Till. (APHIS-2010-0047-4233)

Response: APHIS understands based on public comment that many sugar beet growers value access to H7-1 sugar beet and feel that it is an important part of their sugar beet operations. The comment is consistent with the analysis in the FEIS.

Comment: This past year we planted both conventional sugar beets and roundup ready sugar beets. The conventional beets were sprayed 5 times with a total of 220 oz of chemical per acre and the roundup ready beets were sprayed 2 times with a total of 44 oz of chemical per acre. The conventional beets had 176 more oz of chemical per acre applied, and some of the chemicals have very long soil residual. Some of the conventional chemicals actually stay in the soil for more than a year. With the extra chemical you also have the 3 extra trips across the field which means spending more time and using more fuel. If we are trying to be more efficient and farm cleaner more trips across the field is not the way to do that.

The conventional fields also had weeds left to go to seed which means that we will have to use more chemicals in next years crop to control the new weeds.

The yield on the conventional beets was about 4 tons per acre less and over 1% less sugar content. The total sugar per acre was 1731 pounds less. This means that we need more acres of conventional beets to produce the same amount of sugar and more conventional acres means even more chemicals used. (APHIS-2010-0047-4426)

Response: APHIS understands based on public comment that many sugar beet growers value access to H7-1 sugar beet and feel that it is an important part of their sugar beet operations. The comment is consistent with the analysis in the FEIS.

Comment: The Willamette Valley is world renowned for high quality, consistent production of many seed crops. The purity of these crops is guaranteed by the Oregon State University Certification system. We have to adhere to standards of crop rotation, isolation distances and weed tolerances. This is common practice for seed growers in the Willamette Valley. For crops not covered by the system, there is a stringent protocol in place for how to decide which crops can be grown where. This protocol has worked well for a number of years resulting in uncontaminated seed crops of similar types and species being produced within this one geographic area. We follow guidelines of isolation distances, rotation schedules, cultivation practices, and herbicide use - all for the specific purpose of avoiding cross contamination.

This is especially true for sugar beet seed. In many ways much of our cropping rotation revolves around the placement of this crop. We plan four to five years out in order to have fields available that meet isolation requirements as well as crop history and herbicide history. During the growing season we are careful not to accidentally transfer any pollen or mature seeds out of the field. At harvest time we have to load our seed into boxes withing the field boundary. Again, not to let any viable seeds escape. The whole load is throughly tarped before transport. After harvest the seeds that have spilled on the ground are allowed to sprout and then killed before a new crop is planted. We do not plow under any viable seeds which could then sprout later on. The fields are scouted for a few years after beets have been produced to make sure no volunteer plants appear, and if so, they are removed.

Meeting these requirements is not easy, but the rewards for doing so make it well worth the effort. Sugar beet seed will often be our highest returning crop and in many cases worth twice as much as wheat, corn or grass seed. It is a very unique crop in that the value of it remains consistent regardless of the follies of Wall Street or the fluctuations of the grain market. Beet seed remains a stable, high value crop and its husbandry and harvest is done with minimal additional equipment over and above what a typical seed producer would have on hand. It is also a great rotation for grass seed, allowing us a chance to control unwanted grass weeds by moving to a broadleaf crop. (APHIS-2010-0047-3485)

Response: Thank you for explaining production practices used on your farm. The comment is consistent with the analysis in the FEIS.

Comment: There is little likelihood of gene drift if the crop is grown within some parameters such as bolter control. There is no other effective method of controlling one specific weed which is wild beets (beta macrocarpa). Wild beet (beta macrocarpa) is a prolific seed producer with a very long term of viability. Imperial Valley soils vary from sandy loam to heavy clay. The following methods of weed control have been found to be ineffective or economically unfeasible. Hand weeding at the stage of growth when this needs to be done the wild beets are very hard to discern from sugarbeets. When the wild beets are large enough to differentiate from sugarbeets, most of the damage has already occurred and removal is physically and economically unfeasible because of the biomass that has been generated. Crop rotation requires too long for rotation to any crop produced

her to have any effect. The viability of wild beet seed is in the realm of 15 years or more. Other available herbicides are not effective. Cultivation will only remove the wild beets in the furrow. (APHIS-2010-0047-4009)

Response: APHIS understands based on public comment that many sugar beet growers value access to H7-1 sugar beet and feel that it is an important part of their sugar beet operations. The comment is consistent with the analysis in the FEIS. APHIS analyzed the effects of the use of H7-1 sugar beet in the Imperial Valley of California.

Comment: The DEIS's discussion of transgenic contamination fails to consider several important factors that APHIS has been confronted with time and again. Additionally, the DEIS lacks any meaningful discussion of the consequences of transgenic contamination.

Contamination Is Likely

The DEIS fails to objectively evaluate the likelihood of environmental and intertwined economic harm from transgenic contamination, as Congress intended and as NEPA mandates. As comments to this docket will show, transgenic contamination is likely and will happen by a variety of means if APHIS deregulates RRSB. Transgenic contamination occurs through a variety of pathways. Pollination of non-genetically engineered plants by genetically engineered plants, mixing of genetically engineered seed with non-genetically engineered seed, improper seed cleaning or equipment cleaning, weather events, and human error all lead to transgenic contamination.

As noted above, APHIS's analysis of gene flow and contamination ignores *Sugar Beets I* and *II* evidence documenting extensive contamination in the Willamette Valley at distances far greater than 4 miles. This evidence demonstrates, *inter alia*, that not only is contamination through gene transfer possible, but that within three years of RRSB commercialization, contamination had begun. The DEIS's omission of any discussion of this vital evidence from *Sugar Beets I* and *II* renders APHIS's conclusions about gene flow and transgenic contamination arbitrary and capricious.

Response: APHIS disagrees with this comment. APHIS extensively analyzed cross-pollination and concluded that while gene flow could occur, overall levels would be below the level of detection for sensitive DNA-based assays. APHIS does not agree that the presence of the H7-1 trait in vegetable beet seed above these levels is likely. This analysis is based on the best scientific studies, modeling, and a history of the production of physically distinct *Beta* seed crops whose hybrid off-types would be visually distinguishable should they occur. APHIS thoroughly reviewed the evidence from the Sugar Beets I and II litigation and disagrees that there is evidence that documents extensive cross-pollination at distances far greater than 4 miles. APHIS disagrees with the commenter's interpretation of an anecdotal observation that runs counter to a bevy of controlled scientific studies and modeling predictions. Mechanical mixing between sugar beet and vegetable seed production is unlikely because no farms grow the same seed crop in the same year and harvesting and cleaning equipment are not shared between vegetable beet seed and sugar beet seed producers (see sec. III.B.1.b.(11)). Vegetable beet and sugar beet seed are also not cleaned and processed in the same facilities. In addition, APHIS considered the economic consequences of cross-pollination should detectable levels occur (see sec. IV.D.3-4).

Comment: Several recent reports further call into question APHIS's conclusion that transgenic contamination is "not expected." For example, a 2008 Government

Accountability Office (GAO) study analyzed several major transgenic contamination incidents from the past decade, noting the billions of dollars in economic damages associated with them. After reviewing both APHIS's and the industry's capacity for oversight, the GAO concluded that "the ease with which genetic material from crops can be spread makes future releases likely." In the Union of Concerned Scientist ("UCS") report, "Gone to Seed," UCS found that about 50% or more of the certified non-GE corn, canola, and soybean seed has been contaminated with transgenes. The level of contamination was typically 0.05%-1.0%, far greater than the minimum levels that can be detected. "Gone to Seed" demonstrated the frequency and levels of contamination of soybean seed was found to be about as high as for corn. Soybeans are largely self-pollinating (do not pollinate other soybean flowers very often), while corn is highly out-crossing. Therefore, the contamination of soybean seed is likely to be largely from causes other than cross-pollination. Such causes could include seed mixing or human error, and suggests that these sources may be at least as important as cross-pollination.

Another report, "A Growing Concern: Protecting the Food Supply in an Era of Pharmaceutical and Industrial Crops," Union of Concerned Scientists (UCS) analyzed whether GE pharmaceutical-producing crops could be kept out of food. This report demonstrates how difficult this is, even for pharmaceutical crops that would be grown on small acreage and under stringent confinement, to avoid contaminating food. The authors of this report examined confinement methods, such as field separation, cleaning of farm equipment, segregation of seed, and others, and found that it would still be difficult to ensure the absence of contamination. The experts felt that contamination might be prevented by taking heroic means, such as geographical isolation from food crops. UCS concluded that even though it may be theoretically possible to prevent or mitigate contamination, it would not be economically feasible.

The DEIS does not address concerns articulated in these materials or explained why they should not alter the agency's conclusions.

Response: APHIS disagrees with this comment. APHIS is well aware of these documents and their conclusions. These reports are not relevant because they deal with crops grown for grain and not crops such as sugar beet and vegetable beet, which are harvested prior to flowering. When a crop flowers, there is an opportunity for neighboring crops to cross-pollinate with each other. In contrast, vegetable beet and sugar beet crops do not flower unless grown for seed, so no gene flow can occur between neighboring crops on the vast majority of acreage (more than 99 percent) used to produce these crops. Furthermore, in the case of the grain crops mentioned above, there is a GE-sensitive market for each crop. However, there is not a GE-sensitive market for sugar beet. No organic sugar beet industry exists in the United States. Moreover, the small amount of conventional sugar beet that is produced is not identity-preserved from GE sugar beet. The stakeholders concerned about cross-pollination to H7-1 sugar beet are those producing vegetable beet seed, which is a visually distinct crop from sugar beet. This fact is significant because in the case of the crops studied in the GAO report or Union of Concerned Scientists reports, unwanted cross-pollination or commingling of seed is often not visually apparent. In contrast, hybrids between sugar beet and vegetable beet are easily detected after the crop is grown. The transgene can be removed from the crop through culling of the hybrid off-types. Furthermore, hybrids between different beet crops are unwanted regardless of their GE status, so seed producers take "heroic measures" as a matter of course. They normally use large isolation distances to minimize detectable cross-pollination between different seed crops because all parties are harmed when their seed contains hybrid off-types. “Heroic measures” are feasible because the total vegetable beet seed and sugar beet produced in the United States is less than 1,000 and 5,000 acres, respectively, while corn production is 90 million acres, and soybean production is 75 million acres. It is much simpler to find 4-mile isolation distances between farms totaling 1,000 acres than between farms totaling 100 million acres. These points are discussed in much greater detail in the FEIS (see secs. IV.D.3, IV.D.4, and IV.B.5).

V Biological

Comment: APHIS asserts that none of the herbicides considered in the impact assessment have acute or chronic toxicity effects on mammals, birds, reptiles, fish, amphibians, or invertebrates at application rates used in H1-7 sugar beet production. However, glyphosate has been observed to have synergistic mortality effects on aquatic species at levels well below environmental exposure limits created by the EPA and other agencies (citing (Kelly *et al.*, 2010). Continuous exposure to a toxin over an extended period of time, often measured in months or years, can cause irreversible effects. Glyphosate has been shown to trigger early development and cause congenital malformations in frog and chicken embryos at sub-lethal doses.

Furthermore, studies have shown glyphosate to be a mammalian endocrine disruptor, which may be toxic to human placental cells, and induce reproductive problems at doses below agricultural dilutions. Of further concern are recent studies that indicate "inert" ingredients in Roundup, such as polyethoxylated tallow amine (POEA), have been shown to significantly increase the toxicity of glyphosate formulations for both acute and chronic exposure. In evaluating the potential effects of H1-7 deregulation, APHIS needs to consider the likely health consequences of increased glyphosate use, on animals and humans likely to be affected by exposure.

Response: EPA, not APHIS, regulates the use of glyphosate and has the legal authority to control the use of glyphosate. Since glyphosate registration and use is under EPA's legal jurisdiction and control, EPA obviously has the expertise and experience in analyzing and evaluating the likely health consequences of increased glyphosate use. APHIS has relied on EPA's analyses and evaluations of glyphosate use in its DEIS and FEIS evaluating the potential effects resulting from its regulatory decision on the petition for the deregulation of H7-1 sugar beet. Accordingly, the potential environmental effects resulting from the considered alternatives for APHIS' regulatory decision on the petition for nonregulated status is the focus of its FEIS. As APHIS describes in section V, glyphosate use has been increasing over the last two decades, and its regulatory decision on the petition (whether it determines H7-1 sugar beet should or should not have nonregulated status) will not materially change that trend. APHIS examines the effects of changes in herbicide use under the three alternatives on human health in section IV.F. Endocrine disrupters are discussed in section II.C.1. In addition, APHIS has expanded the discussion on amphibians in section IV.C.1. The paper referred to by the commenter above (Kelly *et al.*, 2010) is irrelevant because it discusses fish, which reside in aquatic habitats that have glyphosate measurements that are so diluted that effects are negligible. APHIS discusses in the FEIS similar synergistic effects on amphibians as these organisms are more likely to inhabit shallow surface waters that could potentially have measurable levels of herbicide above an effects threshold. The commenter warns that continuous exposure to a toxin over an extended period of time can cause irreversible effects. While this may be true, glyphosate is not a toxin that organisms are likely to be exposed to over months or years. As described in the DEIS and FEIS, glyphosate has a short half-life in the environment. It either rapidly metabolizes or is sequestered by tightly binding to soil, which is why even sensitive crops can be planted within days of spraying fields with glyphosate. APHIS disagrees with the assertion that glyphosate has been shown to be an endocrine disrupter. As described in the DEIS and FEIS, EPA has initiated an Endocrine Disruptor Screening program to investigate whether chemicals released into the environment are endocrine disruptors. Assays are still being developed to make this determination. As this program has not advanced to the point of categorizing chemicals as endocrine disruptors, it is premature to draw a conclusion that glyphosate is indeed an endocrine disruptor. APHIS discusses the toxicity of inert ingredients in the FEIS.

Comment: APHIS has failed to properly analyze the environmental impacts of transgenic contamination, including the super weeds epidemic.

In preparing an EIS, an agency must take a "hard look" at the impacts of the proposed agency action so that the agency may "make decisions that are based on understanding of environmental consequences." The EIS must also include a full and fair discussion of the proposed action's effects and their significance. Relevant effects may be "ecological aesthetic, historic, cultural, economic, social, or health, whether direct, indirect, or cumulative." H7-1 sugar beets will genetically contaminate other crops and cause significant environmental impact. The DEIS understates the potential for transgenic contamination from H7-1 sugar beets and inaccurately states that this will not be a significant harm.

Response: APHIS disagrees with this comment. Throughout the FEIS, APHIS "took a hard look" by extensively analyzing the potential for cross-pollination between sugar, vegetable, and wild beets and the direct, indirect, and cumulative impacts of cross-pollination between these species. APHIS also describes the cultural and biological factors that influence the potential for cross-pollination.

Comment: The Weed Science Society of America, North Central Weed Science Society, and the Western Society of Weed Science commented: One specific edit- please delete the following sentence (bottom pg. 241, top of pg. 242): "*Two options for resistance management are: (1) use the desired herbicide until resistance occurs and then change to an alternative; and (2) rotate control methods to delay the on-set of resistance*." This statement appears out of context and we are strongly opposed to the first option. (APHIS-2010-0047-4530)

Response: APHIS has removed the first option from the discussion of management options to mitigate weed resistance.

Comment: The Weed Science Society of America, North Central Weed Science Society, and the Western Society of Weed Science commented: Mitigating the evolution of herbicide resistance depends on reducing selection through diversification of weed control techniques; minimizing spread of resistance genes and genotypes via pollen or propagule dispersal; and eliminating additions of weed seed to the soil seedbank. Effective deployment of such a multi-faceted approach will require shifting from the current concept of basing weed management on single-year economic thresholds.

Herbicide resistance management programs must consider utilization of all cultural, mechanical, and herbicide options available for effective weed control in each situation and employ the following best management practices (BMPs):

1. Understand the biology of the weeds present.

2. Use a diversified approach to weed management focused on preventing weed seed production and reducing the number of weed seeds in the soil seedbank.

3. Plant into weed-free fields and then keep fields as weed free as possible.

4. Plant weed-free crop seed.

5. Scout fields routinely.

6. Use multiple herbicide mechanisms of action that are effective against the most troublesome or herbicide-resistance-prone weeds.

7. Apply the labeled herbicide rate at recommended weed sizes.

8. Emphasize cultural practices that suppress weeds by utilizing crop competitiveness.

9. Use mechanical and biological management practices where appropriate.

10. Prevent field-to-field and within-field movement of weed seed or vegetative propagules.

11. Manage weed seed at harvest and post-harvest to prevent a buildup of the weed seedbank.

12. Prevent an influx of weeds into the field by managing field borders.

The long-term economic benefits of avoiding additional costs associated with managing herbicide resistant weeds are clear. Nevertheless, widespread adoption of these BMPs must overcome several real barriers, in particular growers' focus on immediate economic returns, which when combined with the belief that evolution of herbicide resistance in weeds is unavoidable and that continued availability of novel herbicide technologies will solve the problem.

While many U.S. soybean, corn, and cotton growers employ at least some BMPs, a significant proportion of growers are not practicing adequate proactive herbicide resistance management. Two key recommendations in particular must be more widely implemented: diversifying weed management practices and using multiple herbicide mechanisms of action. Sugar beet growers need to be educated about mechanisms of action and made aware that discovery of new herbicide chemistries is rare, that the existing herbicide resource is exhaustible, and that indiscriminate herbicide use leading to rapid evolution of herbicide resistant weeds may result in the loss of herbicide options for all. (APHIS-2010-0047-4530)

Response: APHIS has updated the FEIS to include the information in this comment.

Comment: In addition, the microorganisms resulting from "Roundup" leaching into the soil are resistant to most current antibiotics. You are allowing the creation of more MRSA bugs. What will you do when someone you love contracts one of these organisms? Prevent them NOW! I am a former microbiologist. (APHIS-2010-0047-4292)

Response: APHIS disagrees with the comment. There is no credible evidence that glyphosate selects for microorganisms that are resistant to antibiotics. The comment provides no such evidence.

Comment: Let's not put all our beets in one basket! Variety is nature's method of assuring survival of beets to any virus or pest. If only one GE beet existed and succumbed to some virus or pest, it could threaten our food system. Would the desire for profit from a monopoly over the beet market drive some to risk the very survival of our species? (APHIS-2010-0047-4288)

Response: The commenter appears to be implying that the H7-1 sugar beets available to growers are all genetically identical, which is not the case. The H7-1 trait has been bred into many different varieties of beets that are adapted to various growing regions. Disease pressure, weed pressure, and cultivation practices vary by region. All of these factors influence the success of a beet variety in a region. As such, beet varieties that are successful in one region may not be in others. Each sugar beet cooperative works with sugar beet breeders to test varieties in the targeted region before they are approved for use by growers in the cooperative. Therefore, the adoption of H7-1 sugar beet does not change the likelihood that a single virus would affect sugar production or the Nation's food supply when compared to conventional sugar beet varieties. Sugar beet breeding and variety testing are described in the FEIS.

Furthermore, USDA coordinates a national system of plant germplasm called the National Plant Germplasm System (NPGS). USDA established the NPGS to preserve the genetic diversity of crop plants and encourage its use in research, education, and breeding. The NPGS preserves, multiplies, evaluates, catalogues, and distributes germplasm. At present, the NPGS's germplasm banks effectively safeguard the genetic diversity of thousands of species, including beets and Swiss chard, and distribute these worldwide and free of charge and restriction on use.

USDA maintains a germplasm bank of *Beta* crops at the Western Regional Plant Introduction Station in Pullman, Washington. As of April 29, 2010, the *Beta* collection contained 1,722 accessions of cultivated beet crops, which included table beets, Swiss chard, fodder beets, and sugar beets. Each accession was either a unique cultivar or a plant collected in the wild that is considered genetically unique. There were 83 accessions of cultivated beet that are used as leafy vegetables, 162 accessions that are used as table beets, 105 accessions that are used for fodder, and 714 accessions that are used for sugar extraction (sugar beets). In addition, there were 21 accessions categorized according to the end use "biomass," probably meaning that they produce much vegetation or large roots that could provide the raw material for energy production. There were also 637 cultivated beets in the genebank that were not yet classified according to a particular end use or were wild *Beta vulgaris subsp. vulgaris*. The NPGS's *Beta* collection is highly diverse. For example, as of April 29, 2010, the bank contained 572 accessions of *Beta vulgaris subsp. maritima*, a taxon that readily crosses with cultivated beet and is currently being used by USDA's Agricultural Research Service (ARS) scientists as a source of resistance to disease. There were 10 other *Beta* taxa, represented by 175 accessions, which were also included in the *Beta* collection.

Comment: Herbicide resistant (HR) weeds have long been a serious and underappreciated obstacle to development of a truly sustainable agricultural system. HR weeds are both the result of an unsustainable fixation on exclusively chemical means of weed control, and also the occasion for still greater dependence on herbicides. Table 1 (provided as an attachment to the comment) shows that GR weeds have increased dramatically in geographic extent over just the past four years, with an average of 3.1 million acres added each year over that period. The average annual gain over each of the past four years exceeds the overall acreage that became infested in the entire eight years from the time the first RR crop-associated GR weed emerged in 2000 (horseweed in Delaware) through 2007. As portrayed graphically in Figure 1 (provided as an attachment to the comment) with finer-grained data, GR weed emergence has been increasing exponentially over the past four years. (APHIS-2010-0047-4351)

Response: APHIS acknowledges that GR weeds are rapidly becoming more prevalent. However, APHIS disagrees with the numbers presented in table 1 and figure 1, as submitted by the Center for Food Safety (CFS). These numbers are based on a misinterpretation of data on the weedscience.org Web site curated by Dr. Ian Heap. On this site, weed scientists and extension agents have reported a range of acreage that may be infested with herbicide-resistant weeds. The CFS commenter noted that "ISHRW organizer Dr. Ian Heap made a point estimate of 10.4 million acres infested with GR weeds in May of 2010, when the maximum acreage infested was 11.4 million acres," and therefore concluded that the upper-bound estimates more closely approximate real-world conditions. APHIS asked Dr. Heap to comment on the CFS's analysis. In his reply to APHIS, Dr. Heap stated, "their [CFS'] conclusion that 'This suggests that the upper-bound estimates more closely approximate real world conditions' is wrong. I believe that when researchers put in values of 1-2 million acres infested there is a tendency to overestimate the actual number of acres. Some researchers are more prone to overestimates than others, and I quite often question their estimates and in reflection they may reduce their estimate by up to tenfold. The point again is that these are very subjective guesses, often not based on scientific surveys. They should only be used as general indications on how widespread a resistant weed has become." Because the acreage infested with GR weeds is very subjective and the error is magnified at higher acreages, APHIS does not consider the data from table 1 or the analysis shown in figure 1 to be meaningful and, consequently, has not included them in the FEIS. For the estimate used in the FEIS, APHIS refers to a comment made by Ian Heap that "an estimated 6 percent of the total planted corn, soybean, and cotton acres in the United States (about 10 million acres) have some level of weeds that are resistant to glyphosate" (WSSA, 2010).

Comment: It is well known and completely undisputed in the weed science community that glyphosate-resistant crop systems are responsible for the vast majority of glyphosate resistant weeds. APHIS's attempt to obfuscate this point by speaking of the number of "weed species" that have evolved resistance to glyphosate in non-RR crop settings is wrong on several counts. First, an entire "weed species" does not evolve resistance to an herbicide; rather, geographically distinct populations of a weed species evolve resistance, while most remain susceptible. Second, as explained in CFS Science Comments 2010, it is the acreage infested by a GR weed population that mainly determines its agronomic and environmental impact, not number of "weed species" with resistant populations. The number of weed species with GR populations or biotypes is not a good indicator of impact because this parameter says nothing about the size of the population (i.e. acreage of land infested), which in turn correlates with the amount of additional herbicide or tillage or hand weeding utilized to control the resistant weed population. (APHIS-2010-0047-4351)

Response: APHIS acknowledges that the prevalence of GR weeds is related to the amount of glyphosate use. As more than 75 percent of glyphosate use in the United States is on GR crops, it stands to reason that most of the acreage of GR weeds will be on land used to raise GR crops. With regard to the comment that an entire weed species does not evolve resistance to an herbicide, APHIS is well acquainted with the concept of biotypes and includes a discussion of biotypes and how selection increases the prevalence of biotypes (for example, see p. 235 of the DEIS). APHIS disagrees with the commenter's assertion that the number of weed species that has evolved resistance is unimportant. As described in the FEIS, the fact that relatively few species have developed resistance means that glyphosate is still an effective herbicide against most weed species. As such, it will continue to offer value for weed control. APHIS agrees that the acreage infested with GR weeds is related to the extent that alternative herbicides or nonchemical means of weed control will need to be adapted to supplement glyphosate use. APHIS discusses nonchemical weed control in section III.B.1.d.(2), non-glyphosate herbicides in section III.B.1.d.(3), and the possibility that increased prevalence of GR weeds will increase the use of non-glyphosate herbicides in section IV.B.1.b.(2) of the FEIS.

Comment: Over 99% of the reported GR weed-infested acreage emerged in soybeans, cotton, corn and/or sugar beets, all crops that are predominantly Roundup Ready (Figure 2"). (APHIS-2010-0047-4351)

Response: CFS over interpreted the data on acreages infested with GR weeds and made invalid comparisons. There has not been a systematic survey of acreages infested in GR and non-GR croplands. As Dr. Heap noted, "These data are very subjective guesses, often not based on scientific surveys. They should only be used as general indications on how widespread a resistant weed has become." APHIS also disagrees with this comment because it ignores the impact from years of glyphosate use on non-Roundup Ready® crops. Glyphosate was used for about 20 years, before the introduction of Roundup Ready® crops, as a burn-down herbicide on fields subsequently planted to Roundup Ready® crops. It simply is not possible to quantitate the contribution of Roundup Ready® and non-Roundup Ready® crops to the prevalence of GR weeds.

Comment: Crop rotation offers little or no protection against rapid evolution of glyphosate-resistant weeds when some or all of the crops in the rotation are Roundup Ready. Figure 2 (submitted as an attachment to the comment) also refutes another misconception in the DEIS. APHIS states erroneously that glyphosate-resistant weeds are most common when glyphosate is used on the same crop planted year after year without crop rotation, for instance continuous Roundup Ready soybeans or corn. APHIS further states that only "two species of weeds" have been selected for in situations involving rotation of RR corn and RR soybeans, and no GR weeds have arisen in a three-crop rotation. These statements are grossly misleading. Figure 2 shows that while roughly half (40 of 79) of GR weed reports have only "soybeans" listed as the crop setting, and five more list only "cotton," the aggregate GR weed-infested acreage of those 45 reports is quite small – less than 1.5 million acres. In contrast, 12 million acres of "cotton, soybeans" cropland and 1.2 million acres of "corn, soybeans" have been infested with GR weeds, or over 13 million acres in a two-crop setting. Likewise, five reports list three of four crops (corn, cotton or sugar beets, and soybeans) that are predominantly Roundup Ready as the crop setting, with up to 2 million acres infested. These data clearly demonstrate that the great majority of GR weeds (those infesting 14 million acres or more) have evolved on cropland that is used to grow two and even three crops, contrary to APHIS's assumption that GR weeds arise primarily in single crop situations. (APHIS-2010-0047-4351)

Response: Figure 2 and its conclusions are based on CFS' erroneous use of the data collected by the International Survey of Herbicide Resistant Weeds. CFS' conclusion that continuous cotton contributed very little GR weed, while most is from a cotton-soybean rotation, is contradicted by literature. For example, according to a survey conducted in 2006, "two-thirds of cotton producers in this region (Southeast US) had grown glyphosate resistant cotton continuously for 3–5 years" (Foresman and Glasgow, 2008). According to Neve (2008; 2011a), cotton is often grown as a continuous monoculture, but where rotation is practiced, the most common rotational crops are maize and, less commonly, soybean. The fact that most cotton is not grown in rotation and that when it is grown in rotation soybean is not the predominant rotation crop is inconsistent with the commenter's conclusion that most GR weeds evolved in a cotton-soybean rotation. In addition, the reports submitted to the International Survey of

Herbicide Resistant Weeds do not provide agronomic history, so it is not possible to know what crops, if any, were rotated with each other.

In his reply to APHIS on figure 2 supplied by the commenter, Dr. Heap stated, "Figure 2. is a misrepresentation of the data. Most of the acres represented in the figure should be 'continuous cotton' where glyphosate-resistant Palmer amaranth is the major problem. I understand where the confusion comes from, and I will explain. When a weed becomes resistant to a particular herbicide mode of action (in this case glyphosate) it is only listed in the state once as a unique case. Researchers then are asked which situations (crops) the glyphosate resistant weed has been identified in, for the whole state. Thus in Georgia the case of glyphosate-resistant Palmer amaranth has been identified in two crops – cotton, and soybean. But there is no implication that it is identified in a rotation of cotton and soybean, nor is there any indication of the split for the crops on the acres infested. In the case of Georgia, the researchers reporting the case (Stanley Culpepper and Erik Prostko) estimate that there are 1 to 2 million acres of glyphosate-resistant Palmer amaranth in the entire state. In reality 90% of those acres are probably in continuous RR cotton. So to conclude that there are 1 to 2 million acres of GR Palmer amaranth in a cotton/soybean rotation in Georgia is wrong. If the researchers had also identified GR Palmer amaranth in one peach orchard and a single case on a roadside then Figure 2 would show a crop rotation of cotton/peaches/soybean/roadsides – just to point out the error in their interpretation."

The statement that "crop rotation offers little or no protection against rapid evolution of glyphosate-resistant weeds when some or all of the crops in the rotation are Roundup Ready" is also contradicted by the experience in Western Canada, where GR weeds are a minor problem despite Roundup Ready® canola being grown on 3 million hectares annually and widespread glyphosate use in no-till systems being prevalent in this area (Blackshaw, 2011). Though Roundup Ready® canola has been grown in Canada since 1996, the first report of GR weeds occurred in 2012 on 100-500 acres. Presumably, the absence of GR weeds has been due to the adoption of integrated weed management practices and the use of 3- to 5-year crop rotations (Blackshaw, 2011). In contrast, the selection and spread of GR weeds have been more rapid and widespread with continuous cropping of soybean, corn, and cotton. Furthermore, CFS' statement is also contradicted by modeling studies conducted by Neve (2011b), who concluded that rotation between two GR crops reduced the risk of selection and spread of resistant weeds compared to continuous cropping.

Comment: While APHIS implies that RRSB were introduced commercially in 2005 (e.g. EIS at 538: "H7-1 sugar beets have been widely adopted since initial deregulation (2005)"), EIS at 546: "…continue to experience the weed control observed over the past 5 years and described under Alternative 2" to characterize weed control with RRSB, falsely implying commercial use since 2005), this is not accurate. (APHIS-2010-0047-4351)

Response: In section III.A. of the DEIS and FEIS, APHIS states that H7-1 was primarily used for production beginning in 2008: "This chapter describes key aspects of the affected environment in terms of two scenarios: (1) pre-2005 when production practices were based on the exclusive use of conventional sugar beet seeds and roots; and (2) from March 2008 to August 2010 when production practices switched almost exclusively to the use of H7-1."

Comment: One commenter stated that GR biotypes of common ragweed, giant ragweed, and common waterhemp are found in Minnesota and North Dakota and that their spread has been rapid. (APHIS-2010-0047-4351)

Response: The DEIS includes information on the occurrence of these weeds (see pp. 26 and 563 and table 4-20). The FEIS has been revised to incorporate information noted by the commenter on the spread of these weeds through the Midwest.

Comment: A commenter mentioned Stachler's (Weed Science Professor at North Dakota State and expert on weed management in sugar beet) recommendation that clopyralid be used to control GR ragweed. (APHIS-2010-0047-4351)

Response: The DEIS (p. 545) and FEIS discuss the use of clopyralid to control GR giant and common ragweed in sugar beet.

Comment: A commenter mentioned that biotypes of giant ragweed and common ragweed have been selected for resistance to ALS inhibitors. (APHIS-2010-0047-4351)

Response: The DEIS contains this information in table 3-25, which also appears in the FEIS.

Comment: A substantial population of glyphosate resistant waterhemp on hundreds of sites covering up to 10,000 acres was recently confirmed in the North Dakota county of Richland, which had 29,350 acres of sugar beets in 2007. The GR waterhemp is thus infesting a sizeable proportion of the sugar beets in that county. (APHIS-2010-0047-4351)

Response: APHIS contacted Jeff Stachler, a weed science expert at North Dakota State University, for an update on the prevalence and management of GR waterhemp in the Midwest and updated the FEIS accordingly.

Comment: Thus far, however, the most problematic weeds in the Red River Valley are kochia, pigweeds and lambsquarters. One reason kochia is so problematic in sugar beets is that virtually all of it in Minnesota and North Dakota has evolved resistance to triflusulfuron, and it is now resistant to all members of this large class of ALS inhibitor herbicides. Kochia would of course become considerably more difficult to control in RRSB if it also evolves glyphosate-resistance. GR kochia and lambsquarters (see below) have been considered likely in North Dakota since at least 2009. It was recently located in two counties of southern North Dakota, one of them a sugar beet-growing county (Sargent), and will have a substantial impact when it does evolve glyphosate resistance. The first GR kochia biotype emerged in western Kansas in 2007, infesting cotton, soybeans and corn. It has progressively spread since then. A recent report suggests that GR kochia has spread throughout the entire western third of Kansas:

The presence of glyphosate resistance in four populations of kochia in western Kansas was confirmed in 2007. The populations were dispersed more than 100 km apart and were considered to have developed resistance independent of each other. A few additional reports of lack-of-control of kochia with glyphosate in other regions were received in 2008 and 2009 and the number of such reports escalated dramatically in 2010. An extensive driving tour and unscientific field survey in the fall of 2010 confirmed the presence of uncontrolled kochia in many corn, soybean, and fallow fields throughout the western one-third of Kansas that had been sprayed with glyphosate alone or in mixture with other postemergence herbicides. Seed was collected from 17 kochia populations dispersed throughout the region that had survived spraying operations. Glyphosate dose-response trials are being conducted to determine if the sampled populations are indeed resistant to glyphosate as suspected. If resistance is confirmed, then glyphosate-resistant kochia is prevalent throughout western Kansas.

Assuming the resistance is confirmed, there are several troubling aspects about this report. First, independent evolution of glyphosate-resistance in four separate populations would suggest that kochia individuals with the capacity to survive glyphosate are not exceedingly rare (as one might assume if only one population had evolved resistance and spread via tumbleweed). Second, the dramatic escalation in number of reports in 2010 (in Colorado as well as Kansas) suggests the problem is worsening. The fact that this kochia survives glyphosate and other postemergence herbicides suggests it may have multiple resistance, perhaps to ALS inhibitors as in Minnesota and North Dakota. Finally, the presence of GR kochia throughout an area as large as the western third of Kansas suggests a capacity for rapid evolution or spread. (APHIS-2010-0047-4351)

Response: APHIS discusses the possibility that GR kochia could be selected or spread into sugar beet fields in the DEIS on pages 537-546. APHIS has updated the FEIS to include the information supplied by the commenter.

Comment: RRSB growers have regarded lambsquarters as their worst weed over the past two years (2009 and 2010) citing the survey of weed control and production practices on sugarbeet in Minnesota and Eastern North Dakota. (APHIS-2010-0047-4351)

Response: APHIS has reviewed these survey reports published over the last 3 years: (Stachler *et al.*, 2009; Stachler *et al.*, 2011; Stachler *et al.*, 2012b).

The survey asks the growers to identify their worst weed problem. In the 2011 survey, 29 percent of the growers indicated that they did not have a worst weed problem. As for common lambsquarters, the number of RRSB growers who named it as the worst weed problem decreased from 30 percent in 2009, to 23 percent in 2010, to 16 percent in 2011. APHIS interprets this data to indicate that glyphosate use on RRSB provided excellent weed control in 2011 and that common lambsquarters is lessening as a weed problem for RRSB growers.

Comment: One commenter took issue with the rate of glyphosate used by APHIS to estimate national glyphosate use. APHIS used 0.75 pounds acid equivalent per acre (lbs. ae/acre), but the commenter points out that weed shifts have necessitated using up to 1.125 lbs., the maximum allowable rate. (APHIS-2010-0047-4351)

Response: At the suggestion of the commenter to improve the estimate of glyphosate used by sugar beet growers to better reflect increasing use due to weed shifts, APHIS reanalyzed herbicide use based on the most recent data available, the herbicide use data from the 2011 survey from Minnesota and eastern North Dakota (Stachler *et al.*, 2012b). While in 2011, 0.75 lbs. ae/acre continued to be the most common herbicide treatment reported by all growers in the Midwest, APHIS acknowledges that more growers were using higher rates than in previous years. In addition to reporting the single application use rates, the surveys also report the average total rate of glyphosate applied per acre, which provides a much more accurate estimate of the glyphosate applied to the region. The average total rate reflects the number of applications made and the concentration of glyphosate applied at each application, which can vary from 0.75 to 1.125 lbs. ae/acre. Therefore, instead of using a rate per application of 0.75 lbs. or 1.125 lbs. ae/acres, APHIS used the average total rate for the season, which was 2.21 lbs. ae/acre (or 2.7 lbs. active ingredient (ai)/acre) in the 2011 growing season. This value was also used instead of 1.89 lbs. ae/acre to estimate national glyphosate use in the table in the cumulative impacts section (table 5-1 in the DEIS).

As implied by the commenter, the average total rate of glyphosate applied to RRSB increased in 2011 and 2010 relative to 2009, when the rates were 2.21, 2.09, and 1.85 lbs. ae/acre, respectively. However, the trend was interrupted from 2008 to 2009 when the rate decreased from 1.93 to 1.85 lbs. ae/acre. Presumably, weed shifts were occurring from 2008 to 2009, so the reduction in herbicide used must be attributable to other factors that could influence weed pressure. In addition to weed shifts, weather is an important factor that influences the use rate. For example, in 2011, rains during planting season delayed when herbicide could be applied, resulting in higher overall use rates of herbicides on both H7-1 and conventional sugar beets compared to 2010 (Stachler *et al.*, 2011; Stachler *et al.*, 2012b). Therefore, some part of the increased use rate from 2010 to 2011 is likely attributable to the weather.

To compare herbicide use under Alternatives 1 and 2 in the DEIS, APHIS used national herbicide use data from 2000 and compared it to estimated herbicide use based on survey data from Minnesota and North Dakota in 2010. In several respects, the data might not be comparable: (1) the regional data from Minnesota and North Dakota might not be representative of the national data; (2) the data from 2000 and 2010 might not be comparable due to yearly weather differences; and (3) the data from 2000 and 2010 might not be comparable due to weed shifts that have occurred over the past decade. To make a more reliable comparison in the FEIS, herbicide use estimates were based only on 2011 survey data from Minnesota and eastern North Dakota, which represent approximately 55 percent of the sugar beet grown in the United States. In 2011, 10 percent of the surveyed growers planted conventional sugar beet. By comparing herbicide used on conventional and H7-1 sugar beet in just this region from the same year, weather- and weed shift-related differences between the comparators are minimized relative to comparing statistics from a decade apart. Furthermore, regional differences in herbicide use are not as extreme as national differences would be.

Comment: One commenter believed that APHIS contradicted itself in its description of the stale seed bed because page 113 of the DEIS states that in stale seed beds the fields are tilled in the fall and then left untouched in the spring, while page 130 indicates that stale seed bed is when the field is tilled in advance of sowing the crop to encourage weed germination and then tilled again just prior to sowing the crop. (APHIS-2010-0047-4351)

Response: In the stale seed bed technique, weed seeds are encouraged to germinate by tillage in advance of planting the crop. However, there are multiple ways to kill the weeds that are encouraged to germinate. In some cases, additional tillage is used. In others, the seed bed is undisturbed to discourage the germination of additional seeds. Instead of tillage, weeds may be killed by herbicide treatment, burning with a propane flamer, or—for small scale farms—an application of clove oil (Taylor, 2009). These points have been clarified in the FEIS.

Comment: One commenter stated that horseweed should be noted as a problematic weed in sugar beets based on a report by Christy Sprague, an extension specialist in Michigan. (APHIS-2010-0047-4351)

Response: APHIS discussed with Dr. Christy Sprague the likelihood that GR horseweed would be a problem weed in sugar beet. Dr. Sprague told APHIS that there is a trend to use the stale seed bed technique for sugar beet without tillage in the spring, although some growers continue to use tillage. In Michigan, horseweed can emerge in both the fall and the spring. For growers who do not use tillage in the spring, GR horseweed that emerged during that season would not be effectively controlled with glyphosate and could be problematic. However, GR horseweed is not likely to become a problem because sugar beet growers could resort to spring tillage should it become prevalent in Michigan sugar beet fields. This information and discussion are included in the FEIS.

Comment: One commenter believed that APHIS was wrong to suggest that the GR horseweed that was confirmed in Michigan in 2007 in Mason County on Christmas tree farms spread to a no-till soybean field in Ionia County and a stale seed-bed sugar beet field in Gratiot County. The commenter points out that the report (Sprague, 2011) did not state whether it was dispersed from the Christmas tree nursery population or evolved separately from glyphosate selection pressure in the sugar beet field. According to the commenter, independent evolution of glyphosate resistant populations of horseweed and other weeds is quite favored by the frequent rotations involving RRSB and other RR crops. In fact, Michigan has the highest percentage of sugar beet acreage that is estimated to rotate to another RR crop (66%). (APHIS-2010-0047-4351)

Response: APHIS acknowledges that the report did not suggest that the GR horseweed spread from the Christmas tree farm. APHIS recognizes that it is possible, as suggested by the commenter, that the population in Gratiot County was selected independently from the population on the Christmas tree farm. The FEIS has been revised accordingly. Nevertheless, it is also possible that it spread this far based on a report noted in the FEIS, (Shields *et al.*, 2006), which concludes that horseweed can travel up to 300 miles from a single plant. The distance between Mason, Ionia, and Gratiot counties is well within 300 miles. The DEIS did not conclude that 66 percent of sugar beet acreage is rotated to another Roundup Ready® crop; rather, it indicated that 66 percent is the maximum estimated by the amount of Roundup Ready® crops in the State. Based on information APHIS received from Michigan Sugar Company on crop rotations by sugar beet producers, only 34 percent of growers use a three-crop rotation, 41 percent use a four-crop rotation, and 24 percent use a five-crop rotation. Growers using a four- or five-crop rotation would include wheat, dry beans, or pickling cucumbers in the rotation, none of which are GR. Therefore, the likelihood of a sugar beet grower rotating to another Roundup Ready® crop is expected to be less than 66 percent in Michigan. The FEIS has been updated with this information.

Comment: A commenter informed APHIS that GR ragweed was identified in Nebraska, GR kochia and waterhemp are now in Nebraska, and GR kochia may be present in Colorado. (APHIS-2010-0047-4351)

Response: These instances have been noted in the FEIS.

Comment: Glyphosate-resistant weeds have triggered substantial adverse impacts wherever they have emerged: increased use of glyphosate and other, more toxic herbicides; increased use of tillage and abandonment of conservation tillage; a massive rise in hand-weeding; and skyrocketing weed control costs. (APHIS-2010-0047-4351)

Response: Weeds resistant to non-glyphosate herbicides cause the same adverse impacts that the commenter is ascribing to GR weeds, namely increased use of more toxic herbicides, increased use of tillage, abandonment of conservation tillage, a massive rise in hand-weeding, and skyrocketing weed control costs. The agency thoroughly discusses this issue in section III.C.3 of the DEIS and FEIS. Because GR crops allow weeds to be so effectively controlled, they substantially mitigate the adverse impacts growers currently face. While it is true that the emergence of GR weeds may result in a loss of the benefits initially obtained with GR crops, under Alternative 1 the benefits would not be realized and the same impacts described by the commenter would occur without their use. Growers may increasingly adopt integrated weed management techniques that prolong the usefulness and benefits of the technology.

Comment: APHIS should assess whether alfalfa is really so little rotated with sugar beets as suggested in Table 3-6, where only a small fraction of sugar beet acreage is rotated to alfalfa in a single state (Idaho), and adjust those figures as needed. (APHIS-2010-0047-4351)

Response: APHIS extensively analyzes the possible rotations of alfalfa with sugar beets in the cumulative impacts section of the FEIS. The estimates of acreage in this section are more likely to represent alfalfa and sugar beets being grown in the same county rather than the two crops being rotated on the same field. APHIS' analysis was based on industry predictions from market research and is an overestimate of alfalfa acreage planted in the short term.

Comment: APHIS's reliance on industry best practices, including Monsanto's Technology Use Guide (TUG), to mitigate the evolution and adverse environmental impacts of glyphosate-resistant weeds is arbitrary and capricious and fails to satisfy APHIS's statutory duty to "[protect] [] the agriculture, environment, and economy of the United States." First, Monsanto's TUG recommendations are themselves grossly inadequate and in some respects counterproductive.

APHIS elsewhere concedes that Monsanto's endorsement of rotations from RRSB to other Roundup Ready crops as a supposed weed resistance management practice is misguided and actually promotes rather than prevents the evolution of glyphosate-resistant weeds. Second, to the extent the TUG recommendations have any value, the DEIS incorrectly assumes that farmers regularly observe them, despite no evidence to this effect, and considerable evidence against this assumption (see below). There is no evidence that Monsanto enforces TUG provisions and the DEIS' claim that Monsanto's voluntary stewardship measures will forestall the emergence of glyphosate-resistant weeds lacks any merit.

Voluntary stewardship measures to mitigate weed resistance, whether proffered by industry or public sector agronomists, have been a dismal failure. Hard, empirical data demonstrate conclusively that weeds are continuing to rapidly evolve resistance to glyphosate. This would not be occurring if stewardship measures were effective. In other words, the failure of voluntary stewardship is demonstrated by the continuing rapid spread of the problem stewardship is meant to mitigate.

CFS discussed Johnson et al (2009) in comments on the USDA's draft EA for RRSB partial deregulation, yet this study, despite its independence and quality is not discussed or cited in the draft EIS. CFS also extensively discussed the efforts of Monsanto and its academic associates (including Robert Wilson, who is heavily cited by APHIS in the EIS) to mislead farmers into growing Roundup Ready crops and using glyphosate continuously, year after year, practices that even APHIS now admits promote the rapid evolution of glyphosate-resistant weeds. APHIS also failed to respond to this evidence and discussion in the EIS. (APHIS-2010-0047-4351)

Response: APHIS is not relying on "industry best practices, including Monsanto's Technology Use Guide (TUG), to mitigate the evolution and adverse environmental impacts of glyphosate-resistant weeds." The commenter is confused about APHIS' role. Maintaining the long-term efficacy of glyphosate or any other herbicide is outside the scope of the FEIS and the authority of APHIS. EPA regulates the use of pesticides and specifically defines the amounts of each pesticide that can be applied to sugar beet and other crops during the growing season.

The Monsanto TUG recommendations on mitigating the spread and selection of GR weeds are indeed recommendations and are not enforced. These recommendations are just one source of information. The FEIS discusses other sources of information and efforts by universities, extension agents, herbicide manufacturers, commodity groups, and sugar beet industry associations to educate growers on best practices (see sec. III.C.3.a.(3)).

APHIS disagrees with the commenter that the following of voluntary stewardship measures lacks any merit. Sugar beet growers have strong financial and practical interests in managing weeds effectively to reduce the selection of herbicide-resistant weeds and to maximize yield potential. The FEIS discusses how awareness among growers is increasing regarding the need to minimize the potential for development of glyphosate resistance, based on surveys that farmers are proactively adopting best management practices (see sec. III.C.3.a.(3)). The FEIS also describes that sugar beet growers and processors have established funds to support research and extension activities on weed resistance. As discussed in the FEIS, researchers from Colorado, Nebraska, and Wyoming, in cooperation with Monsanto, are developing region-specific technology usage guides to address weed management in cropping rotations that include sugar beet. Guides will provide regional and weed-specific (kochia, common lambsquarters, and pigweed) recommendations for corn, small grains, dry beans, and sugar beet, therefore enhancing the benefits of crop and herbicide rotations.

Farmers are aware that they will pay more for weed control when herbicide-resistant weeds are prevalent (see sec. III.D.1.e. of the FEIS). Some farmers can be expected to take a long-term view towards more sustainable practices and will be willing to incur additional management costs to prevent or delay selection of resistance, especially if there is uncertainty regarding the development of alternative herbicides (Pannell and Zilberman, 2000). Others may be unwilling to incur additional costs until the resistant weeds directly affect their farms either because they take a short-term view, are faced with financial hardship, expect substitute herbicides to become available over time, or believe that their individual actions will not prevent or delay the prevalence of herbicide-resistant weeds (Pannell and Zilberman, 2000). Approximately 80 percent of growers surveyed in Delaware responded that it was worthwhile to incur additional costs now to preserve glyphosate for future use (Scott and VanGessel, 2007). To encourage sustainable use of glyphosate, Monsanto has implemented the Roundup Ready Plus® incentive program for farmers to include residual herbicides, many of which are sold by other companies, in their herbicide management programs in addition to glyphosate (Monsanto, 2011). Rebates of up to $5 per acre for corn, $10 per acre for soybean, and $22 per acre for cotton are available for using recommended combinations of residual herbicides along with glyphosate. These rebates provide an economic incentive for growers, especially those who may take the short-term view, to adopt the recommended practice of including multiple herbicide chemistries in the rotation.

APHIS acknowledges that maintaining glyphosate selection by rotating exclusively between Roundup Ready® crops is not ideal. However, APHIS has stated in the DEIS and FEIS that crop rotation has great value for weed management and that rotation between Roundup Ready® crops is still better than continuous cropping of a Roundup Ready® crop because it takes advantage of the differences in crop ecology that foster different dominant weeds and facilitates the use of alternative herbicide chemistries.

APHIS has extensively reviewed the literature on weed management practices in sugar beet and its rotation crops. The commenter is mistaken by his assertion that (Johnson *et al.*, 2009) is not cited. It is cited twice in section III.C.3 of the EIS. Furthermore, under Alternative 1, as well as Alternatives 2 and 3, there is likely to be an increase in the spread of GR weeds.

APHIS disagrees with the commenter's characterization of Professor Robert Wilson, a sugar beet expert and extension weed specialist at University of Nebraska. APHIS relied on Dr. Wilson for practical information on growing sugar beet in the Great Plains, especially with regard to weed control. APHIS cited his peer-reviewed research after independently reviewing it. These works were scientific studies and not promotional materials as alluded to by the commenter. Among the work cited were studies by Dr. Wilson where he recommends the use of multiple herbicide chemistries to forestall GR weeds (Wilson Jr and Sbatella, 2011) and analyzes weed management practices and their effects on weed populations and soil seedbanks (Wilson *et al.*, 2011).

Comment: APHIS should make predictions of herbicide use for at least 10 years into the future to account for inevitably rising weed resistance. In addition, APHIS should factor in usage of the dimethenamid-P recommended to control GR waterhemp, rather than ignore this herbicide. As noted earlier, the glyphosate rate utilized by APHIS appears to be too low even for the "snapshot" of current practices, and should of course be scaled gradually upward to account especially for increasing tolerance in common lambsquarters, which both has a history of "creeping resistance" to glyphosate and is regarded as the worst weed by Red River Valley RRSB growers (a substantial 23% in 2010, Stachler, JM et al (2010), Table 26). In addition, Sequence (a premix of S-metolachlor and glyphosate) appears to be registered for RR sugar beets, and will likely be used much more in the coming years, given resistance to other popular herbicides besides glyphosate. The increased use of these additional herbicides should also be factored into projections of the toxicity comparison between conventional sugar beets and RRSB. (APHIS-2010-0047-4351)

Response: In the cumulative impacts section of the FEIS, APHIS has included an analysis of past herbicide use and has made some qualitative predictions on future use based on past uses and current trends in crop adoption and weed management. APHIS has no way to accurately predict herbicide use for the next 10 years. There have been 4 years of glyphosate use data collected in Minnesota and eastern North Dakota. Between the first and second year, glyphosate use decreased by 4 percent. Between the second and third year, glyphosate use increased 13 percent. Between the third and fourth year, glyphosate use increased 6 percent. Herbicide use data is not available for the other sugar beet-producing regions. In our opinion, this amount of data is too scant to form the basis of a meaningful trend analysis. Based on conversations with Jeff Stachler, a weed scientist at North Dakota State University, dimethenamid-P is not an effective herbicide for waterhemp control, causes leaf injury to plants, and is not expected to be widely used to control GR weeds in sugar beets. It is seldom used currently (Stachler *et al.*, 2008; Stachler *et al.*, 2009; Stachler *et al.*, 2011; Stachler *et al.*, 2012b). Similarly, metolachlor is seldom used on sugar beets, although it has been registered for use since 2003 (EPA, 2003; Stachler *et al.*, 2008; Stachler *et al.*, 2009; Stachler *et al.*, 2011; Stachler *et al.*, 2012b). Even though Sequence has been registered for use on H7-1 sugar beet since 2010 (EPA, 2010), it was not listed in Minnesota or North Dakota survey data as one of the herbicides used in the past 2 years (Stachler *et al.*, 2011; Stachler *et al.*, 2012a). Therefore, APHIS does not agree that the toxicity of metolachlor needs to be analyzed in the FEIS. APHIS notes that three alternatives to dimethenamid-P and metolachlor that are much more commonly used on sugar beet—ethofumesate, cycloate, and EPTC—were analyzed in depth in the DEIS and FEIS. Use of non-glyphosate herbicides—such as clopyralid, desmedipham, phenmedipham, quizalfop, and clethodim—might increase depending on the effectiveness of preplant herbicides—such as ethofumesate, EPTC, and cycloate—and recommendations from local weed experts. APHIS has revised the FEIS to include the most recent glyphosate use rate of 2.7 lbs. ai/acre.

Comment: A commenter stated that APHIS should predict the socioeconomic impacts of increased tillage and hand weeding that might possibly result from an increase in GR weeds. (APHIS-2010-0047-4351)

Response: APHIS has analyzed the socioeconomic impacts of adopting RRSB and estimated a net benefit to the grower of over $200 per acre nationwide (see sec. III.D. of the FEIS). If GR weeds become widespread, this socioeconomic benefit could be diminished to the grower but could create economic opportunities to field workers. APHIS predicts that growers will choose to grow conventional sugar beet if GR weeds become so prevalent that adoption of H7-1 beet is no longer profitable, resulting in the socioeconomic and environmental impacts being equivalent to adopting Alternative 1. APHIS has also considered the impacts of GR weeds on other GR crops as well as the contribution of H7-1 sugar beet to this issue under Alternatives 2 and 3 (see the cumulative impacts section of the FEIS).

Comment: One commenter took issue with APHIS' conclusion that glyphosate provides another mechanism of action in the toolkit of weed control measures, stating:

This conclusion is, of course, absurd. The first problem is that RRSB does not provide "another herbicide mechanism of action." Rather, it essentially replaces all other weed control measures, as indicated by the fact that 95% of all herbicide treatments in the Red River Valley sugar beets were glyphosate alone (the other 5% are mostly glyphosate mixed with other herbicides, like clopyralid). RRSB does not enrich the weed control toolbox, it destroys it and all the tools in it, just as other RR crops have done before it. (APHIS-2010-0047-4351)

Response: APHIS disagrees with this comment. For growers and weed scientists who are concerned with weed control, glyphosate is seen as part of the solution. Overwhelmingly, they believe that glyphosate augments the toolbox rather than destroying it. For example, according to Duke (2011), "The use of glyphosate with GR crops is the most important weed management technology in agronomic crops in the western hemisphere." Other herbicides have not been as relied upon as glyphosate because they may damage the crop, are not as effective on a wide variety of weeds, require precise timing for effectiveness, may have become less effective through the selection of herbicide resistance, may be more difficult to mix, or may be more dangerous to the applicator. When GR crops were first introduced, GR weeds were not very prevalent, and few growers appreciated the need to incur additional costs to manage GR weeds. Growers are more aware now of the need to manage GR weeds due to personal experience with GR weeds and education campaigns that promote adopting more diverse weed management strategies. For example, according to (Shaw *et al.*, 2009),"In a market research study that surveyed 350 growers in 2005 and again in 2009, in response to the question, 'are you doing anything proactively to minimize the potential for resistance to glyphosate to develop,' 67% said yes in 2005 and 87% said yes in 2009." This significant increase in proactive resistance management demonstrates that growers are gaining awareness of the benefits of diversified weed management programs. In a 2007 survey of 400 corn, soybean, and cotton growers, resistance management programs were often or always used by 70 percent or more of all three grower groups (Frisvold *et al.*, 2009; WSSA, 2010). According to (Culpepper *et al.*, 2010), "Proactively, some U.S. producers are hand-roguing fields as part of a zero-seed-production approach to address the increasing occurrence of GR weeds, mainly Palmer amaranth. The expenses these producers have incurred are far less than that of those who allowed a few plants to escape and are later confronted with sizeable soil seedbanks of resistant weeds that must be rogued multiple times each year to achieve a harvestable crop." These examples indicate that growers are increasingly shifting to a long-term strategy to manage GR weeds, which includes diversified weed management programs rather than solely relying on glyphosate for weed control.

Comment: A commenter took issue with APHIS' conclusion that adoption of H7-1 sugar beets are expected to result in a net decline in the development and dispersal of non-glyphosate herbicide-resistant weeds due to the introduction of an additional mechanism of action for weed management:

"For APHIS's prediction that there will be a net decline in herbicide-resistant weeds to be true, there would have to be massive expansion of weeds resistant to non-glyphosate herbicides to counteract the tidal wave of glyphosate resistance that the data discussed above represents. (Recall that GR weeds have increased in scope by roughly two orders of magnitude over just the past four years, and that the appearance of new populations is accelerating (CFS Science Comments – Appendix 3)). APHIS did not present any data to support such a trend. At most, there are tables that contain reports of sugar beet weeds that have evolved resistance to various non-glyphosate herbicides, mostly in the 1990s, with no indication of whether these HR weeds are increasing in scope, on the decline, or have entirely disappeared (HR weed populations are sometimes less fit and so recede in competition with fitter non-HR weeds when use of the corresponding herbicide is curtailed). In any case, one would expect that any "legacy" weeds resistant to non-glyphosate herbicides that infest conventional sugar beets would have been suppressed, over the past 5-15 years, in those hundreds of thousands of sugar beet acres that are rotated to an RR crop and thus treated with glyphosate. APHIS does not anywhere discuss this scenario. In contrast, GR weed selection pressure in RRSB is amplified by post-emergence glyphosate use on those same 600,000 plus RR crop rotation acres, as crop rotations already overly centered on glyphosate become still less diverse." (APHIS-2010-0047-4351)

Response: APHIS disagrees with this comment. There has not been an explosion of GR weeds in sugar beets. After 4 years, the first reports of GR weeds being found in sugar beet fields are just beginning in the Midwest, and there are no reports of GR weeds in sugar beet fields in other regions (see sec. III.C.3). In addition, weed control has overwhelmingly been the worst problem in sugar beet production throughout the United States in part due to the prevalence of weeds resistant to non-glyphosate herbicides (see sec.III.C.3). In the Midwest, where survey data is available, it is clear that few growers rate weeds as their worst problem since the adoption of H7-1 sugar beet (Stachler *et al.*, 2012a) [see table 27 of the DEIS]. While the percentage of growers who rated weeds as their worst problem ranged from 25 to 61 percent in past years, the percentage was 5 percent in 2011—the lowest on record during a year where early rains exacerbated the weed problems (Stachler *et al.*, 2012a). Among growers raising H7-1 sugar beet in Minnesota and eastern North Dakota, 69 percent rated weed control excellent, 14 percent rated it good, 2 percent rated it fair, and 3 rated it poor (Stachler *et al.*, 2012a). In contrast, among growers raising conventional sugar beet, 25 percent rated weed control as excellent, 48 percent rated it good, 10 percent rated it fair, and 3 percent rated it poor (Stachler *et al.*, 2012a). Despite the commenter's claim that GR weeds are exploding in sugar beet crop land in Minnesota and North Dakota, glyphosate is still providing "excellent" weed control in nearly 70 percent of fields, meaning that 90 to 99 percent of the weeds do not survive to flower (scores defined in (North Dakota State University, 2011)). In conventional sugar beet fields, control is excellent in just 25 percent of fields, and a much higher number are fair (65- to 80-percent control) to good (80- to 90-percent control). This statistic means that a much larger number of weeds produce seed in conventional sugar beet fields than in H7-1 sugar beet fields. As the commenter correctly surmised, legacy weeds diminish as glyphosate provides excellent control, which is why APHIS concluded in the FEIS that glyphosate use on H7-1 sugar beet is contributing to a diminution of weeds resistant to non-glyphosate herbicides.

Comment: One commenter claimed that APHIS assumes that any GR weeds that evolve will be easily handled with alternative herbicides. (APHIS-2010-0047-4351)

Response: Glyphosate provides an additional mechanism of action that can aid weed control. APHIS did not say that any GR weeds that evolve will be easily handled with alternative herbicides. APHIS states in the DEIS and FEIS, "If glyphosate resistant weeds were to become prevalent in sugar beets, combinations of herbicides with different mechanisms of action are expected to still provide effective control provided that the glyphosate resistant weed does not already carry resistance to multiple herbicides." This does not mean that glyphosate and non-glyphosate herbicides can control weeds that have resistance to both herbicides.

Comment: One commenter disagreed that glyphosate should be used in tank mixtures with other herbicides even though it is still effective on most other weeds. He supports his point of view with a quote from the eminent weed scientist, Stephen Powles (Laws, 2010), "Within the cotton, corn and soybean belt the massive reliance on glyphosate means it will be driven to redundancy because many of the big driver weeds such as Palmer pigweeds, waterhemp, ragweed and johnsongrass will be resistant. There may be many weed species still controlled by glyphosate, but glyphosate will fail on the driver weeds and that means overall failure." (APHIS-2010-0047-4351)

Response: APHIS has read the article cited by the commenter (Laws, 2010) and disagrees with the commenter's interpretation of Powles remark. Powles and others in the weed science community advocate using a diversity of measures to address weed control. The problem noted by Powles relates to using a single method of weed control on GR crops. The problem is the single method of weed control, not the use of the GR crop itself. For example, in the very same article quoted by the commenter, (Laws, 2010), Powles states, "diversity is the key to preserving herbicide compounds such as the triazines, ALS and ACCase inhibitors; that is, diversity in cropping systems, herbicide modes of action and non-chemical weed control measures." In contrast to what is implied by the commenter, glyphosate increases the diversity of measures that can be used for weed control. APHIS is not aware that Powles or other weed scientists object to the use of tank mixtures with glyphosate. Tank mixtures are one way to increase the diversity of herbicide modes of action used. From a resistance-management perspective, using tank mixtures is superior to using sequential applications of different herbicides (Neve *et al.*, 2011a;

Norsworthy *et al.*, 2012). Numerous groups have advocated this approach along with other techniques to increase the diversity of weed control methods (Neve *et al.*, 2011a; Norsworthy *et al.*, 2012; Vencill *et al.*, 2012).

Comment: One commenter pointed out that the recent confirmed report of GR Palmer amaranth in Michigan may be problematic for growing sugar beet. (APHIS-2010-0047-4351)

Response: APHIS included a discussion of GR Palmer amaranth, noting that it has been detected in Michigan but has not historically been a problematic weed in sugar beet. The commenter did not provide any evidence to support his claim that it is a problematic weed in sugar beet.

Comment: APHIS received a comment indicating that although the agency noted that glyphosate can be present in air and rain, the agency did not account for these new facts in assessing risks to amphibians and fish. (APHIS-2010-0047-4435)

Response: APHIS disagrees with this statement. APHIS did take into account the fact that amphibians and fish are exposed to glyphosate present in air and rain when it moves from air and rain into surface water (see secs. III.E.4. and IV.E.4 of the FEIS). Glyphosate in surface water comes from any number of sources, including runoff and rain and atmospheric deposition. Measurements of glyphosate in surface water already include the contribution of glyphosate that cycled through the atmosphere. APHIS considered measurements of glyphosate in surface water from the following sources: (Coupe *et al.*, 2011), (Battaglin *et al.*, 2005). (Scribner *et al.*, 2007; Battaglin *et al.*, 2009).

Comment: A commenter felt that APHIS should factor plant-sequestered glyphosate into risk assessments because, citing (Doublet *et al.*, 2009) "Following application, pesticides can be intercepted and absorbed by weeds and/or crops. Plants containing pesticides residues may then reach the soil during the crop cycle or after harvest. However, the fate in soil of pesticides residues in plants is unknown. Absorption of both herbicides in plant delays their subsequent soil-degradation, and particularly, glyphosate persistence in soil could increase from two to six times. The modifications of herbicide degradation in soil due to interception by plants should be considered for environmental risks assessment." (APHIS-2010-0047-4435)

Response: EPA conducts risk assessments for pesticide registration, which are outside the scope of this EIS. APHIS notes, however, that the commenter did not faithfully represent the point that (Doublet *et al.*, 2009) made. Doublet (Doublet *et al.*, 2009) suggests that the absorption of glyphosate in plants should be taken into account in the modeling of pesticide fate, especially for risk assessments for pesticide registration.

Comment: A commenter felt that APHIS should not equivocate on whether amphibians will be present in sugar beet fields. (APHIS-2010-0047-4435)

Response: APHIS is unaware of any surveys or other studies of amphibians in sugar beet fields, and the commenter did not provide any data on the abundance of amphibians in sugar beet fields. While APHIS does not discount that some may be present, the agency expects sugar beet fields to be less attractive habitat to amphibians than less managed terrestrial alternatives due to the intensity with which sugar beet fields are managed.

Comment: A commenter noted that glyphosate formulations used on crops are more toxic to amphibians than glyphosate alone and that water bodies adjacent to glyphosate treated fields can also be contaminated at levels toxic to amphibians. The commenter said that APHIS needs to reconsider the impacts in light of real world practices and outcomes, [citing (Battaglin *et al.*, 2009)] which showed that water bodies adjacent to glyphosate treated fields can also be contaminated at levels toxic to amphibians. The commenter further noted that glyphosate can have indirect effects on amphibians, citing Vera et al. (2010). In addition, the commenter noted that APHIS did not rely on the latest studies in assessing the risks of increased glyphosate-based herbicide use to amphibians. (APHIS-2010-0047-4435)

Response: APHIS reviewed references submitted by the commenter and incorporated information into the EIS as appropriate. In particular, APHIS notes in the FEIS that in certain localized instances, levels of glyphosate in surface water can be high enough to cause sublethal effects on amphibians. APHIS includes the following summary in the FEIS: "Two points of view have developed regarding the environmental risk posed by the use of glyphosate formulations containing POEA and similar surfactants. One view is that when used in accordance with directions stipulated on product labels, the concentration of glyphosate (and by inference the concentration of POEA or associated surfactants) will be sufficiently diluted to avoid toxic concentrations in water-bodies likely to receive runoff or be contaminated by spray-drift. The opposing view is that amphibians may be particularly susceptible to the toxic effects of these pesticides because their preferred breeding habitats are often shallow, lentic or ephemeral pools that do not necessarily constitute formal waterbodies, and which can contain higher concentrations when compared to larger water-bodies" (Mann *et al.*, 2009).

Comment: One commenter felt that APHIS did not take into account key studies of negative consequences of increased glyphosate use on nontarget plants, particularly sublethal effects that may affect plant reproduction. (APHIS-2010-0047-4435)

Response: APHIS devotes sections III.C.3.b and IV.C.3.b of the FEIS to the topic of herbicide drift and impacts on nontarget plants. APHIS acknowledges that glyphosate is a nonselective herbicide that can adversely impact a wide range of nontarget plant species if drift occurs. EPA regulates the use of herbicides, including label restrictions designed to control spray drift.

Comment: One commenter felt that APHIS did not consider the impact of being able to apply glyphosate during the entire H7-1 sugar beet growing season. (APHIS-2010-0047-4435)

Response: Glyphosate is not used during the entire H7-1 growing season. By label restriction, the last application of glyphosate must occur at least 30 days prior to harvest (see sec. III.B.1.d.(4) of the FEIS). As described in the FEIS (sec. III.B.1.d), both glyphosate and non-glyphosate herbicides are typically only applied during the first 2 months of growth prior to canopy closure (about 4 months before harvest).

Comment: One commenter noted that species vary in sensitivity to drift levels of glyphosate and that the species used in EPA's tests to determine sensitivity to glyphosate may not adequately represent the range of responses found in wild species. (APHIS-2010-0047-4435)

Response: APHIS discusses the fact that species vary in sensitivity to glyphosate in section III.C.3.a of the FEIS. EPA, not APHIS, regulates herbicide use and potential impacts to nontarget organisms.

Comment: A commenter noted that formulations have not been assessed by APHIS for their impacts to non-target plant species. (APHIS-2010-0047-4435)

Response: APHIS considered the required phytotoxicity testing conducted in support of pesticide registration for each of the 13 herbicides analyzed in the FEIS, which includes formulated product testing on nontarget plants. APHIS is not aware of, and the commenter did not provide, a data set for phytotoxicity testing based on formulated products beyond those already reviewed by EPA.

Comment: One commenter noted that glyphosate drift from applications to GR crops happens when other plants are likely to be most vulnerable. The commenter supports the statement with (Lee *et al.*, 2005), a risk assessment based on agriculture in Fresno, CA. The commenter further stated, "So in spite of the non-volatile nature of glyphosate and label restrictions on application rate, droplet size, wind speed, equipment set up; with ground and air applications; drift injury does happen, and needs to be taken into account in assessing risk of increased glyphosate applications longer during the season to non-target plants." (APHIS-2010-0047-4435)

Response: APHIS acknowledged that drift from glyphosate could occur (see FEIS secs. III.C.3.b and IV.C.3.b). However, APHIS disagrees with the commenter that the drift scenario presented by (Lee *et al.*, 2005) represents a relevant case study for GR sugar beets. A wide variety of crops are grown year-round in Fresno, CA. Many of these varied crops use glyphosate, including GR cotton and non-GR crops, such as grapes, tomatoes, almonds, and oranges (figs. 30 and 31 in (Lee *et al.*, 2005)). Crops that could be impacted include alfalfa, sorghum, corn, onion, peppers, and rice. In the situation in Fresno, CA, where glyphosate is applied throughout the year and a wide diversity of crops are being grown, the window of opportunity for a nearby crop to be flowering during glyphosate application is high. In contrast, sugar beets are grown predominantly in the north, where they are among the first crops to be planted in the spring. Because herbicide applications are concentrated in the first 2 months of growth (typically April and May), they are completed by the time most nearby crops are flowering (an exception might be winter wheat).

Comment: One commenter noted that given the cryptic nature of important sublethal glyphosate effects and variations in sensitivity between species under different conditions, label restrictions may not be adequate to protect threatened and endangered plants, even if the farmers know that there are such species nearby and go to and follow the instructions on the Monsanto Pre-Serve Web site. In other words, the "legal precautions" represented by the EPA label use restrictions may not be adequate given new knowledge about glyphosate effects on non-target plants. (APHIS-2010-0047-4435)

Response: Herbicide use impacts on threatened and endangered (T&E) species are under the purview of EPA and are outside the scope of this EIS. APHIS' action does not affect EPA's regulation of the pesticide. EPA is currently considering the registration of glyphosate. As part of that assessment, they are conducting an assessment of T&E species.

Comment: One commenter noted that APHIS did not consider relevant research showing that changes in populations of rhizosphere microorganisms, including pathogens, that occur in RR crop systems where glyphosate is used post-emergence can increase the risk of diseases in subsequent crops. (APHIS-2010-0047-4435)

Response: APHIS has considered the research alluded to by the commenter and discusses this topic in section IV.C.2.b of the FEIS.

Comment: A commenter noted that APHIS does not consider the effects of glyphosate use on increased weediness of and gene flow between *Beta* varieties and species, citing papers by Londo et al. (Londo *et al.*, 2010; Londo *et al.*, 2011b; Londo *et al.*, 2011a) and Watrud et al. (Watrud *et al.*, 2011). (APHIS-2010-0047-4435)

Response: APHIS reviewed the four papers noted by the commenter and has incorporated relevant material as appropriate in the FEIS. APHIS noted that the observation that sublethal concentrations of glyphosate may delay flowering, reduce self-fertility, and thereby promote outcrossing (Londo *et al.*, 2011b) may have relevance to the likelihood of cross-pollination between wild beet and sugar beet in Imperial Valley, and it has introduced this discussion in the FEIS. However, APHIS does not consider that the scenario raised by (Londo *et al.*, 2011b) of increased gene flow between a canola crop and feral canola is relevant to gene flow between vegetable beet and sugar beet seed fields for the following four reason: (1) Glyphosate is generally not used in sugar beet seed fields because half the plants are sensitive (as described in sec. III.B.1). In order for an analogous situation to occur (i.e., mimic of drift onto a vegetable beet seed field), either the vegetable beet seed grower or a neighbor would need to use glyphosate at about the time that the vegetable beet plants were flowering. As there are few, if any, Roundup Ready® crops (including corn, soybean, canola, alfalfa, cotton, or sugar beet root crops) grown in the Willamette Valley, glyphosate use is expected to be low there (FEIS, fig. 5-3). (2) Vegetable beets are self-incompatible, so glyphosate exposure during flowering is not going to diminish self-fertility as would occur in *Brassica*. (3) Sugar beet seed and vegetable beet seed fields are miles apart, so cross-pollination is much less likely than between a crop plant and wild relatives or volunteers bordering a crop, as more commonly occurs with canola. (4) Feral populations of beets and sexually compatible species are not known to occur in the Willamette Valley where beet seed is produced. Elsewhere in the United States, cultivation of H7-1 sugar beet for root production occurs with little to no flowering and no proximity of sexually compatible species.

Comment: A commenter noted that even if the potential of the glyphosate tolerance trait moving from H7-1 to other sexually compatible *Beta* species in the United States is low, under glyphosate selection the trait will be selected and become common. Then these populations, unlikely to be detected and thus left uncontrolled, will increase the likelihood of gene flow in the future. In fact, *Brassica* populations with herbicide resistance traits have spread widely in unmanaged areas, without being controlled or monitored for over a decade. They are interbreeding, and even stacking different traits in combinations not found in agriculture (Schafer *et al.*, 2011)). Similarly, populations of wild cotton in Mexico have incorporated herbicide-resistance and other transgenes, also without being monitored or controlled for 15 years. (Watrud *et al.*, 2011; Wegier *et al.*, 2011)discuss this possibility for *Beta* species: "As cultivation of transgenic glyphosate-resistant sugar beet (*Beta vulgaris* L), which is a chenopod, increases in the United States, establishment of feral glyphosate-resistant sugar beet in disturbed habitats can be anticipated (Arnaud *et al.*, 2003; Fénart *et*

***al.*, 2007) and perhaps should be monitored for potential unintended ecological effects." (APHIS-2010-0047-4435)**

Response: APHIS disagrees with the following statement: "As cultivation of transgenic glyphosate-resistant sugar beet (*Beta vulgaris* L), which is a chenopod, increases in the United States, establishment of feral glyphosate-resistant sugar beet in disturbed habitats can be anticipated." To support their statement, (Watrud *et al.*, 2011) cite two papers on wild beet populations in Europe, (Arnaud *et al.*, 2003) and (Fénart *et al.*, 2007). In contrast to Europe, sexually compatible wild beet populations have failed to establish anywhere in the United States except California. In addition, feral populations of sugar beet have failed to establish anywhere in the United States. The speculation in (Watrud *et al.*, 2011) does not include a plausible reason for why wild or feral beet populations are now suddenly expected as a result of the cultivation of H7-1 sugar beet when such populations failed to appear after a century of conventional beet production. Where no wild populations exist, the scenarios discussed by (Schafer *et al.*, 2011; Wegier *et al.*, 2011) will not occur. In California, where wild beets do occur, the only remaining sugar beet-producing region is the Imperial Valley. In Imperial Valley, the climate is so hot and dry, wild beets only grow in cropland and irrigation ditches. APHIS discusses the likelihood of gene flow from sugar beet to wild beet in sections III.B.5 and IV.B.5 of the FEIS.

Comment: Should growers not be allowed to plant Roundup Ready sugar beet, weed control will have to be done using conventional herbicides that, when compared to glyphosate, are generally more harmful to wildlife, fish, humans and our environment.

Response: This comment is consistent with the analysis in the EIS.

Comment: Based on the crops produced where sugar beet is grown in North Dakota and Minnesota, there is no issue of cross-pollination since sugar beet and none of its relatives are grown for seeds in these states. In areas where beets or its relatives are grown for seeds, literature suggests that it will be unlikely for pollen from a foreign source to penetrate the pollen cloud and successfully pollinate an unintended crop especially when the isolation distances are followed. Further, the use of mainly (85%) cytoplasmic male sterile plants to carry the roundup resistance gene (H7-1 trait) will further reduce the possibility of accidental cross pollination and transfer of the H7-1 trait.

Response: This comment is consistent with analysis in the EIS.

Comment: Because sugar beet are slow to emerge and develop a canopy, early season weed competition can result in significant yield reductions (Wilson *et al.*, 2001)Therefore, sugar beet growers have learned to rely on two important weed management techniques: 1) apply postemergence herbicides when weeds are less than two inches tall, and, 2) to retreat at weekly intervals until weeds die and the canopy can provide weed control. Failure to follow these parameters results in crop yield reductions or added costs for hand labor to remove weed escapes (Kniss, 2010; Wilson *et al.*, 2011).

Growers relied on treating sugar beet early and often with conventional herbicides, these principles also proved to be effective when growers began using glyphosate. Early weed control experiments with glyphosate demonstrated that treating small weeds was more effective than treating 10-inch weeds, and, that applying two applications of glyphosate at two week intervals improved common lambsquarters and pigweed control over that achieved with a single glyphosate application or two applications extended over a four

week interval (Wilson Jr *et al.*, 2002). Growers have demonstrated that the concept of treating small weeds and treating often until sugar beets develop a canopy prevents weeds from shading the crop. In addition, weeds that may have been injured with a single application of glyphosate can usually be killed when a second treatment follows in two weeks. Postemergence applications of glyphosate have not injured the sugar beet plant, which has resulted in faster canopy development while conventional herbicides caused injury that stunted the crop and increased the time from emergence until row closure. Therefore, most sugar beet growers have found they can achieve excellent weed control with two timely applications of glyphosate.

In contrast, the micro-rate herbicide "cocktail" of conventional herbicides associated with weed control techniques for conventional sugarbeets required grower perseverance and patience, and presents many downsides in weed control compared to glyphosate-resistant sugarbeet. The cocktail used by most growers consists of a combination of Betamix, UpBeet, Stinger and methylated seed oil adjuvant. For the cocktail to work effectively, herbicides had to be applied sequentially with the first application beginning as soon as weeds began to emerge and were one inch or less. Weeds injured, but not killed by the first treatment, needed to be treated in five to seven days or they would recover and become a weed escape. In addition, a second flush of weeds would emerge and require the initial herbicide treatment to be applied again. This process could continue for four to six weeks and require three to four herbicide applications. If there was sufficient wind or rain to delay treatments, weed control suffered.

Most growers utilized specialized band sprayers to apply a seven to ten inch band of spray over the crop row; sprayers could cover 12 to 24 rows and travel at speeds of four to five mph. In comparison, glyphosate is applied as a broadcast spray with sprayers that cover 40 to 60 feet and can travel at five to 10 mph.

The effects of the conventional cocktail to sugarbeet was influenced by air, temperature and sunlight. If growers applied the cocktail in the early morning and midday temperatures rose to above 80º to 90º F, severe crop injury could occur. To avoid injury, growers started spraying in the late afternoon when air temperatures began to decline. Therefore, a grower farming several hundred acres of sugarbeets would spend most of their afternoons and evenings during May and June spraying sugarbeets. With glyphosate, the time spent spraying sugarbeets declined dramatically. In addition, glyphosate can be applied in the morning when temperatures are cooler, winds generally calm, and weeds are more susceptible to herbicide uptake, without concerns of later day weather. Growers using the conventional weed control had to take special precautions for the variability of weather and spend more time and resources in application of these less environmentally-friendly herbicides. Growers would find it difficult and expensive to return to this outdated technology

Growers have strong economic incentives to utilize properly their glyphosate-resistant sugar beet cropping systems, and their actions reflect this. Sugar beet growers and processors have established funds to support research and extension activities on weed resistance. Western Sugar Cooperative sponsors grower meetings at multiple locations in their growing regions to provide every grower the opportunity to discuss industry issues and learn about new research developments. Researchers from Colorado, Nebraska, and Wyoming, in cooperation with Monsanto, are developing region-specific technology usage

guides to address weed management in cropping rotations that include sugar beet. Guides will provide regional and weed specific (kochia, common lambsquarters and pigweed) recommendations for corn, small grains, dry beans, and sugar beet, therefore enhancing the benefits of crop and herbicide rotations.

The Benchmark Study was conducted over a four-year period on 155 farms, across six states, with a minimum of 40 acres per farm. Results from this study demonstrated two important concepts in regard to glyphosate-resistant (GR) crops (Wilson Jr, 2009). First, weed control is improved by rotating GR crops, compared to continuous cropping of GR cotton and soybean. Second, weed management is improved by adding a herbicide at planting with a different mode of action than glyphosate, or by combining glyphosate applied postemergence with another herbicide.

The results from the Benchmark Study clearly relate to sugar beet. Even when sugar beet are grown in rotations that include other GR crops, the rotations usually contain non-GR crops that introduce herbicides with different modes of action. In GR crops, growers are progressing from only using glyphosate and are applying conventional preemergence herbicides at planting and mixing other herbicides with glyphosate when the herbicide is applied postemergence. This all points to the conclusion that GR sugar beet are sustainable with crop rotation and utilization of herbicides with different modes of action than glyphosate. These techniques also reduce the potential for weeds becoming resistant to glyphosate (Wilson Jr, 2009).

In the EA, APHIS fails to address the ramification of Alternative 1 on sugar beet growers' ability to participate in NRCS-sponsored programs.

Extensive early season preplant tillage associated with conventional sugar beet production has resulted in wind and water erosion in many sugar beet growing regions. During the 2002 growing season in Idaho and the 2007 growing season in Nebraska and Wyoming, 25 to 35% of the sugar beet acreage was replanted due to wind erosion and lack of soil moisture.

Approval of H7-1 sugar beet has allowed sugar beet growers to change their tillage practices over the past two years. Growers have reduced preplant tillage and moved to cropping systems that incorporate no-tillage, strip-tillage, and planting into small grain cover crops. The movement away from preplant tillage which contributes to soil erosion and loss of soil moisture has allowed sugar beet growers to meet specific conservation requirements in NRCS programs. Growers who participate in NRCS programs are required to develop a conservation plan for their farms that must be approved by NRCS. Growers have designed their plans around the utilization of H7-1 sugar beet and subsequent use of glyphosate for weed control which has allowed for a reduction in tillage.

If sugar beet growers are required to revert to conventional sugar beet herbicides, preplant tillage will be needed for herbicide (Nortron or RoNeet) incorporation and growers risk failing to meet the NRCS requirements in their conservation plan. Without an approved conservation plan, growers risk losing conservation compliance and eligibility for commodity, conservation, and disaster payments (2008 Farm Act). (APHIS-2010-0047-3850)

Response: APHIS has reviewed the information provided by the commenter and included it in the FEIS in sections III.B.1.c and IV. B.1.c, as appropriate.

Comment: A significant finding of the benchmark study on glyphosate-resistance management, in which I (Robert Wilson) was involved as a principal researcher, was the integration of soil residual herbicides preemergence to the planting of the GR crops (Wilson *et al.*, 2011). Residual herbicide use in GR corn, cotton and soybean has been the primary academic recommendation to provide improved consistency of weed management, especially early-season control to deter the evolution of GR weed species.

For sugar beets, cycloate, EPTC, ethofumesate, dimethenamid-P, S-metolachlor, and pyrazon provide soil residual properties. The most widely used soil residual herbicide in sugarbeet is ethofumesate, which can be applied at the time of planting and may be positioned in soil with rainfall or irrigation to provide control of pigweeds, lambsquarters, nightshade and kochia.

Ethofumesate is an important tool available to sugar beet growers for GR weed management. Recent experiments conducted by (Wilson Jr and Sbatella, 2011) demonstrate its utility for late-season weed control in GR sugar beet. Sugar beet growers can provide diverse GR weed management by utilizing a herbicide at planting with soil residual characteristics, followed by tank mixtures of postemergence herbicides with different modes of action after weed emergence.

I would like to reiterate that herbicide-resistance does not eliminate a herbicide's usefulness. Two GR weeds have been reported in Nebraska, horseweed and giant ragweed. Yet, over 10,000,000 acres of GR crops were planted in Nebraska in 2010 and treated with glyphosate. Growers continue to find value in the technology by managing weeds using herbicides with multiple modes of action, crop rotation and tillage. (APHIS-2010-0047-3850)

Response: APHIS concurs and has reached the same conclusion. (Wilson Jr and Sbatella, 2011) is reviewed and discussed in the FEIS.

Comment: The DEIS also mentions the potential for wild beets to crossbreed with H7-1 beets in California, but says that more studies are needed to determine what those effects might be. APHIS needs to conduct those studies before deregulating H7-1 beets. Without further explanation, APHIS cannot abandon the issue of wild beet contamination with its conclusion that "no gene flow is expected to occur from H7-1 sugar beets to wild beets."

Response: APHIS did not conclude in the DEIS that more studies are needed to determine what effects might be if wild beets were to cross-breed with H7-1. APHIS thoroughly analyzed the available data, and is confident in its conclusion that no gene flow is expected to occur to *B. macrocarpa* (see sec. IV.B.5 of the FEIS). Furthermore, APHIS has discussed what the effects might be in the remote chance that introgression of the H7-1 trait does occur into *B. macrocarpa or B. maritima* (see sec. IV.B.5 of the FEIS).

On July 7, 2011, Don Huber, Professor Emeritus Purdue University, met with Catherine Wotecki, USDA Under Secretary for Research Education, and Economics; Gregory Parham, USDA-APHIS Administrator; and Dr. Steven Kapps, Senior Advisor for Animal Protection and Production in the Office of the Chief Scientist. During the meeting, Dr. Huber raised a number of concerns with the use of glyphosate and GR crops and further articulated his concerns in a letter dated July 31, 2011. APHIS is using this response to comment on the sugar beet EIS to respond to the issues raised by Dr. Huber that pertain to H7-1 sugar beet, as noted below:

Comment: The current crop and animal production environment is NOT normal and NOT sustainable! We are experiencing an escalating incidence of crop, animal, and human diseases, the emergence and reemergence of diseases once rare or under practical control, and new diseases previously unknown to science. There are published scientific studies documenting the intensification, and sometimes direct relationship, of these situations to genetically engineered (GMO) crops and/or the products they were engineered to tolerate. The wide spread epidemics experienced in recent years of Fusarium root rot and head blight of cereals, take-all of cereals, stalk rot and ear rots of com, sudden death syndrome of soybeans, high mycotoxin levels in crops, and an increase in numerous other plant diseases are just a few examples of debilitating conditions recently experienced in production agriculture (Fernandez et al, 2005, 2007, 2008, 2009; Johal and Huber, 2009; US Wheat and Barley Scab Initiative, 2009, 2010). I am receiving reports of the wide-spread incidence of Goss' wilt of corn for the third year in a row.

The previously unknown cause of reproductive problems threatening the viability of animal production, presented by the American Cattlemen's Association on July 24, 2001 to the Senate Agriculture Committee (Anonymous, 2002), is consistent with information on and characteristics of the 'newly' recognized electron microscopic sized organism and the impact of glyphosate and GMO crops that are becoming much clearer. The recent Indian Supreme Court finding (AgroNews, 2011) that commercial data submitted on the safety of genetically modified crops failed to meet internationally accepted standards for toxicological assessment highlights the need for independent, objective evaluation of this program for pest control. Although there is a significant body of critical research that has not been conducted in this regard, there is a growing list of scientific, peer-reviewed papers documenting serious safety issues with glyphosate at levels many times lower than permitted in the foods we consume and feeds fed our animals that are consistent with animal and human health and disease issues that are documented in practice (Antoniou et al, 2010, 2011; Aris and Leblanc, 2011; Benachour et al, 2007; Chainark, 2008; EFSA, 2007; Gasnier et al, 2009, 2010; Mazza et al, 2005; Paganelli et al, 2010; Pusztai and Bardocz, 2007, 2010; Ran et al, 2009; Schefers, 2011; Schubbert, et al, 1998; Seralini et al, 2009, 2010, 2011; Sharma et al, 2006; Tudisco et al, 2010; de Vendomois et al, 2009; Walsh et al, 2000)."

Glyphosate is a strong metal chelator that immobilizes essential plant nutrient elements (Bernards et al, 2005; Glass, 1984; Jolley et al, 2004; Lundager-Madsen et al, 1978; Martell and Smith, 1974; Motekaitis and Martell, 1985; Nilsson, 1985; Ptaszynski and Zwolinska, 2001; U.S. Patent Office, 1964) to reduce physiological efficiency and increase susceptibility of plants to disease (Bramhall and Higgins, 1988; Ganson and Jensen, 1988; Hornby et al, 1998; Keen et al, 1982; Johal and Rahe, 1984, 1988, 1990; Johal and Huber, 2009).

This broad-spectrum herbicide is also a very strong, but selective, biocide that inhibits and is toxic to many beneficial soil microorganisms responsible for plant nutrition and natural disease control, while stimulating soilborne plant pathogens and their synergists (Boyette,

et al, 2006; Dick and Lorenz, 2006; Fernandez et al, 2005, 2006, 2008, 2009; Huber and McCay-Buis, 1993; Huber et al, 2005; Huber, 2010; Kremer and Means. 2009; Kremer et al, 2000, 2005; Lanen et al, 2009; Larson et al, 2006; Levesque and Rahe, 1992, 1993; Levesque et al, 1987; Liu et al, 1995, 1997; Lorenz et al, 2008, 2009; Means et al, 2007; Mekwatanakarn and Sivasithamparam, 1987; Motavalli et at, 2004; Sanogo et al, 2000, 2001; Smiley et al, 1992; Yang, 2010; Zobiole et al, 2010).

Mineral nutrients function in plant metabolism and as plant constituents, and there is a close relationship of mineral nutrient sufficiency with disease resistance (Datnoff et al, 2007; Englehard, 1989; Huber, 1980; Huber and McCay-Buis, 1993; Huber and Haneklaus, 2007; Johal and Huber, 2009). As a strong micronutrient chelator, glyphosate reduces the physiological efficiency, uptake, and translocation of manganese and other essential nutrients in the plant and seed (Bellaloui et al, 2009; Cakmak et al, 2009; Gordon, 2007; Eker et al, 2006).

It is the strong chelating ability of glyphosate that makes it a broad-spectrum herbicide by inhibiting enzymes such as EPSPS in the shikimate pathway and other enzymes (Ganson and Jensen, 1998) that are important for plant resistance to soilborne pathogens (Rahe et al, 1990; Schafer et al, 2009, 2010). Thus, glyphosate's herbicidal mode of action is through increased disease susceptibility (Rahe and Johal, 1984, 1988; Rahe et al, 1990; Schaffer et al, 2009, 2010). Genetically engineered plants that are tolerant of glyphosate contain the bacterial EPSPS-II gene and various other genes to maintain some tolerance to the soilborne fungal pathogens that kill normal plants.

Plants genetically engineered to contain the EPSPS-II bacterial gene are less efficient in the uptake and utilization of micronutrients even in the absence glyphosate that adds an additional stress on the plant and produces a 'yield drag' (Benbrook, 1999; Dodds et al, 2002; Gordon, 2006, 2007; Zobiole et al 2010e). Since there is nothing in the glyphosate-tolerant plant that affects the chelation of micronutrients by glyphosate, the application of glyphosate also reduces the uptake, utilization, and bioavailability of micronutrients to impair photosynthesis, water use efficiency, amino acid metabolism, nodulation, nitrogen fixation, and nutrient value of Roundup Ready® plants (Hernandez et al, 1999; King et al, 2001; Purcell et al, 2000, 2001; Reddy et al, 2000; Zobiole et al, 2010a, b, c, d, e, f, g, h, 2011a, b, c).

Glyphosate is systemic in the plant, accumulates in meristematic tissues (growth points and reproductive structures), and is exuded from roots into the soil to damage adjacent or subsequent crops (Coupland and Caseley, 1979; Kremer et al, 2005; Reddy et al, 2003, 2004; Rodrigues et al, 1982). The strong chelating ability of glyphosate with mineral nutrients, and absorption in clay lattices (Farenhorst et al, 2009), inactivates glyphosate in most soils; however, this chelating detoxification may take several days or weeks and the chelated compound may persist in soil for a considerable time to be desorbed later as an active compound damaging to plants and microbes. The French Supreme Court ruled in 2009 that claims of biodegradation of glyphosate (as contained in the U.S. label) constituted fraud.

Glyphosate residues in seed and plant tissues significantly damage seed germination and subsequent plant growth (Barker, 2010) as well as produce a toxicological hazard for animals and humans (Antoniou et al, 2010. 2011; Benachour et al, 2007; Chainark, 2008; EFSA, 2007; Gasnier et al, 2009, 2010; Mazza et al, 2005; Paganelli et al, 201 0; Pusztai and Bardocz, 2007, 2010; Ran et al, 2009; Schefers, 2011; Schubbert, et al, 1998, Seralini et at, 2009,2010, 2011; Sharma et al, 2006; Tudisco et al, 2010; de Vendomois et al, 2009; Walsh et al, 2000). Dr. Hanna Mathers, Ohio State University, has documented that glyphosate can accumulate in perennial plants for years. Glyphosate can drift during application and soil residues can be desorbed and damage adjacent or subsequent crops in the rotation at extremely low concentrations (Bott et al, 2011; Eker et al, 2006; Farenhorst et al,2009; Laitinen et al, 2005; Neumann et al, 2006; Tesfamariam et al, 2009).

Mineral nutrients are not only essential for plant growth and function, but plants are also the source of minerals essential for animal and human nutrition. Glyphosate significantly reduces the content and bioavailability of mineral nutrients in feed and food (Bellaloui et al, 2009; Bott et al, 2008; Cakmak et al, 2009; Gordon, 2006; Zobiole et al, 2010b, d, g) to create functional mineral deficiencies in plants, animals and people fed the low mineral-available plant constituents. Glyphosate residues in feed and food products could also directly reduce mineral bioavailability on ingestion of this strong mineral chelator (Barker, 2010). Transmission of the gene from feed to animals is a well-documented phenomena with unknown consequences (Brown, 2000; Chainark, 2008; EFSA, 2007; McAfee, 2003; Pusztai and Bardocz, 2007, 2010; Ran et al, 2009; Schubbert et al, 1998, Seralini et al, 2009, 2010, 2011; Sharma et al, 2006; Tudisco et al, 2010). Thus, residual glyphosate in seed, and gene transfer (flow) in feed, food, and the environment constitute serious production and toxicological concerns for food and feed safety.

There has been a growing incidence of disease in animal production programs (especially cattle, dairy, and swine) associated with low manganese or other micronutrients. Manganese is essential for proper liver function and deficiencies are associated with increased infectious diseases in general, bone and tissue deformities, reproductive failure, and death (Dunham, 2010). Cakmak (2009) reported a 45% reduction of manganese, iron, and other essential nutrients in Roundup Ready soybean seed when plants were treated with glyphosate. The reduced bioavailability and content of manganese and other micronutrients in feed and food grown under glyphosate weed control programs has led to an increased need for mineral supplementation in animal rations. Veterinarians have documented manganese deficiency in new beef and dairy herds this year in Northern Iowa even though educational programs have been alerting producers to the increased need for supplementation. Loss estimates of dairy replacement heifers at birth are now 8-11 %, with the primary cause generally attributed to poor manganese uptake or excess selenium (Dunham, 2011; Schefers, 2011).

There is a serious lack of research on effects of glyphosate (Roundup®) on production, diseases, nutritive value or chemical residues with Roundup Ready alfalfa. Glyphosate is known to affect all of these factors negatively. Alfalfa, a legume, is our fourth most important agricultural crop and is produced in all of the states; however, it's profitable production is dependent on efficient fixation of atmospheric nitrogen through e symbiotic relationship with soil bacteria (Rhizobiaceae) and genetic resistance to another plant

pathogenic bacterium, *Clavibacter michiganense insidiosum*. A general decline in nitrogen fixation of beans, lentils, peas, and soybeans has been observed since the introduction of glyphosate herbicide. The application of glyphosate to leguminous plants inhibits nitrogen fixation in two ways: 1) glyphosate translocated to weed or RR crop root tissues and in root exudates is toxic to the *Bradyrhizobium*, *Rhizobium*, and other soil-borne bacterial species in the soil that are associated with root tissues that synergistically fix nitrogen for the plant to use physiologically for amino acid and protein synthesis (Zablotowicz and Reddy, 2007; Zobiole et al, 2010 a, h, 2011) and 2) by physiologically immobilizing both nickel and manganese in root tissues that are required by the bacterial and plant enzymes involved in nitrogen fixation (Purcell et al, 2000; Purcell, 2001; Zobiole et al, 2010a, b, 2011). A consequence of reduced nitrogen fixation is lower production efficiency and low nutritive value (amino acid and protein content) for animal or human food. Reduced N, P, K, Ca, Mg, S, B, Cu, Fe, Mn, and Zn have been found in Roundup Ready alfalfa compared with normal alfalfa, and lower nutrient content of soybeans and corn are also reported (Bellaloui et al, 2009; Bott et al, 2008; Cakmak et al, 2009; Eker et al, 2009; Gordon. 2006; Ozturk et al, 2008; Zobiole et al, 2010b, d, g) to contribute to the increased disease, infertility, and reproductive failure in animals that is being commonly observed unless supplemental minerals are supplied in the ration to compensate for the reduced levels in crops produced under glyphosate and or GMO weed management practices .

Profitable alfalfa production was very limited until genetic resistance to the wide-spread *Clavibacter michiganense insidiosum* causing bacterial wilt was developed. This organism occurs world-wide and is an extremely damaging pathogen of non-resistant alfalfa. Research in 2009 and 2010 demonstrated the loss of genetic resistance of Roundup Ready corn hybrids to Goss' wilt (*Clavibacter michiganense nebraskensis*), a very closely related bacterium and disease to alfalfa bacterial wilt, when the surfactant or glyphosate formulations were applied directly to the plant. Goss' wilt, a previously very localized and limited disease, has occurred in epidemic proportions in wide-spread areas of the Midwest the past two years and has already been diagnosed in broad areas of Iowa this year. The loss of genetic disease resistance, productivity, and reduced nutrient value could strike a mortal blow to struggling U.S. dairy and beef operations dependent on this most valuable forage for herbivores. The newly recognized electron microscopic-sized organism causing reproductive failure in animals has been prolific in Goss' wilt infected corn to raise serious concerns for the safety of glyphosate treated Roundup Ready® alfalfa.

New electron microscopic-sized 'organism' causing infertility and miscarriage in animals.

There has been a noticeable increase in reproductive failure and fetal losses in the Midwestern U.S. since 1998-2000, just a few years after the introduction of Roundup Ready® crops and the subsequent increase in glyphosate useage and exposure. This entity was only discovered after exhaustive searches for the cause of infertility, pseudopregnancies, and miscarriage (spontaneous abortions) that could not be attributed to any other known cause of these reproductive failures in animals. It now threatens the viability of cattle, dairy, equine, swine, and poultry production (Anonymous, 2000; Scheffeer, 2011). It is estimated that as high as 10-11 % of producers are experiencing this problem with some being forced into bankruptcy or switching to crop production because of it. The frequency of reproductive failure is increasing in all animal species.

After ruling out all previously known causes of reproductive failure, and a thorough and exhaustive search for the etiologic agent, a very small suspect agent was identified in 1998 in aborted placenta and fetal tissue with an electron microscope at 38,000 X magnification. The organism was eventually isolated and cultured on a defined agar medium – initially in conjunction with larger microorganisms such as gram positive bacteria – and later in pure culture. Pure culture inoculum was then used to test Koch's postulates to establish this organism as the etiologic agent causing reproductive failure. It can prevent pregnancy, kill a fertilized egg early to produce a pseudopregnancy, or induce a mid- to late term miscarriage later in pregnancy. Injection into a fertilized chicken egg for instance, kills the developing embryo within 24-48 hours. Detailed examination of aborted (miscarried) fetuses and placenta for the newly recognized organism has shown its presence in all of the cases examined to date. In animals, it has been identified in placental tissue, amniotic fluid, fetal tissue, stomach contents, semen, eggs, manure of several animal species, and milk from dairies feeding distillers protein.

An intense search for the inoculum source for animal infection led the scientists to soybean meal in the animal ration as a major source of the organism. It occurs in high populations in soybeans -, especially if infected with sudden death syndrome (SDS) caused by the soilborne fungal plant pathogen, *Fusarium solani* fsp. *glycines*. The organism has been identified in the mycelium of this *Fusarium* species that infects the roots of soybean plants, and subsequently in leaves and seed of plants symptomatic for SDS. The organism has been observed in soil; fungal mycelia; soybean leaves, seed and meal; various corn tissues – especially those with Goss' wilt; distillers meal; and fermentation feed products (corn silage, haylege, wheatlage, etc.). The 'new' organism is in very low concentrations or absent from the non-GMO plants and grain samples evaluated to date. Animal miscarriages have been identified from lA, IL, KY, MI, MO, NE, ND, SD, and WI.

Characteristics of the 'organism:'

The organism is very small and is seen only with a transmission or scanning electron microscope at 25,000-50,000 magnification. It is pleomorphic depending on the media and environment, varying from small spore-like entities to filamentous growths appearing to originate from the somewhat small spherical bodies. Cultural characteristics under the EM resemble mold growth with filamentous and spore-like growths produced. It can be cultured on defined agar media and produces both general forms of growth depending on the media and environment. High energy X-ray analysis (XRF and XANES mapping) of concentrated growth removed from an agar media surface showed a generally uniform mineral composition consisting of (in decreasing order) iron, zinc, potassium, manganese, and a small amount of calcium generally evenly distributed throughout the amorphous mass analyzed, typical of living material. This 'organism' does not appear to 'fit' into any of the known taxons although we are awaiting results from molecular sequencing and other analyses for this purpose.

Potential interactions of the 'new' organism with glyphosate:
Increased severity of plant diseases after glyphosate is applied is well documented and, although rarely cited, increased disease susceptibility is the herbicidal mode of action of glyphosate (Johal and Rahe, 1988, 1990; Johal and Huber, 2009; Schafer et al, 2009, 2010).

The loss of disease resistance in Roundup Ready®sugar beets when glyphosate was applied prompted researchers at the USDA sugar beet laboratory to include a precautionary statement in their paper, e.g. "Precautions need to be taken when certain soil-borne diseases are present if weed management for sugar beet is to include post-emergence glyphosate treatments" (Larson et al, 2006). Increased disease severity is documented from glyphosate applied 2-3 years previous to planting a cereal crop (Fernandez et al, 2005, 2007, 2009). Glyphosate also increases the severity of *Fusarium* diseases in other crops in the rotation (Fernandez et al, 2008).

Severe epidemics have occurred the past few years on our three major crops: wheat (take-all root and crown rot, Fusarium root and crown rot, Fusarium head blight and high mycotoxin concentrations), corn (Goss' wilt, Gibberella stalk rot, high mycotoxin concentrations), and soybean (sudden death syndrome -or SDS and Fusarium root rot) where weather conditions were favorable for disease. These diseases were especially pronounced under glyphosate weed management practices and/or with GMO crops. Many producers are finding that production of their primary crops has become unprofitable because of high disease incidence, yet there were isolated fields of non-GMO and non-glyphosate management within all of these epidemic areas where plants remained healthy and productive. These healthy fields had the same rainfall, temperature, and soil conditions as those adjacent to severely diseased fields where GMO or glyphosate management practices were used.

Although most com hybrids have been genetically resistant to Goss' wilt, preliminary research in 2010 demonstrated that the application of glyphosate herbicide or surfactants nullified this resistance and rendered them fully susceptible to this pathogen. This disease was commonly observed in many Midwestern U.S. fields planted to RR corn in 2009 and 2010, while adjacent non-GMO com with the same temperature, moisture and soil conditions had very light to no infections in spite of the high inoculum present in no-till crop residues. Severe infection by Goss' wilt is already reported from wide-spread areas of the Midwest this year. The increased Goss' wilt in 2010 was a major contributor to the estimated almost one billion bushels of com 'lost' last year (based on USDA August estimated yields and actually harvested crop reported by USDA in January) in spite of generally good harvest conditions.

The excessive use of glyphosate, encouraged by RR crops and further development of glyphosate-resistant weeds (Gaines et al, 2010; Johnson et al, 2009), is a major contributor to the increased severity and epidemics of plant and animal diseases, reduced nutrient quality, high mycotoxin levels, and toxic chemical residues we are experiencing in production agriculture. The glyphosate-GMO-weed management system has not been adequately researched for safety, equivalency, or sustainability (Brown, 2000; McAfee, 2003)."

Response: APHIS carefully examined the concern that glyphosate reduces the uptake, translocation, and utilization of essential mineral nutrients, particularly manganese, in both tolerant and non-tolerant plants and seeds. Although a decrease in various mineral nutrients does not in itself constitute harm to plants, APHIS found that studies examining the levels of iron, manganese, and zinc in glyphosate-treated plants have generated conflicting results. There are fewer studies examining other micronutrients; these studies have similarly generated conflicting results. In some cases, deficits in one or more of these minerals were observed in glyphosate-treated plants, while in other cases deficits were not observed (in addition to the studies cited in the letter, see (Ebelhar *et al.*, 2007) and (Rosolem *et al.*, 2009)). Many of the studies that found mineral deficits measured mineral content shortly after the plants were treated with glyphosate and did not determine whether mineral levels recovered over time. Two greenhouse studies reported a reduction in manganese levels in seed of glyphosate-tolerant and non-tolerant soybeans treated with glyphosate many weeks earlier at the full or 1 percent of the typical label rate, respectively (Cakmak *et al.*, 2009; Zobiole *et al.*, 2010). Importantly, results of greenhouse studies may not reflect actual field situations. Indeed, two separate field studies have found no reduction in manganese levels after glyphosate-tolerant soybeans were treated with glyphosate at standard label rates (Ebelhar *et al.*, 2007), (Vyn *et al.*, 2010)). A third field study found a reduction in iron levels in seeds of non-tolerant soybeans treated with glyphosate at one-eighth typical label rate; the extent of reduction decreased as the time since treatment increased, and reduced exposure to glyphosate had no effect on the non-tolerant soybean yield (Bellaloui *et al.*, 2009). APHIS is not aware of any studies that demonstrate deficits in mineral nutrients in glyphosate-tolerant alfalfa, and none of the references provided by Dr. Huber report such studies. In summary, the currently available evidence does not support the conclusion that exposure to glyphosate leads to meaningful decreases in manganese or other mineral content in glyphosate-tolerant or non-tolerant plants.

Regarding concerns about relationships between glyphosate, glyphosate-tolerant plants, and increased incidence or severity of various plant diseases, exposure to glyphosate—like exposure to other herbicides—can increase the susceptibility in non-tolerant plants to disease. The weight of evidence indicates that glyphosate likely does not cause increased disease susceptibility in glyphosate-tolerant plants. While initial studies in the greenhouse did indicate that glyphosate-tolerant sugar beets might be more susceptible to root rot (Larson *et al.*, 2006), no such increased susceptibility was observed in subsequent field studies (Larson, 2010). The suggestion that there has been an increased incidence of specific diseases of wheat, corn, and soybean over the last few years, and that this increase is associated with glyphosate-tolerant crops and/or the use of glyphosate management practices is not supported by the data and references noted in the Huber letter. Our assessment of the studies referenced on non-tolerant wheat and barley production agrees with the assessment of the authors (Fernandez *et al.*, 2005; Fernandez *et al.*, 2009); the association they observed between previous glyphosate use and Fusarium Head Blight in these crops is very small and the data do not establish a cause-effect relationship between glyphosate use and plant disease. A more recent study specifically designed to test for such a relationship found no increase in disease in non-tolerant wheat or barley grown in rotation after glyphosate-tolerant soybeans that had been treated with glyphosate (Berube *et al.*, 2012). In sum, the weight of currently available evidence does not indicate that glyphosate treatment leads to greater disease in glyphosate-tolerant crops or in subsequent non-tolerant crops planted in rotation.

The concern that glyphosate use leads to reductions in nodulation and nitrogen fixation in glyphosate-tolerant legumes is also not supported by the weight of evidence. While laboratory studies indicate that the growth of certain nitrogen-fixing bacteria is inhibited by glyphosate and initial greenhouse studies demonstrated reductions in nodule number and/or mass per plant in glyphosate treated as compared to untreated glyphosate-tolerant soybeans, the observed reductions were neither strong nor consistent and in many cases were accompanied by decreases in root and/or shoot mass such that there was no difference in nodulation when normalized to mass. Moreover, more recent studies in both the greenhouse and the field have found no or only minor reductions in nodulation or nitrogen accumulation in glyphosate-tolerant soybeans treated with glyphosate (Reddy and Zablotowicz, 2003; Zablotowicz and Reddy, 2007; Bellaloui *et al.*, 2008; Bohm *et al.*, 2009; Powell *et al.*, 2009). When minor reductions in nitrogen content did occur after treatment with typical label rates of glyphosate, there was no negative effect on yield. APHIS could find no support for the statement that there has been a general decline in nitrogen fixation in leguminous plants since the introduction of glyphosate as an herbicide.

Dr. Huber raised a number of concerns about negative effects on animal health resulting from the use of glyphosate and/or glyphosate-tolerant crops in production agriculture. First, it was mentioned that reduced mineral levels in feed derived from plants exposed to glyphosate, particularly reduced manganese levels, create "functional mineral deficiencies" in animals unless supplemental minerals are provided. Dr. Huber stated that these mineral deficiencies contribute to increased disease, infertility, reproductive failures, and developmental deformities in animals. Mineral deficiencies are known to result in the types of problems described. Indeed, mineral deficiencies in feed, including manganese deficiency in soy- and corn-based feeds, have been known for many years prior to the widespread use of glyphosate (Scheffers, 2011). As noted, problems created by such deficiencies can be corrected by providing supplemental minerals in the feed. Moreover, as discussed above, the weight of evidence does not support the conclusion that glyphosate use is resulting in mineral deficiencies in glyphosate-tolerant or non-tolerant plants that are used for animal feed. Second, it was stated that glyphosate residues in food and feed products could directly reduce mineral bioavailability upon ingestion. APHIS could not find, and Dr. Huber did not provide, any evidence to support this statement. Third, it was stated that glyphosate residues in seed and plant tissue produce toxicological hazards for animals and humans. EPA has determined that glyphosate may be classified as either a Category III (slightly toxic) or Category IV (practically nontoxic) substance and is of low acute toxicity by oral, dermal, inhalation, and ocular routes of exposure (U.S. EPA 1993). In EPA's most recent human health dietary risk assessment, an acute analysis was not conducted for lack of an acute toxicity endpoint, and chronic dietary risks were not of concern. EPA has also classified glyphosate as not likely to be a human carcinogen. EPA's most recent ecological analysis has also shown glyphosate to be of low risk to birds, mammals, terrestrial invertebrates, and aquatic organisms. EPA is currently re-evaluating risks from glyphosate to humans and the environment as part of its registration review of glyphosate (US EPA, 2009). Fourth, regarding the concern about potential negative consequences of gene transfer from feed to animals, APHIS and the U.S. Food and Drug Administration (FDA) have previously addressed this issue (e.g., (FDA, 1998; USDA-APHIS, 2009)).

Dr. Huber raises a specific concern about an association between the introduction of glyphosate-tolerant crops and the emergence of a newly identified pathogen that can cause infertility and miscarriage in animals. It was implied that the organism is highly associated with GE glyphosate-tolerant crops, especially when they are infected with other pathogens. Although the letter includes a number of summary statements and conclusions, APHIS was not provided with any actual data concerning this alleged pathogen nor even the names of any scientists involved in its study. APHIS can make no conclusions about the existence of this organism, its distribution, its association with GE crops including glyphosate-tolerant crops, or its effects on animals in the absence of actual data. APHIS welcomes the opportunity to review and evaluate any documented data concerning the referenced microorganism, particularly: methods and results of diagnostic tests and histological examinations of sample materials; data establishing that the organism is an infectious agent and establishing its effects on animals; and epidemiological or ecological data that identify plant hosts, exposure pathways, distribution, and history associated with the organism sufficient to establish causal links between glyphosate-tolerant crops and the presence of the organism in plants and plant products.

In addition, Dr. Huber raises the concern that glyphosate applied to glyphosate-tolerant crops can, at low concentrations, cause damage to adjacent non-tolerant crops or to subsequent crops grown on the same land. It was stated that glyphosate could be exuded from the roots of treated plants into soil, and then be taken up by the roots of adjacent plants. Glyphosate exudation from the roots of treated plants is well established. However, in the experiments cited by Dr. Huber, the non-tolerant plants were located inches away from the treated plants. This situation is not relevant to most agricultural contexts, and glyphosate application would be precluded if a non-tolerant crop is closely interplanted with a tolerant crop.

Dr. Huber also states that glyphosate can persist in the soil and later be desorbed from soil particles and taken up by plant roots and, in this way, could provide a mechanism by which subsequent crops might be exposed to low levels of glyphosate. APHIS carefully considered this route of exposure. Experimental data indicate that glyphosate residues can be desorbed from soil, particularly if phosphorus fertilizer is added to the soil. Not unexpectedly, as noted above, research also indicates that low-level exposure to glyphosate can have adverse effects on non-tolerant plants. However, the amount of glyphosate that would become available to plants via desorption from the soil will vary widely from one location to another, depending on factors such as time since application and soil characteristics such as pH and microbial activity (Borggaard and Gimsing, 2008). It is not clear that soil desorption would result in the exposure of subsequent non-tolerant crops to levels of glyphosate sufficient to cause harm. Moreover, should there be locations where glyphosate persistence and remobilization may pose a problem, proper crop choice and management practices can alleviate potential damage. APHIS is not aware of any reports that clearly demonstrate that the use of glyphosate-tolerant crops and/or glyphosate weed management practices causes negative impacts on non-tolerant crops subsequently grown on the same field. Many herbicides have residual activity and require a period of time before crops can be planted back in the field. In contrast, glyphosate-sensitive crops can be planted into glyphosate-treated fields with no plant-back restrictions (FEIS section III.B.1.d.(3)).

VI Physical

Comment: One commenter stated that APHIS needs to incorporate information from a number of references, including (Battaglin *et al.*, 2005; Battaglin *et al.*, 2009; Chang *et al.*, 2011; Coupe *et al.*, 2011) on the behavior of glyphosate herbicides in water, air, soil, and within plant residues. For example, the commenter indicated that information regarding how frequently glyphosate is found in surface waters near RR crops should be incorporated:

"These recent studies conclude that glyphosate and presumably surfactants are found in most surface water samples when measured after herbicide applications, showing that offsite movement is much more common in areas where Roundup Ready crops are grown than APHIS states. Also, glyphosate is found in air and rain in concentrations higher than more volatile herbicides, against APHIS' predictions based on physical properties, showing the importance of basing risk assessments on real-world data." (APHIS-2010-0047-4435)

Response: APHIS examined the papers mentioned in the comment; all were incorporated into the FEIS. APHIS disagrees that offsite movement is more common than stated in the FEIS. (Coupe *et al.*, 2011) estimated that less than 1 percent of the applied glyphosate moves into surface water. (Battaglin *et al.*, 2005) typically found glyphosate in streams after application at rates below 1 percent of EPA's maximum concentration level (MCL), suggesting "that the concentrations of glyphosate measured in Midwestern streams in 2002 would not be expected to cause harm to wildlife or aquatic organisms." Furthermore, according to (Battaglin *et al.*, 2005), "although glyphosate was found in many samples, other herbicides with similar or less total use in the Midwestern United States, such as acetochlor, atrazine, and metolachlor, were often detected more frequently and at higher concentrations. It is probable that glyphosate is not as mobile and is transformed more rapidly in the environment than these other herbicides." They also found that atrazine exceeded its MCL in 57 percent of premergence samples, acetochlor exceeded its MCL in 25 percent of preemergence samples and 4 percent of postemergence samples, and alachlor and simizine exceeded their MCL in 2 percent of premergence samples. This paper is consistent with the conclusions in the FEIS that glyphosate is not as mobile in the aqueous phase or as toxic to wildlife as other herbicides.

Comment: The district I manage provides irrigation water to over 875 water users located in Goshen County, Wyoming and in Sioux, Scotts Bluff and Morrill counties of Nebraska. These water users irrigate approximately 117,000 acres. Lands served by the District have historically and are currently used to grow sugar beets. They are a very important crop for the irrigators within the District and elsewhere in the area. From my own personal observations, I have seen the use of Roundup Ready Sugarbeet seed and other crops like Roundup Ready Corn make a huge difference in the water demand by these crops. Much of the reduction is due to better control of weeds using glysophate weed control products, reduction in the weed population reduces their competition with crops for water and nutrients. I have also seen first hand the improvements to beet yields and the time and costs associated with harvest. With Roundup Ready seed, the fields are virtually clear of weeds that add to harvest conditions and cost. Many producers I have talked to would not grow sugar beets if it were not for Roundup Ready seed. The loss of this valuable technological advancement could and would have a devastating affect on the economy of the area, which depends heavily upon the sugar beet industry. (APHIS-2010-0047-3403)

Response: APHIS has updated the EIS to incorporate the information in this comment (see sec IV. E.4.a.). .

Comment: I have the right to insure that I am getting the best organic foods for me and my family. RoundUp chemical kills all the beneficial organisms in the soil which promote healthy growth of plants. Therefore the yield is not large as Monsanto claims unless larger quantities of fertilizers are used, which in turn pollute our rivers and streams; our drinking water. GE plants are also more subject to disease than Organically grown crops which are naturallly resistant to local disease due to seed selection and natural survival of the fittest. (APHIS-2010-0047-4383)

Response: APHIS has evaluated H7-1 sugar beets in a PPRA and concluded that these sugar beets are no different with respect to pest or disease susceptibility, yield, or other growth characteristics from other conventional sugar beet varieties, with the exception of resistance to the herbicide glyphosate. APHIS has no evidence to believe that sugar beet growers use a different fertilizer regime for H7-1 and conventional sugar beets, and the commenter has provided no evidence.

Comment: Two growers at the public meeting in North Dakota said that they used less water on H7-1 sugar beets because the application of chemicals on H7-1 sugar beets used less total water:

With Roundup, we are using roughly three less sprays to control weeds. And so just with that, the water we are saving on our farm is roughly 20,000 gallons of less water being used with less applications. Also, that means less diesel fuel being used and less exhaust emitted into the air, which is also good for the environment.

Using Roundup, we only use 5 gallons of water per acre, where before we were using 20 gallons of water per acre on each spray, so that—do the math, that's, that's a lot of water that we're not using and that's beneficial to the environment.

Response: APHIS recognizes that some growers may use less water because the application of glyphosate requires less water than other herbicides used on sugar beets.

Comment: APHIS relies heavily on the anticipated increase in conservation tillage associated with a full deregulation of RRSB as an environmental benefit relative to conventional sugar beet production. However, the DEIS itself shows that APHIS's reliance is misplaced. Even with 95 percent adoption of RRSB from 2009-2010, conservation tillage did not increase substantially. "[I]n the areas with the greatest proportion of acres dedicated to sugar beet production, conservation tillage does not appear to be used widely." (DEIS at 666). The vast majority of RRSB adoption that will occur has already occurred; APHIS's claims of increased conservation tillage and its beneficial effects on soil and air quality are contrary to the record.

Response: APHIS disagrees with the commenter's assertions because APHIS does not rely on growers adopting any particular production practices in the DEIS or FEIS. In some regions, such as the Great Plains and Northwest, strip till and even no till are being used as a result of the adoption of H7-1 sugar beet whereas in Imperial Valley, tillage is used for irrigation purposes and not just for weed control. However in all sugar beet growing areas, growers report using less cultivation to control weeds during the growing season. Overall, there has been a substantial increase in the use of conservation practices as a result of the adoption of H7-1 sugar beet. This subject is discussed in the FEIS in sections III.B.1 and III.E.2.

Comment: **APHIS examined the question of tillage with respect to glyphosate-tolerant soybeans and found no support for this presumption. A 2010 report from NRCS—USDA's experts on soil erosion—also argues against any meaningful effect of RR crops in promoting conservation tillage: Below, we reproduce a graph of soil erosion on U.S. cropland based explicitly on type of tillage regime. Consistent with and extending further into the past, the ERS data presented above, soil erosion (a proxy for conservation tillage) decreased dramatically in the 15 years before the first RR crop, RR soybeans, were introduced. Interestingly, soil erosion rates level out precisely between 1997 to 2007, the decade that American agriculture made the massive switch to RR soybeans, cotton, and corn. This proves conclusively that the great majority of acreage converted to conservation tillage since 1982 was converted for reasons unrelated to RR crop systems because they simply did not exist when the conversions took place.**

Response: The commenter suggests that APHIS considered the presumption that herbicide-resistant soybeans contribute to conservation tillage, citing a paper prepared by the Economic Research Service (Fernandez-Cornejo and McBride, 2002). While APHIS did not write this paper, the agency read it. The authors conclude that growers who adopt herbicide-resistant crops adopt conservation tillage at higher rates than those growing conventional crops. Likewise, growers who use conservation tillage are more likely to use herbicide-resistant crops than conventional crops. However, the authors were unable to establish a causal relationship based on the data available at the time of the report. However, Givens (2009) concludes that there is a causal relationship.

APHIS asked agronomists at the sugar beet cooperatives if they were aware of conservation tillage being used on sugar beet. APHIS received the following reply from the Ag Manager at Western Sugar Cooperative: "We were probably around the 15 to 20% of the Nebraska beet crop on strip till prior to RR beets. After 4 years of RR beets our growers are using strip tillage on at least 75 – 80% of the beets grown in Nebraska. We also have a small percentage of our acres that are no tilled. Growers wouldn't even attempt this without RR beets!" (Wilson Jr, 2012). APHIS also received a reply from the Director of Agriculture at Amalgamated Sugar Company in Idaho: "With the introduction of H7-1 sugar beets there has been adoption of minimum till practices. It is estimated that minimum till practices were applied to 32,400 acres in 2011. This is out of a planted acreage of 188,486 acres. Before the use of H7-1 there was very little use of minimum till. Growers have also reduced their tillage operations. It was the general practice to cultivate 3 to 4 times per season. With the advent of H7-1 most (80 to 90 percent) cultivate only 1 to 2 times per season" (Schorr, 2012).

The 2010 report from NRCS referred to by the commenter does not discuss tillage (USDA-NRCS, 2010). Therefore, it is not possible to conclude from the report conclusively or otherwise "that the great majority of acreage converted to conservation tillage since 1982 was converted for reasons unrelated to RR crop systems" because the report did not even deal with the topic of tillage. It is a high-level report on erosion from agriculture lands and the changes in erosion as the result of management of highly erodible lands. There are many methods that are used to manage highly erodible lands. However, these methods and their practical adoption are not the focus of the study.

VII Human Health/Animal Feed

Comment: APHIS received comments from a few growers indicating that they have become allergic to chemicals that are used on conventional sugar beets. For example: "I've been growing sugar beets for 25 years. Over the years I became allergic to the chemicals. Round Up Ready Beets has allowed me to continue to be a sugar beet farmer." (APHIS-2010-0047-3684)

Response: It is not clear exactly what is meant by "allergies" in these comments. APHIS discusses the effects of three alternatives on human health, including health effects on workers, in the EIS. APHIS reviewed the information available on herbicides used on sugar beet; the herbicides that cause skin sensitivities are listed in table 3-53 of the FEIS.

Comment: APHIS received several comments from individuals who have concerns about the safety of eating GE foods. The comments do not raise specific concerns about H7-1 sugar beets. They cite concerns about GE foods generally. Commenters made unsupported claims that foods derived from GE crops are responsible for a number of diseases and health concerns, including cancer, Celiac disease, birth defects, organ failure, and food allergies. Several commenters referred to a study on hamsters: "A Russian study done on hamsters showed a marked increase in mortality rate and a decrease in fertility, and complete infertility in the second generation of hamsters fed on GMO foods. At the same time, we see rising infertility rates clinically." (APHIS-2010-0047-3187).

Comment: APHIS assumes that a second study referenced is from (Aris and Leblanc, (2011b): "There was a recent study done in Canada by a team at Sherbrooke University Hospital in Quebec and accepted for publication in the peer-reviewed journal Reproductive Toxicology has found that 93% of blood samples taken from pregnant women, 80% from umbilical cords and 67% of non-pregnant women tested positive for traces of the toxic Bt protein Cry1Ab originating from GM food consumed as part of a normal diet in Canada, where GM presence in food is unlabelled. This shows that the Bt proteins have survived the human digestive system and passed into the blood supply – something that regulators had said could not happen." (APHIS-2010-0047-4292)

Response: APHIS evaluates and describes the effects of the three alternatives on human health in sections III.E and IV.F of the FEIS. APHIS has concluded that there are no human health-related impacts associated with H7-1 sugar beet. APHIS also examined the potential for human health effects associated with changes in management practices under Alternatives 2 and 3. Nothing in APHIS' analysis supports the commenters' assertions.

In addition, no U.S. agency has made an assertion linking GE crops to the presence or increased prevalence of any disease. Furthermore, a report from the European Commission (European Commission, 2011) examines the risk of GE crops and concludes: "The main conclusion to be drawn from the efforts of more than 130 research projects, covering a period of more than 25 years of research, and involving more than 500 independent research groups, is that biotechnology, and in particular GMOs, are not per se more risky than e.g. conventional plant breeding technologies."

Commenters did not provide support for their assertions that GE crops are related to specific diseases and health concerns. Therefore, APHIS cannot evaluate the validity of these statements. Based on the best available scientific evidence, the commenters' assertions are unfounded.

APHIS was unable to locate the Russian study on hamsters that examined mortality and fertility. There are several Internet references to the study, but none provide a link to the actual study. APHIS searched several databases and was not able to identify the paper. The commenter did not provide a copy of the study, so APHIS cannot evaluate it.

APHIS assumes that the study of pregnant women and infant blood is (Aris and Leblanc, 2011a). In that particular study, the Cry1ab protein (a common insecticidal protein introduced into GE crops such as corn) was detected in 93 percent of maternal blood, 80 percent of fetal blood, and 69 percent of blood from nonpregnant women. The subjects of this study all resided in Sherbrooke, an urban area of Eastern Townships of Quebec, Canada. H7-1 sugar beets do not contain the Cry 1ab protein.

In response to the assertion that GE crops are responsible for an increase in food allergies, APHIS discusses both the EPSPS protein and allergens associated with sugar beet in section III.F.1 of the FEIS. As discussed in this section, it has been reported that two allergenic proteins, Beta v 1 and Beta v 2, have been identified in pollen from conventional sugar beet (Luoto *et al.*, 2008).

APHIS also reviewed the data related to allergenicity for the EPSPS protein. As described in the DEIS:

- There are no known reports of allergies or significant pathogenicity to *Agrobacterium* sp., the soil bacterium used as the source of the CP4 EPSPS coding sequence for H7-1 sugar beets and other GR plant lines (Swiss Institute of Bioinformatics, 2011). This bacterium has been known to infect people, but generally only locally (e.g., in tissues surrounding catheters) in immunocompromised patients, as with many other common bacteria (Van Baarlen *et al.*, 2007).
- There is an absence of immunologically relevant amino acid sequence homology between CP4 EPSPS and known allergens, as determined by comparing the CP4 EPSPS' amino acid sequence using the FASTA algorithm to sequences in the ALLERGEN3 database (Monsanto and KWS SAAT AG, 2010) (Hileman *et al.*, 2002) and as confirmed by APHIS using an updated FASTA database, (FARRP (Food Allergy Research and Resource Program).
- The CP4 EPSPS protein is rapidly degraded in *in vitro studies* using simulated gastric and intestinal fluids. Two studies were performed to assess the *in vitro* digestibility of CP4 EPSPS protein. In the first study, the CP4 EPSPS protein was exposed to simulated gastric and intestinal fluids (Harrison *et al.*, 1996). The half-life of the CP4 EPSPS protein was reported to be less than 15 seconds in the gastric fluid, greatly minimizing any potential for the protein to be absorbed in the intestine. The half-life was less than 10 minutes in the simulated intestinal fluid. The second study, conducted under different experimental conditions, reported similar results, as noted in the FDA consultation (U.S. FDA, 2004).

Therefore, the best available scientific information does not support the assertions of the comments that eating food derived from GE crops such as H7-1 sugar beet is associated with an increase in food allergies, reproductive disorders, or other diseases.

VIII Socioeconomic

Comment: Several sugar beet growers and sugar beet cooperatives commented that the cost of complying with the current requirements of the partial deregulation (USDA-APHIS, 2011b) is burdensome. One commenter claimed, "Indeed, the requirement under our APHIS Compliance Agreement to inspect for bolters before bolting and pollination are biologically possible imposed at least 3,750 hours in unnecessary field personnel work on our cooperative in 2011 -a cost of at least $52,500 in hourly time, not including the cost of fuel and mileage, costs that are borne by our grower shareholders." (APHIS-2010-0047-3874)

Response: Permanently adopting the partial deregulation is considered under Alternative 3 in the EIS. APHIS examined the cost associated with compliance agreements and calculated it to be around $2 an acre (see sec. IV.D.1). While many of the commenters felt that the conditions were unnecessary, they did not offer a figure to counter the estimate of $2 an acre. The numbers cited by the commenter are consistent with that figure when inspection costs and fuel costs are included.

Comment: Several sugar beet growers, sugar cooperatives, and employees of related businesses wrote to express a belief that H7-1 sugar beet was needed to keep sugar beet production profitable in their communities. APHIS received several estimates of the value of the sugar beet industry to the local economy of the different commenters. For example:

RRSB is critical to Snake River's and Amalgamated's financial well-being. In 2005, before RRSB technology was available, Amalgamated closed one factory and reduced employment by over 100 employees because of reduced demand for sugar beet acreage caused by poor profitability. In 2008 alone, Snake River lost over 25,000 acres of sugarbeets when numerous members permanently forfeited their shares and instead planted alternative, more profitable, crops. These two events demonstrate that sugarbeet growers compete for limited agricultural acreage in a highly competitive environment.

RRSB made sugarbeets attractive again because they increased grower efficiency while simultaneously reducing growers' per acre operating costs. However, if Snake River's growers are forced to plant conventional seed, the loss of yield and sugar content alone will lead to significant revenue losses- harming not only Amalgamated and Snake River, but its growers, their employees, and the people who depend on the sugarbeet industry. These losses do not even take into account additional costs for conventional sugarbeet herbicide and equipment, labor, and efficiency losses.

Recent experience has shown that, some growers will turn to planting other crops and forfeit their shares in Snake River rather than incurring these additional costs and endure reduced profitability for their sugarbeets. If a grower does so, their forfeited stock is retired in the cooperative system, and cannot be used plant sugarbeets. In turn, Amalgamated's costs for processing sugarbeets increase for all remaining growers - including me. This could lead to the closure of more Amalgamated factories and, possibly, the ultimate closure of Amalgamated and Snake River. (APHIS-2010-0047-3874)

A related business wrote, "IDFA will not comment on such technical matters as the environmental impact of H7- 1 sugar beets. Rather, we would like to highlight on the

negative economic impact that an abrupt withdrawal of H7- 1 sugar beets from the marketplace would have on our $110-billion industry.

Ice cream and dairy products consume 11% of industrial sugar deliveries. Industrial users account for most purchases of sugar in the United States. In fiscal year (FY) 2011, total deliveries (consumption) of sugar by industrial users in the U.S. market were 5,465,737 short tons actual weight. Of this number, dairy accounted for 605,866 short tons or 11%.

Beet sugar derived from H7-1 sugar beets now accounts for most domestically produced sugar. The dairy industry primarily relies upon domestic sugar industry for our needs. Therefore, the impact on both industrial producers and retail consumers of affected dairy products would be substantial and negative. USDA previously estimated that users and consumers of sugar would pay an extra $1.6 billion if H7-1 sugar beet seed could not be planted in 2011. The average price paid by industrial users at wholesale would have risen 24%, according to USDA. Prices are already at record-high levels, largely for other reasons, so this further price rise would look even more dramatic when compared to normal price ranges. Ultimately, these increased costs are reflected in higher prices for consumers. These further price increases would come while U.S. consumers are already stressed by high prices as a result of tight sugar supplies. As such, it will be very difficult to absorb further price increases, thus potentially resulting in significant economic damages and job loss in the sugar-using dairy products industry.

Concluding, IDFA supports alternative 2, full deregulation of H7-1 Sugar beets. Otherwise, the result is likely to be market turmoil, unnecessarily high costs and the loss of jobs and small businesses in an already-stressed U.S. economy. For various reasons, tight supplies are already driving up sugar prices to record levels. In this challenging economic environment, IDFA's sugar-using members can ill afford to incur further cost increases, nor are consumers well-positioned to absorb these costs. IDFA strongly urges APHIS to act decisively in this matter. (APHIS-2010-0047-4192)

Response: APHIS examined the cost of sugar beet production under the three alternatives (see secs. III.D.1 and IV.E.1). APHIS also examined the trends in sugar beet and sugar cane plant closures and identified the decline in the number of farms growing sugar beet (see tables 3-31 and 3-34). The analysis in the FEIS supports the commenter's conclusion that some processing plants are likely to close if they are not profitable, the availability of sugar beet positively contributes to that profitability, and the production of H7-1 sugar beet is more profitable than conventional sugar beet. This profitability comes from lower herbicide costs, lower labor costs, and reduced equipment use.

In addition, the FEIS includes an analysis of the impacts of GR weeds on resistance management costs. If the cost of managing GR weeds was to become high enough that sugar beet was no longer profitable, then growers may choose to grow other crops, thereby reducing the availability of sugar beet and potentially resulting in future plant closures. The cost of weed resistance management is the function of many variables (e.g., weather, weed pressure, chemical and labor costs, and the price of sugar and other crops that compete for acres) and influenced by growers' choices. Therefore, the ultimate effect of weed management on sugar beet plant closures is speculative.

Effects, such as the price of sugar, on food processors that use sugar to produce processed foods are an indirect effect of the impacts of the three alternatives to the sugar beet industry. APHIS analyzes the effect of each alternative on the availability of sugar beet seed and the cost of sugar beet production in the FEIS. APHIS agrees that decreases in the availability of sugar can increase the costs for sugar and products that are made with sugar. APHIS discusses these impacts in section IV.D.1 of the FEIS.

Comment: We need RR sugarbeets for our farm to be able to grow sugarbeets.They have the diease package's that we need like Aphanomyces, Rhizoctonia, Fusarium, Cercospora. All the good Varieties have these package's built in. There are not enough good non GMO Varieties for the industry to plant. (APHIS-2010-0047-3441)

Response: APHIS describes sugar beet breeding and variety testing in the FEIS. The cooperative determines the availability of varieties based on variety performance in field trials. APHIS discusses the impact of each alternative on the near-term availability of seed in section IV.B.1 of the FEIS.

Comment: APHIS received comments from vegetable beet growers and seed companies. A vegetable beet seed production manager commented that H7-1 trait was identified in some of their seed lots (APHIS 2010-0047-3281), indicating that cross-pollination had occurred between H7-1 sugar beets and some of their vegetable beet seed. This information contradicted information in the EIS, which indicated that the agency was unaware of any cross-pollination from H7-1 sugar beets to vegetable beet seed in the Willamette Valley.

Response: At the time that the DEIS was prepared, APHIS was unaware of the testing done by Universal Seeds. APHIS followed up with the company and has incorporated the information provided by the company into the FEIS in sections III.B.5 and IV.B.5.

Comment: I currently and have for the past 40years grown Swiss Chard for seed, some if not all will be shipped over Sea's to Japan, China, South Africa and Europe to name a few. Most counties DO NOT want GMO containation. As you know Sugar Beets will cross with Swiss Chard. The Beet companies currently stay 3 miles away from my fields but they have planted closer than that in the past few years. They at one point wanted my fields at least 5 miles away and told me to back off, but since they have Sugar beet fields all around my isolation had nowhere to go. I'm grandfathered in here since I've grown Chard for 40 years and my father did before that. Its just a big company trying to push out a smaller one for their own $$$. This year I have 126 acres of Swiss Chard for seed and cannot afford contaminations of GMO into my crop. (APHIS-2010-0047-3220)

Response: APHIS followed up with this commenter via telephone. After discussing the commenter’s specific comments, APHIS concluded that the analysis in the FEIS is consistent with the information provided by the commenter.

Comment: My name is Frank Morton. I am an organic seed grower in Oregon's Willamette Valley. I grow both table beet and Swiss chard seed on contract for organic seed companies in the US, Great Britain, Australia, and Canada. These customers do not want to risk buying contaminated seed from the Willamette Valley. Presently, I must pay for genetic testing of all my Beta vulgaris seed crops prior to selling them to my customers, and if I get positive results, that seed will be worthless to me. The reputation of the Willamette Valley has already taken a hit from the perceived risk of purchasing high value beet or chard seed grown here. I know of contracts cancelled due to the avoidable risk associated with Oregon grown seed. The illegal rules adopted by the USDA only allow

transgenic sugar beet seed production in western Oregon...home of a thriving specialty seed industry known for its purity standards. (APHIS-2010-0047-4383)

Response: APHIS notes that the commenter does not claim to have ever had any positive results from the genetic testing of any of his *Beta vulgaris* seed crops, but only comments hypothetically that his seeds will be worthless if he ever gets any positive results. APHIS also notes that though the commenter claims that Willamette Valley has "taken a hit from the perceived risk of purchasing high value beet or chard seed grown here," this grower has elsewhere acknowledged that the value of his seed operations have increased nearly 60 percent since the sugar beet litigation began in 2008 (Morton, 2011). APHIS analyzes the potential effects of the three different alternatives on *B. vulgaris* seed production in the DEIS and FEIS. APHIS specifically considered the impacts of each alternative on growers in the Willamette Valley of Oregon. While sugar beet, table beet, and chard seeds are all grown in this area, sugar beet seed is the primary crop among the three. The commenter's statements regarding contracts and testing are consistent with the analysis in the DEIS and FEIS. APHIS includes a discussion of potential lost contracts for individual growers in the Willamette Valley and an analysis of the cost to growers of testing seed to meet contract specifications in the FEIS. APHIS certainly disagrees with the commenter's characterization of the Willamette Valley growers association's isolation distances "rules" as being somehow illegal or only allowing transgenic sugar beet seed production. None of the three alternatives that APHIS is considering in the FEIS restrict the production of any type of seed other than H7-1 seed. Under Alternatives 1 and 3, specific regulatory permits issued by APHIS are required to produce H7-1 seed.

Comment: If you were to ask me, the organic red beet growers are the ones who need to police their practices more. Every year we find at least 5 red beets in our 205 acres of sugar beets. We have not had a sugar beet bolter since 1996. The growers of red beets are the ones being sloppy and careless in their handling of seed and beets not the sugar beet growers. If roundup ready sugar beets are not deregulated, then you should at least make sure the red beet growers are following our same guidelines. The red beet growers CONTAMINATE our sugar beets every year reducing our sugar content and clear juice purity damaging our income. (APHIS-2010-0047-3766)

Response: APHIS acknowledges the comment. Cross-pollination moves in both directions. Based on the commenter's figure of 5 red beets in 205 acres, the level of cross-pollination between these crops is well below 1 in 10,000 seeds; in fact, it is less than 1 in 1,000,000 seeds. APHIS based its assessment on the assumption that currently used isolation distances were likely to consistently achieve a level of cross-pollination below 1 in 10,000.

Comment: Transgenic sugar beet production poses a risk of contamination to our beet and chard supply. As stated in the Environmental Impact Statement (EIS), sugar beets are wind pollinated and easily cross---pollinate with both table beets and Swiss chard. Because pollen can travel several miles, it is nearly impossible to prevent cross-pollination of crops in an area where there is highly concentrated seed production, such as Oregon's Willamette Valley, where a significant amount of beet seed is grown.

The unwanted spread of genetically engineered traits threatens organic markets and livelihoods. Maintaining genetic purity with proper isolation distances and sufficient testing is difficult. Yet because organic standards prohibit use of genetically engineering, genetic contamination results in marketplace rejection.

Transgenic contamination of conventional sugar beets and conventional and organic table beet and Swiss chard is almost a certainty under full deregulation. With no mandatory measures in place to keep GE and non---GE fields distant enough to prevent contamination, there will be an increased level of gene flow from GE to non---GE fields resulting in contaminated seed.

Oregon and Washington account for over 80 percent of U.S. chard and table beet seed production. This de-regulation will send much of this seed production to other countries, resulting in a loss of a high value specialty market for U.S. growers. Organic farmers should not have to shoulder the whole burden of protecting seed integrity. The genetic polluters should be held liable for contamination. USDA should prohibit the commercial use and planting of Roundup Ready Sugar Beets, unless it can fully protect organic farmers and consumers from unwanted contamination from genetically engineered crops. (APHIS-2010-0047-4543)

Response: APHIS analyzed the impacts that the three alternatives could have on organic vegetable beet growers and discussed the current vegetable beet market in the DEIS and FEIS (see secs. IV.D.4 and III.D.4). APHIS disagrees with the commenter's characterization that "transgenic contamination of conventional sugar beets and conventional and organic table beet and Swiss chard is almost a certainty under full deregulation." APHIS analyzed the likelihood of cross-pollination and concluded that it is a rare (but not absent) event. Given the current practices in the Willamette Valley, APHIS concluded that the likelihood of cross-pollination is less than 1 seed in 10,000 seeds. In areas where sugar beet seed is not grown, the likelihood approaches zero. APHIS does not have the authority to hold anyone liable for contamination. APHIS has not seen evidence for a loss of seed production to other countries. It appears that if vegetable beet seed is less profitable, alternative seed crops are an option to grow for export. APHIS disagrees that the inadvertent presence of GE material in an organic crop constitutes a violation of the organic rule.

Comment: Controls delineated in Appendix A of Appendix D. are not sufficient to protect abutting lands, farmed or fallow or forest or residential garden, from "unauthorized releases" caused by inevitable and unchecked incidents of drift. For example, there needs to be greater clarity on the grower's and the responsible entity's obligations and culpability following an ABUTTER'S report to the adjoining grower of an incidence of "unauthorized releases" on the abutter's land caused by unplanned and UNCHECKED pollen, seed, or chemical drift. This Appendix A. needs to reflect the obligation, BEYOND just their own property, that the grower and the responsible entity BOTH have to act on an abutter's report of "unauthorized release" on the abutter's land, including the obligation for full and timely restitution. This paragraph applies: "...In incidents involving unauthorized releases and/or noncompliance, growers shall give notice immediately to the responsible entity so that the responsible entity may notify APHIS/BRS. When contacting APHIS/BRS, the authorized representative shall describe the incident, the date it occurred, the location (including county and state and GPS coordinate(s) of release site), name and address of grower, and field personnel associated with the incident. The authorized representative shall also provide immediate or short term corrective actions and, if necessary and available, long-term plans to return the situation to compliance and prevent similar incidents from occurring in the future..." Fix this paragraph to protect abutters from "unauthorized" drift. (APHIS-2010-0047-4292)

Response: The commenter is discussing an example of a compliance agreement that APHIS referenced as part of its analysis of Alternative 3. However, it is unclear from the comment what modifications to the compliance agreement are recommended by the commenter. The compliance agreement identifies the conditions that apply to growing sugar beet roots for sugar production. The comment appears to be referencing pollen movement, an issue associated with seed production. Seed production is not authorized under the compliance agreement in appendix D.

Comment: Employees from several sugar beet cooperatives and sugar beet processing plants commented on the importance of sugar beets to their rural communities. They discussed the number of people employed by the sugar industry and the value of the industry to growers and their communities.

Response: APHIS reviewed this information and incorporated it into the FEIS where appropriate.

Comment: I am a insurance agent working for Nodak Mutual Insurance Company selling all types of insurance products including crop insurance. This crop insurance is adminstered by the RMA agency of the USDA.
I support farmers having the choice to plant sugarbeets engineered for tolerance to the herbicide glyphosate because it saved RMA millions of dollars in losses to the Minndak area alone.

The MinnDak area had a terrible crop year due to the excessive rains. Without the technology found in Genuity Roundup Ready beets, my husband and crew would not have been able to harvest beets on the 4 to 12 ton fields due to the weed pressure that would have been there using conventional seed. Because of the Roundup Ready sugar beet, we were able to kill all of the late emerging weeds and harvest what ever the Good Lord provided to us. These tons therefore were not paid out as losses and MinnDak Farmers Cooperative was able to process up to 150,000 tons of more beets. This saved my company and RMA over $7,000,000 just in my little neck of the woods.

Thank you for considering my comments. (APHIS-2010-0047-3613)

Response: APHIS acknowledges that flexibility in weed management may be responsible for fewer crop losses during years with excessive rain. Many of the herbicides that are labeled for use on sugar beets have restrictions on the timing of applications. APHIS analyzes changes in herbicide use throughout the FEIS.

Comment: The Oregon Legislature recognized the increased emphasis on local small-scale food in 2011 when they passed House Bill 2336, allowing small-scale commercial processing of vegetables into preserves and acidic foods. This bill de-regulated inspection of certain processing facilities and products, thereby allowing an increasing amount of growers to enter the market with their homegrown processed products. By allowing these de-regulated producers to enter the market, the availability of more products increases the likelihood that these small producers' products may contain GE sugar beet material cross-pollinated to table beets or Swiss chard. With their overwhelming preference for non-GE foods, consumers will chose not to take the risk of consuming local producers' products. Or worse, they would unknowingly be consuming GE foods, against their expectations from a small local producer.

Response: The Oregon Legislature passed this bill in 2011. At that time, H7-1 sugar beet was already being grown in the Willamette Valley. The bill is about public health, not about the use of GE organisms in agriculture. The act makes no mention of GE plants. It is a food safety law related to the production of canned goods. APHIS disagrees with the commenter's speculation that this bill is related to consumer preference for non-GE foods or that this bill will result in people unknowingly eating GE food. APHIS examines the likelihood of cross-pollination between different *Beta* crop varieties in the FEIS and has found that contamination of the vegetable crop is not possible during the growing season because the crop is harvested prior to flowering and the crops are visually distinguishable so off-types can be recognized and culled from among the progeny. Vegetable beet growers who have concerns about the presence of transgenes in their products may also choose to source seed from growers in regions that do not grow sugar beets or purchase seed from distributors who test for GE material. Furthermore, when sugar beet hybridizes with vegetable beet, the resulting seeds are half sugar beet and half vegetable beet and look different than chard or table beet. Such vegetables are recognizable and can be culled rather than canning them.

Comment: GE modified sugar beet seed production significantly impacts the commerce from small gardens within Oregon because of the cross-pollination possibilities between sugar beets, table beets, and Swiss chard. APHIS fails to analyze the sources of these small-scale growers' seed. Large-scale seed production in the Willamette Valley allows genetic transfer of GE sugar beet material to these smaller crops. APHIS's analysis of this issue is vague and does not constitute a "hard look:" APHIS analysis does not go much beyond the statement that "[h]ome gardeners may or may not use organic methods and may or may not be GE sensitive." This arbitrary and capricious judgment that no study is needed to determine the activities of home or small-scale commercial producers is insufficient under NEPA. Given a choice, consumers do not want GE foods for consumption, and would avoid purchasing crops contaminated with GE material and avoid potentially GE-contaminated crops. There will be a significant impact to the local agricultural market when consumers avoid purchasing table beets and Swiss chard because of the uncontrolled and residual presence of GE material in the environment.

Response: The commenter neither offers data to support the accusation that commerce from small-gardens will be affected nor characterizes the size of this industry or the relative contribution of vegetable beets to this industry. APHIS has not received comments, through scoping, the public comment period, or from people in this industry that provide this information. APHIS disagrees with the commenter's assertion that vague information does not constitute a hard look. When information does not exist or there is uncertainty, it is sufficient to say so. As described in the FEIS, APHIS consulted Oregon Tilth, the USDA national organic program, and litigation records; conducted a well-attended public meeting in Corvallis; and followed up on public comments to form an understanding of the impacts to small-scale growers (see secs. III.B.2, II.B.3, IV.B.2, and IV.B.3). In addition, APHIS obtained information from growers who produce as little as 1 acre of vegetable beet seed. APHIS does not have the authority or the resources to investigate every backyard in Oregon, to know who is letting the occasional plant flower to collect seed, and to analyze where such backyard hobbyists acquire their seed. Nevertheless, APHIS acknowledged in the FEIS that such growers exist and qualitatively analyzed the impacts to them. APHIS examined consumer preferences (see secs. III.D.4 and IV.D.4). In addition, in 2011, APHIS analyzed where vegetable beet seed is produced in the United States and determined that about 50 percent of Swiss chard seed and less than 10 percent of table beet seed is produced in the Willamette Valley. APHIS also learned that two vegetable beet seed producers tested their 2011 seed for H7-1 and neither had any positive results. Based on this information, APHIS has concluded that it is possible to get GE-free seed from both outside of and within the Willamette Valley. APHIS also knows that it is biologically impossible for local producers of vegetable beets to be impacted by H7-1 pollen. Thus, APHIS has concluded that any backyard grower in the Willamette Valley who wishes to grow GE-free vegetable beets could do so. Therefore, while APHIS acknowledges that there may be some people who grow vegetables and wish to avoid GE vegetables, they can source seed from companies that test seed or have contracts with seed growers in areas where sugar beet is not grown.

Comment: This arbitrary and capricious judgment that no study is needed to determine the activities of home or small-scale commercial producers is insufficient under NEPA. Given a choice, consumers do not want GE foods for consumption, and would avoid purchasing crops contaminated with GE material and avoid potentially GE-contaminated crops. There will be a significant impact to the local agricultural market when consumers avoid purchasing table beets and Swiss chard because of the uncontrolled and residual presence of GE material in the environment.

Response: APHIS disagrees with the comment. APHIS examined the vegetable beet industry to the extent that information was available. Vegetable beets cannot be cross-pollinated because they are not allowed to flower. APHIS did not receive any specific data concerning the impacts on home or small-scale commercial operations or vegetable beet growers during the public comment period or while scoping this EIS. APHIS examines consumer preferences with regard to GE products in section III.D.3. The commenter has supplied no information, and APHIS is not aware of any information, indicating that consumers have avoided purchasing vegetable beet produced in Oregon.

Comment: The proposed alternatives two and three are unacceptably significant economic impacts in that they will force some farmers to relocate out of the Willamette Valley. The costs of relocation are surely astronomical. These specific harms, especially to Willamette Valley seed producers, constitute an unacceptably significant economic impact on conventional and organic seed producers.

Response: The possibility of vegetable seed production being relocated out of the Willamette Valley is hypothetical. Despite the controversy that has existed for 3 years, vegetable beet seed production has remained constant at the level of 300 to 400 acres per year, as it was before the controversy. Accordingly, there is no evidence that vegetable beet seed production is moving out of the valley. In addition, if vegetable seed production did move out of the valley, growers are not expected to relocate. Instead, seed companies could contract with a seed grower in a different area to produce vegetable beet seed, and the local seed grower could produce a different crop. The feedback that APHIS received from organic growers is that they tend to produce many different seed crops. (Morton, 2010; Tipping, 2010; USDA, 2011). One grower indicated that his sales of vegetable beet seeds declined from $18,000 in 2009, to $6,500 in 2010, to $3,750 in 2011. Despite the decline of $15,000 in sales of vegetable beet seeds, sales of other organic seeds have increased nearly 60 percent since the sugar beet litigation began, from $151,000 in 2008 to $240,000 in 2011 (Morton, 2011). As such, it appears that the loss of beet seed sales may be compensated by the sale of an even more profitable seed crop. Furthermore, APHIS has not seen any evidence for an unacceptably significant impact on conventional and organic seed producers since H7-1 sugar beet seed production began in 2005.

Comment: The presence of GE traits would not change the likelihood of outcrossing, so the potential for that remains the same. The only difference would be that any outcrossing now might lead to detection of very low level GE traits in such seed. This is a risk that the seed producer should accept if he chooses to grow such seed in this area. This has long been the standard practice in the seed industry: the producer seeking a higher purity standard accepts the responsibility to achieve the isolation required by the intended higher-value market. If such isolation is not possible in the environment of the farm, then it does not make economic sense to attempt to produce that specific product in that location. Economically, the higher value of the higher purity product compensates for the additional costs that may be required to achieve it.

An implication of adopting Alternative 3 is that by permits and regulation, specific isolation zones would be mandated around specific GE-sensitive farms. Reasonable isolation zones are a standard practice in the seed industry, so would remain in effect under Alternative 2 as a practical measure. However, mandating larger isolation zones strictly to allow some segments of agriculture to achieve a zero-tolerance threshold with no risk would be a highly disproportionate response. With the 10-mile radius (over 200,000 acres!) isolation zone requested by the plaintiff in the lawsuit, it would take only two farms to essentially eliminate any other seed production in the lower Willamette Valley. This would result in an industry growing 1.1 million acres of sugar beets and worth $1.5 billion in farm gate value alone to be unable to produce seed of its desired varieties in an established seed production area in order to protect a plaintiff who claimed potential (not actual) lost value of $15,000 in chard seed. This would be a wildly disproportionate regulatory response, undermining support for co-existence among agricultural sectors.

While theoretically a farmer should have complete freedom of choice in what crops to grow, in reality farmer choices are determined by many factors, both economic and environmental. If a single farmer in the well-established sugar beet seed production region of Oregon were to decide to become a chard or red beet seed producer, they would have difficulty achieving their own seed quality goals, while at the same time destroying the value of the region for sugar beet seed production. We have considerable experience in seed production in California, with which I am particularly knowledgeable. For example, the northern Sacramento Valley of California produces a large fraction of the hybrid sunflower seeds used both domestically and globally. Seed producers and companies cooperate to achieve isolation that results in high quality seed with minimal gene flow. However, should an individual farmer, for whatever reason, decide to grow commodity sunflowers in this region without regard for isolation requirements, it would cause major economic damage in a region that is specifically suited to production of this seed crop. The situation for the Willamette Valley and sugar beet seeds is analogous. While a given farmer has a right to make that choice, is it the right choice for the US industry as a whole? And if the government establishes regulations to mandate a required isolation zone to protect this farmer's choice, what about the rights and choices of the surrounding farmers? As is noted in the EIS, the area of a circle increases exponentially with the radius, such that a 1-mile isolation zone encompasses only 2010 acres, while a 5-mile isolation zone encompasses 50,240 acres.

Expanding isolation zones beyond what is scientifically justifiable results in a disproportionate regulatory "taking" of the options of farms surrounding the isolated one. How can it be justified that a single farm (of indeterminate size) should dictate the choices of farmers in 50,000 surrounding acres? This is where mandated isolation zones enforced through permits on seed production would inevitably lead. Alternatively, it is a common occurrence in the seed industry that companies vary their seed production locations in response to changes in cropping patterns in an area. Seed companies go where they can economically achieve their desired level of isolation; they do not attempt to carve such zones out of existing production areas for the same crop. (APHIS-2010-0047-4458)

Response: This comment is consistent with the analysis done under Alternatives 2 and 3, although APHIS makes no conclusion about whether isolation zones constitute a regulatory taking.

Comment: Restricting the use of transgenic technologies in beets only in California or other restricted areas, without any conceivable basis for harm to public health or environmental harm, would simply be arbitrary and capricious. Alternative 3 would arbitrarily restrict or delay new uses or production opportunities that may arise in the future in California or other restricted areas. Alternative 3 requires high transaction costs for detailed testing, monitoring and other activities without equivalent public benefit. It would induce longer-term indirect costs from loss of agronomic efficiency. Methods exist to safeguard seed purity for all producers.

The use of herbicide tolerant beets in California, in this particular instance in the Imperial Valley, would be a great asset to growers and improve the environmental performance of the crop. Glyphosate is a much more benign compound than the mixture of current weed control materials that are used (http://www.ipm.ucdavis.edu/PMG/r735700111.html). It would control problematic wild beet when currently there are no economic alternatives. The presence of these weedy species also complicates other pest management issues, especially the control of sugarbeet cyst nematode, which is an increasingly severe problem in the region. The presence of weed beets makes crop rotation less effective as a management tool for nematodes by maintaining weed hosts for nematodes and leads to the need for expensive and more eco-toxic nematicides, or abandonment of fields for beet production. Herbicide tolerant sugarbeets would help eliminate alternative weed beet hosts acting to maintain nematode populations. (APHIS-2010-0047-3792)

Response: The majority of this comment is consistent with the analysis done under Alternatives 2 and 3. APHIS considers the potential effects on all three alternatives including Alternative 3, which places restrictions on production. Any decision on the petition would be reasoned and grounded in science, based on thorough analysis of the plant pest risk, and would not be arbitrary and capricious.

Comment: Weeds were considered as the worst production problem for sugar beet growers because they were difficult to control with conventional herbicides. Poor weed control not only resulted in reduced yield from competition, but very importantly, delays harvesting operations which can be costly to farmers if there is an early hard freeze and/or heavy rainfall. "Most growers use two applications of glyphosate and have reported excellent weed control. I have conducted several tests which showed that glyphosate can be safely mixed with most of the insecticides and fungicides used in sugar beet without causing

phytotoxicity. Growers wisely use mixtures when possible to reduce the number of passes over a field, thus reducing fossil fuel usage, labor and machinery and equipment. (APHIS-2010-0047-3259)

Response: This comment is consistent with the analysis in the FEIS.

Comment: Mandatory conditions added additional burden and hardship to our research program. It is rather costly to pay for auditors and inspectors, and it is time consuming to be available to take these personnel to multiple sites on multiple occasions, especially when our research activities are hampered by unfavorable weather. (APHIS-2010-0047-3259)

Response: This comment is consistent with analysis in the FEIS.

Comment: Under alternative 3 where compliance agreements would be required for planting H7-1 sugar beet seed for root production. APHIS does not provide estimates on what costs the sugar beet industry will incur to comply with the additional permit requirements. The expenses associated with this regulation ultimately will be borne by sugar beet growers and their families. This expense should be taken into consideration by APHIS in its final decision-making process." (APHIS-2010-0047-3850)

Response: In the socioeconomics analysis, APHIS estimates that the regulatory burden of Alternative 3 would cost the industry between $1 to 2 million per year for the root crop.

Comment: Considering that most of the seeds for sugar beets, Swiss chard, and table beets are primarily grown in the Willamette Valley, the pollen need not travel far to causes serious contamination. Further, considering that 98% of H7-1 is grown in the Willamette Valley, irreversible harm to this region is all but inevitable.

Response: These statements are incorrect. As described in the FEIS, the amounts of sugar beet seed, including H7-1, and Swiss chard seed grown in the Willamette Valley is about 50 percent, not 98 percent. About 50 percent of sugar beet seed is grown in eastern Washington, and about half of Swiss chard seed is grown in Arizona, California, and western Washington. The majority of table beet seed is grown in Washington and California. In addition, as described in the FEIS, all sugar beet and vegetable beet fields need to maintain adequate isolation to have a successful crop for seed purity. In the Willamette Valley, a 4-mile isolation distance is used between open-pollinated varieties of *B. vulgaris*. This distance has been determined by years of experience of the growers in the Willamette Valley to be adequate to keep the level of cross-pollination to an acceptably low level. In addition, because these crops have been coexisting for several decades without any irreversible harm, the notion that irreversible harm to this region is inevitable is conjecture and not supported by the evidence.

Comment: In the face of overwhelming evidence to the contrary, APHIS's conclusion that "no gene flow from sugar beet seed production is expected" is arbitrary and capricious. APHIS's conclusion is based entirely on isolation distances, but, as explained Part III of this comment, the isolation distances will not be good enough for Oregon. APHIS offers an empty assurance to Willamette Valley farmers that, "sugar beet seed is . . . separated by isolation distances established to ensure varietal purity and that reduce the likelihood of gene flow." If APHIS doesn't expect gene flow to occur, then should show that is has investigated transgenic contamination in the area. For instance, APHIS must study whether organic farms growing Swiss chard seed in the Willamette Valley are contaminated with H7- 1 genes. This type of analysis is required to comply with NEPA.

Without more, APHIS's analysis of the impacts of transgenic contamination is conclusory and insufficient under NEPA.

Response: This comment mischaracterizes the FEIS's executive summary. The relevant passage is stated below:

"Movement of genes between sugar beets and other related species requires flowering. Sugar beet roots and table beet and Swiss chard vegetables are harvested before flowering. Therefore no gene flow can occur to the vegetable crop under any of the alternatives. For about half the vegetable beet seed produced in the U.S., no gene flow from sugar beet seed production is expected because the production fields are geographically isolated. For the other half of the vegetable seed, grown in the Willamette Valley, sugar beet seed is grown in proximity but separated by isolation distances established to ensure varietal purity and that reduce the likelihood of gene flow."

APHIS did not conclude that "no gene flow from sugar beet seed production is expected in the Willamette Valley." Rather, APHIS concluded that no gene flow can occur to the vegetable crop under any of the three alternatives considered in detail in the FEIS. APHIS also concluded that for about half the vegetable beet seed produced in the United States, no gene flow from sugar beet seed production is expected because the production fields are geographically isolated.

APHIS disagrees that it has an obligation to proactively study whether organic farms growing Swiss chard have detected any H7-1 genes in their seed lines. APHIS would expect organic farmers growing Swiss chard who were aware of the Notice of Intent to publish an EIS and/or the issuance of the DEIS to inform APHIS if they had detected any H7-1 genes in their seed lines. Moreover, APHIS did specifically inquire about whether people were experiencing any gene flow problem through scoping for this EIS. APHIS encouraged growers to provide this information, and two growers have actually done so. APHIS has included this information in the DEIS and/or FEIS. Additionally, if there is no plant pest risk, APHIS has no legal authority to either pay for or confiscate seed to test for transgenes.

APHIS also disagrees with the statement, "Without more, APHIS's analysis of the impacts of transgenic contamination is conclusory and insufficient under NEPA." First, APHIS' analysis of the impacts of transgenic gene flow (or cross-pollination) is distinct from the extent of actual, if any, transgenic gene flow (or cross-pollination). Second, the extent of actual transgenic cross-pollination does not, by itself, reveal or explain whether isolation conditions are sufficient because it does not reveal how or why the contamination occurs. Third, the adequacy of planting isolation distances are best assessed by gene flow studies, which have been analyzed in the DEIS and FEIS. Fourth, the impacts of transgenic cross-pollination can be accurately assessed by growers' specific feedback and comments on their experiences with low-level presence and its consequences.

Comment: Human exposure to GE modified sugar beet material may come through the ingestion of honey. Bees are active in beet fields. In fact, the USDA encourages honeybee use in the production of beet seed, as "evidence indicates that [bees] may be beneficial [in pollination], and for that reason their activity in flowering beet fields should be encouraged." When bees are present in beet fields, they collect nectar and pollen. The nectar and pollen collection can also increase the GE material footprint, as "[b]ees have a range of at least two to ten miles." This broad range increases the likelihood that GE material can be introduced to humans through the collected honey. The end consumer will

not know if the honey, whether in a primary or ingredient form, contains GE material. This effectively leaves the consumer without a choice to ingest GE products. Additionally, the apiarist will not have a choice whether or not to harvest non-GE honey in any of the areas where GE sugar beets are flowering. This is a significant impact under NEPA, and the EIS fails to address this issue.

Response: APHIS determined that beet pollen, and especially H7-1 beet pollen, is unlikely to be present in Willamette Valley honey. To address this comment, APHIS reviewed the literature and contacted beet seed growers to determine whether bees are active in beet fields as suggested by the commenter. APHIS learned from the staff of West Coast Beet Seed and Betaseed—the entities responsible for all sugar beet seed production in the Willamette Valley—that neither company has used or plans to use beehives in their sugar beet fields (Miller and Lehner, 2012). Therefore, bees must arrive into sugar beet fields from neighboring fields. In addition, several observations suggest that beets are not an attractive source of pollen and nectar. For example, Greg Loberg, the production manager of West Coast Beet Seeds who spends time in beet seed fields every day, indicated to APHIS that he has not noticed bees in sugar beet seed fields, in contrast to fields of insect-pollinated crops where one is very aware of bees in order to avoid being stung. This anecdotal observation is substantiated by the literature. For example, a detailed study of insect pollination of sugar beet seed crops noted that although "many honeybees were foraging nearby on wild flowers, very few were caught on sugar-beet flowers" (Free *et al.*, 1975). Similarly, (1976) concluded that "the finding of numerous honey bees or wild bees on beet flowers in the United States is unlikely if there is other pollen available in the area." Honey beehives are placed into crops that are sources of pollen and nectar, which are attractive to bees. Thus, the likelihood is remote that bees will spend energy to move over some distance from a crop that provides an attractive food source to a crop that does not provide such a source. In addition, an analysis of pollen collected from traps placed in honey beehives in Willamette Valley red clover fields during early, peak, and late bloom indicated that while honeybees visited nine families of plants, the beet family was not among the families of plants that were determined to have been visited (Maxfield-Taylor and Rao, 2011). Furthermore, while it is unlikely that beet pollen is present in honey, the likelihood that the beet pollen has the H7-1 trait is diminished by another 6-7 fold because most of the sugar beet pollen-producing plants lack the H7-1 trait. In 2011, just 15 percent of the acreage used for sugar beet seed production in the Willamette Valley produced H7-1 pollen (see sec. III.B.1.b.(8)).

IX Cumulative effects

Comment: For example, any decrease in the overall biological impacts of herbicide use associated in the short-term with RRSB must be counterbalanced by projected impacts of herbicidal responses to glyphosate-resistant weeds in the longer term. A similar assessment should be carried out for weed control costs, tillage/soil erosion, and productivity of sugar beets (since glyphosate-resistant weeds are more likely to adversely impact yields, because more difficult to control). Adverse impacts on crops grown in rotation with RRSB must also be assessed. While such projections are necessarily imprecise, there are good data to aid in this process that are more fully discussed in CFS science comments.

Response: APHIS has updated the FEIS's cumulative effects section to include more information on the medium- and long-term benefits of adopting H7-1 sugar beet and the medium- and long-term effects of weed management. After conducting this analysis, APHIS has determined that the benefits derived from the adoption of Alternative 2 over the short-, medium-, and long-term outweigh the potential adverse consequences associated with the adoption of Alternative 2. Ultimately, the adverse consequences of adopting Alternative 2 are to return to practices and economic costs more similar to those used and incurred under Alternative 1. The use of resistance management practices over the short-, medium-, and long-term can delay the selection and spread of herbicide-resistant weeds, maintaining the benefits associated with the adoption of Alternative 2.

Comment: An announced closure of the Simplot potato processing plant in Aberdeen Idaho by 2015 makes sugarbeets an even more essential crop to balance the overall crop production area of southeast Idaho. (APHIS-2010-0047-3999)

Response: APHIS acknowledges that sugar beet plant closures, combined with other processing plant closures, can have negative effects on local economies. APHIS describes the closures of sugar beet processing plants over the last several years (see table 3-31) and analyzes the impact of sugar beet availability under each of the three alternatives in the EIS.

Comment: On behalf of the U.S. Canola Association (USCA), I write to offer strong support for the full deregulation of Genuity® Roundup Ready® Sugarbeets, an action which is validated by the draft Environmental Impact Statement (EIS) prepared by the Animal and Plant Health Inspection Service (APHIS).

The USCA believes it essential that USDA's regulatory system offer timely and efficient decisions on biotech crop approvals based on sound scientific evidence to keep agricultural productivity on pace to meet the demands of a growing world population that is expected to require a 70 percent increase in food production by 2050. According to a study released by PG Economics LTD, UK earlier this year, (http://www.pgeconomics.co.uk/pdf/2011globalimpactstudy.pdf) since 1996, biotech traits have added 219.5 million tonnes to global production of soybeans, corn, and canola.

The study also documents major positive environmental impacts of biotech crops. These technologies have reduced pesticide spraying worldwide (1996-2009) by 393 million kg (-8.7%) and as a result, have decreased the environmental impact associated with herbicide and insecticide use on the area planted to biotech crops by 17.1%. Biotech crops have also contributed to significantly reducing the release of greenhouse gas emissions from agricultural practices. In 2009, this was equivalent to removing 17.7 billion kg of carbon

dioxide from the atmosphere. And these improved farming techniques have reduced soil erosion by 1 billion tons annually in the U.S. alone. (http://www.ctic.purdue.edu/) (APHIS-2010-0047-3760)

Response: APHIS acknowledges the comment. Information from this comment and studies conducted in previous years by the noted authors have been incorporated in the FEIS.

Comment: Consideration of cumulative impacts requires "some quantified or detailed information; ... [g]eneral statements about 'possible' effects and 'some risk' do not constitute a 'hard look' absent a justification regarding why more definitive information could not be provided."

APHIS improperly narrowed the scope of its cumulative impacts in several ways.

First, APHIS does not attempt to set temporal boundaries for its analysis because "the actual timeframes for many of the reasonably foreseeable future actions are not definitively known."

Yet lack of definite knowledge about the future is unavoidable; far from being a justification for ignoring future actions and impacts, it is one of the very reasons NEPA demands a cumulative impacts analysis in the first place. APHIS does not mention much less set a temporal boundary in the past, yet past actions and events are important in their own rights and are one obvious source of guidance in projecting future developments. Two critically important developments that APHIS fails to assess, quantitatively over time, are the history of commercial RR crop cultivation, which stretches back to 1996, and the dissemination of glyphosate-resistant weeds by RR crop systems, which dates back to the year 2000. Inability to make precise quantitative predictions is unavoidable in forecasting of this sort, and must not be used a pretext to avoid quantitative analysis altogether.

Response: APHIS has updated the cumulative effects section in the FEIS to better explain the spatial and temporal boundaries used in the analysis. APHIS has clarified that Alternative 1 is the baseline. This baseline includes an analysis of all Roundup Ready® crops introduced since 1996, considers the first GR weeds noted in the United States since 2000, and considers glyphosate use over the last 30 years. APHIS chose Alternative 1 as the baseline for the most conservative estimate of glyphosate use in the cumulative effects analysis. APHIS extensively discusses the selection and spread of GR weeds in sections III.C.1 and IV.C.1 of the FEIS. APHIS has updated those sections to include the most recent information on GR weeds. In addition, APHIS expanded the analysis in section V to include the new information included in sections III and IV with respect to GR weeds.

Comment: A commenter suggested that APHIS failed to properly assess the cumulative impacts of the alternatives described in the EIS. The comment appears to focus on alternative two, the preferred alternative:

NEPA provides that an EIS must evaluate not only the direct and indirect effects, but also the "cumulative impacts" of agency action. NEPA regulations define cumulative impacts as effects "which result from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions" of a person or agency.

Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time. The total impact of a set of actions, adding a small amount here, and a small amount there, could add up to an impact that is "greater than the

sum of the parts." The agency must get a sense of the point at which the environmental threshold is unable to tolerate "even a marginal increase" in activity.

To address cumulative impacts, APHIS must determine "whether the action is related to other actions with individually insignificant but cumulatively significant impacts."

NEPA requires APHIS to consider quantified or detailed information in order to provide a useful analysis of cumulative impacts of past, present, and future projects. NEPA regulations at 40 C.F.R. § 1508.8 specifically require the agency to consider effects that are "later in time or farther removed in distance." Further, general statements about "possible effects" and "some risk" do not constitute a hard look, "absent a justification regarding why more definitive information could not be provided."

APHIS's analysis of the cumulative impacts of H1-7 deregulation fails to satisfy its legal obligation under NEPA. APHIS ultimate conclusion is that "no cumulative effects are expected from adoption of H1-7 sugar beets on a national and regional scale because sugar beet production represents a very small percentage of the glyphosate resistant crops planted on a national and regional level. This reasoning cannot satisfy NEPA and misses the point of cumulative impacts analysis. The percentage of overall increase is irrelevant. Instead, APHIS must analyze its action, even an action that seems "individually minor" to determine the extent to which it may have a "collectively significant" environmental impact. (APHIS-2010-0047-4614)

Response: The commenter misses the point of APHIS' analysis. The Council on Environmental Quality recommends that cumulative impacts be analyzed on a meaningful scale: "For cumulative effects analysis to help the decisionmaker and inform interested parties, it must be limited through scoping to effects that can be evaluated meaningfully. The boundaries for evaluating cumulative effects should be expanded to the point at which the resource is no longer affected significantly or the effects are no longer of interest to affected parties" (http://ceq.hss.doe.gov/nepa/ccenepa/sec1.pdf).

If the addition of a particular action is so small that it would be lost among other actions already taking place, the incremental impact of that action cannot be assessed. If the action's effect is not measureable at a particular scale because it is smaller than the normal variability of the other actions' effects, then it cannot be assessed. APHIS has concluded that the contribution of Alternatives 2 and 3 to the cumulative effects on the environment cannot be measured at a national scale, so there is no measurable change in the baseline at this scale. As such, there are no direct, indirect, or cumulative impacts, either minor or significant at this particular scale. APHIS appropriately narrowed the geographic scope of the analysis to areas where a measurable change in the baseline might occur. By focusing on these areas, APHIS can take a hard look at the impacts and present a meaningful analysis. APHIS did conclude that there were cumulative impacts at the local and regional scale in some cases.

Comment: APHIS fails to adequately analyze cumulative impacts of increased glyphosate use. APHIS says that it is unable to quantify the anticipated increase in glyphosate use.

However, it seems clear that, compared to glyphosate use on conventional sugar beets, the increase will be significant.Glyphosate use would increase on H7-1 sugar beets by about 45-foldcompared to the glyphosate use on conventional sugar beets.

Despite what seems significant in the context of beets, APHIS chooses to examine significance only in the context of the national scale, claiming that the increase in glyphosate use is only "minor."

APHIS evaluated this increase in glyphosate usage in the context of all glyphosate usage . . . glyphosate use on sugar beets with the adoption of H7-1 sugar beets is less than 1% of the total glyphosate use. Therefore, the increase in glyphosate use as a result of the adoption of H7-1 is minor compared to other uses on a national scale.

However, the fact that the relative increase of glyphosate use is "minor" does not mean that the "incremental impact" is minor. APHIS must analyze the "incremental impact" on glyphosate use that will result from the deregulation of sugar beets. APHIS must then analyze this in the context of overall impacts of glyphosate use. Until it does so, APHIS's cumulative impacts analysis cannot meet the requirements of NEPA.

Response: In the environmental consequences section of the DEIS, APHIS analyzes the direct and indirect effects of changes in pesticide use on sugar beets at local levels. APHIS has updated the analysis of total glyphosate use and the contribution of glyphosate use to the total herbicide use at the national level in section V of the FEIS. Analyzing total glyphosate use and change in pesticide use on all crops at the regional and local levels is more challenging because that data is not readily available. Therefore, there is uncertainty regarding the total change in glyphosate use on a regional or local level. Glyphosate is labeled for different uses, many of which do not involve GE crops. Accordingly, depending on regional use, the adoption of H7-1 sugar beet may have a greater or smaller proportional contribution to the change in herbicide use. APHIS has updated the FEIS to examine the regional contributions of H7-1 sugar beet to glyphosate use on GE crops. APHIS discusses the direct and indirect effects of glyphosate on sugar beet to the receiving environment in section IV. The commenter asks APHIS to speculate on the level of glyphosate use that can be tolerated by the receiving environment. However, the FEIS concerns the agency's regulatory decision regarding H7-1 sugar beet, not glyphosate use. EPA regulates the use of glyphosate and other herbicides. The commenter's assertion that there is a specific amount of glyphosate use that would cause significant impacts is based on the assumption that all glyphosate use is equal in its impact on the environment. The quantity of glyphosate that is degraded in the environment is just as important as the quantity of glyphosate that is applied. Many factors contribute to the overall exposure of the receiving environment to glyphosate. These include the application rate, application method, weather, soil type, and application location. The net amount of glyphosate in the local environment at any time is a function of what is applied and what has not yet degraded from previous applications. Glyphosate does not persist for long periods of time. Degradation of glyphosate is discussed in section IV.E.4 of the FEIS. Herbicide use on sugar beet was reanalyzed in the FEIS using survey data from 2011, the latest growing season. The analysis found that higher quantities of glyphosate were used on conventional sugar beets as a preplant burndown than was estimated from data collected in 2000 and that the overall increase in glyphosate use on H7-1 sugar beet was sevenfold, not 45-fold.

Comment: In its scoping section, APHIS lists the following questions relevant to determine the cumulative impact on from increased glyphosate usage:

- **What are the past, present, and future impacts of glyphosate usage on soil quality, water quality, air quality, weed populations, crop rotations, soil microorganisms, diseases, insects,**

soil fertility, food or feed quality, crop acreages, and crop yields as a result of the introduction of glyphosate tolerant

crops?

- **Does the level of glyphosate tolerance within glyphosate tolerant sugar beet plants have an impact on the amount of glyphosate applied on the glyphosate sugar beet crop on a routine basis?**

Response: APHIS agrees that these questions were asked during scoping. However, no one provided information about these areas during the comment period on the notice of intent or the DEIS. APHIS has taken the best available information and used it to assess the cumulative effects of the alternatives on changes in herbicide use, including glyphosate, in the EIS.

Comment: According to the clear language of NEPA regulations defining "cumulative impacts,"APHIS must analyze the incremental impact of its action when added to other past, present, and reasonably foreseeable future actions. To do this analysis, APHIS must be able to answer the following questions:

- **What is the <u>overall environmental impact</u> from glyphosate usage?**

Specifically, according to Table 5-1 on page 650 of the DEIS (see below), what is the environmental impact of the national use of over 178 million pounds of glyphosate?

- **How much will the deregulation increase *impacts from* glyphosate usage?**

Specifically, at what point will the environment be unable to handle even a marginal increase in glyphosate usage?

Table 5- 1

Glyphosate usage on a National Scale						
RR crops	lbs/acre[1]	RR adoption[2]	total acres x 1 million[3]	RR acres x 1 million	lbs x 1000	% of total
Corn	0.95	0.7	87.9	61.5	58454	25.1
Cotton	1.89	0.78	10.9	8.5	16069	6.9
Soybean	1.36	0.93	79	73.5	99919	42.9
Canola	1.125	1	1.5	1.5	1688	0.7
Sugar beet	1.89	1	1.1	1.1	2079	0.9

Response: APHIS has updated table 5-1 in the DEIS (now Table 5-7 in the FEIS) to include more current information on glyphosate use rates. Throughout the FEIS, APHIS extensively discusses the effects of changes in herbicide use under the three alternatives. APHIS has expanded its discussion in section V on the impacts of agriculture to the environment and the incremental contribution of each alternative to those impacts. The focus of the FEIS is APHIS' action on the petition for nonregulated status. APHIS does not regulate glyphosate use or make choices about when or where to apply the chemical. Therefore, the overall impact of nationwide glyphosate use is outside of the scope of this FEIS. As APHIS explains in section V, the majority of glyphosate used in agriculture is not being used in areas where sugar beet is grown, so use on sugar beet cannot contribute to impacts in those regions. APHIS also notes that EPA labels herbicides for use. EPA is currently evaluating glyphosate for re-registration.

Comment: Other problems with APHIS's cumulative impacts analysis include that APHIS claims that any harms of increased glyphosate use will be outweighed by substantial reductions in the use of other pesticides. In order to be analytically meaningful, this statement must be supported by objective analysis over overall impacts from pesticide use.

Response: APHIS includes this analysis in section IV of the DEIS. APHIS has also updated the FEIS to include an analysis of trends in total herbicide use in the United States, including glyphosate use.

Comment: Furthermore, the DEIS does not talk about potential for a monocrop disease. If Monsanto continues to sell GE crops to more and more farmers throughout the country and a significant portion of sugar beet farmers are growing H7-1 beets, a disease specifically targeting this species could devastate the entire Country's crops. This affects both consumers and farmers, alike. NEPA requires APHIS to address these significant impacts.

Response: APHIS disagrees with the comment. The commenter seems to be confused about the distinction between genetic engineering and genetic diversity in crop species. The commenter assumes that all GE crops would be susceptible to the same diseases, which is not true. Corn plants are susceptible to the diseases of corn, and sugar beets are susceptible to the diseases of sugar beets. Furthermore, sugar beets are genetically very diverse, and the H7-1 trait has been bred into hundreds of different varieties. As such, the genetic diversity of H7-1 sugar beet is comparable to the genetic diversity of conventional sugar beet.   Many of the sugar beet varieties are bred to resist particular diseases of sugar beet. Because growers have different disease pressures in different growing regions, some varieties are preferred in some areas and not in others. As described in the FEIS, disease is currently the biggest problem sugar beet growers face, and grower cooperatives typically conduct 3 years of variety trials to assess disease resistance characteristics in each region before adopting a variety. This process helps to avoid the widescale adoption of a variety that will fail to provide disease resistance in a given region. In addition, as part of the PPRA, APHIS assessed pest and disease susceptibility in H7-1 sugar beet and concluded that they are no more susceptible to pests and disease than conventional sugar beet varieties.

Comment: APHIS fails to analyze the cumulative impacts of increased glyphosate use on the creation of super weeds.

Response: Contrary to the commenter's assertion, the DEIS and FEIS contain an extensive analysis of GR weeds, including an analysis of resistant biotypes of weeds that were identified in other regions but could become weeds of sugar beets in the future (see sec. IV.C.3). In addition, APHIS identifies weeds of sugar beet that are resistant to other herbicides (see sec. II.C.3). APHIS has updated the discussion of GR weed selection and spread in sections III.C.3, IV.C.3, and V based on information received during the public comment period on the DEIS and consultations with experts in weed science, including extension agents in sugar beet-growing areas. Unfortunately, there are no comprehensive surveys of the distribution and density of GR weeds on agricultural lands. Reports in current databases do not show the distribution, density, or even persistence of populations over time.

Comment: Super weeds are weeds that have developed a tolerance to glyphosate or other herbicides and, according to farmers interviewed in the *New York Times*, might be "the single largest threat to production agriculture that [farmers] have ever seen." If enough of these weeds exist, Roundup® will no longer be an effective herbicide and farmers will have to use multiple herbicides in their fields. APHIS analysis does not satisfy NEPA because APHIS does not seem sure about how deregulation will affect herbicide use and super weeds. On one hand, APHIS asserts that the deregulation of H1-7 will allow sugar beet growers to control weeds in their own fields more effectively, as well as decrease weed pressure on neighboring fields. On the other hand, APHIS asserts "glyphosate resistant weeds could become a problem for [H1-7] sugar beet growers." APHIS offers little analysis of how the super weeds epidemic will play out. Instead, APHIS points to unenforceable, hypothetical reassurances. For example, APHIS claims "industry and growers are aware of this situation and will likely take proactive measures aimed to reduce and delay the development and spread of glyphosate resistant weeds." Ultimately, however, APHIS has not determined the cumulative impacts of increased glyphosate use because it has not asked the right questions.

Response: The commenter seems to focus on the uncertainty around the future selection and spread of GR weeds, suggesting that it is a flaw in the analysis. APHIS disagrees that it is a flaw to identify uncertainty in future outcomes. Growers choose management practices, including weed resistance management, based on many factors. APHIS cannot control which practices growers will choose, so the agency can only discuss the potential outcomes under different management practices.

In addition, the commenter mischaracterizes APHIS' analysis of glyphosate effects on the selection of resistant weeds and makes a number of assumptions that are incorrect. The commenter defines super weeds as weeds that have developed a tolerance to glyphosate or other herbicides and quotes a New York Times article that states this may be "the single largest threat to production agriculture that farmers have ever seen." APHIS has seen no evidence, and the commenter provides none, to suggest that weeds resistant to glyphosate are somehow more aggressive or invasive than other weeds as implied by the hyperbolic label. The scientific evidence does not support such a hyperbolic concept. Weeds resistant to herbicides have been selected since herbicides were first used in the 1940s, and the farmers quoted in the New York Times article have been dealing with this situation for decades. Any management technique, including tillage or the use of cover crops, will eventually select for weeds that survive the use of that management technique. Thus, there is no contradiction that growers will have more effective weed control with glyphosate use, but that one day they may face a problem controlling GR weeds. It is expected that growers will need to alter and vary management techniques to control the weeds as they are selected against that management technique.

The commenter wrongly asserts that if enough of GR weeds exist, Roundup® will no longer be an effective herbicide. As the FEIS states, Roundup® is effective on over 250 species of weeds. The fact that Roundup® may not be effective on one biotype does not mean that it will no longer be effective on other biotypes of the same weed. Biotypes resistant to atrazine have been prevalent over the last 40 years, yet atrazine has remained the most common herbicide used on corn. Its use has recently been reduced by regulation over concerns of its impacts on nontarget organisms—not because its effectiveness has been diminished due to some weeds developing resistance.

The commenter also implies that there is something wrong with the fact that "farmers will have to use multiple herbicides in their fields." The use of multiple herbicide chemistries has been advocated for years as a best management practice to mitigate the selection of resistant weeds. APHIS does not agree that following a best management practice is bad for farmers.

Comment: In its scoping section, APHIS lists the following questions relevant to determine the Cumulative impact on the development of glyphosate resistant weeds:

- **What glyphosate resistant weeds have been identified and what is their occurrence in crops and in non-crop ecosystems?**
- ***How would the addition of glyphosate tolerant sugar beet impact the occurrence of glyphosate resistant weeds in sugar beet, in other crops, and in the environment?***
- **Which are the most likely weeds, if any, to gain glyphosate resistance and why would they gain such resistance with the use of glyphosate tolerant sugar beet?**
- **What are the current and potentially effective strategies for management of glyphosate tolerant or other herbicide tolerant weeds in glyphosate tolerant sugar beet stands or in subsequent crops?**
- **What are the potential changes that may occur in glyphosate tolerant sugar beet as to susceptibility or tolerance to other herbicides?**

The most pertinent question relating to cumulative impacts is highlighted in bold [and italicized], and currently APHIS has failed to provide a sufficient answer. To find an answer, APHIS must provide much more rigorous and expansive analysis of glyphosate resistant weeds in the environment. It must specifically analyze the impacts of glyphosate resistant weeds resulting from its "past, present, and reasonably foreseeable future" deregulations of other glyphosate crops. For example, APHIS should look back at its approval of at least 87 genetically engineered seeds varieties, not including an additional 22 seeds whose approval status is currently pending. In fact, according to APHIS, it is possible that other herbicide-tolerant sugar beets would be developed in the future. Until APHIS takes a hard look at other past, present, and foreseeable future deregulation decisions, it is impossible to know the cumulative impact of deregulation.

Response: APHIS agrees that these questions were asked during scoping. To the extent that APHIS received information during the comment period on the notice of intent or the DEIS, APHIS has analyzed that data. APHIS has taken the best available information and used it in the assessment. APHIS provides very clear questions to address and answers them in the cumulative impacts section, including the following question noted by the commenter: "How would the addition of glyphosate tolerant sugar beet impact the occurrence of glyphosate resistant weeds in sugar beet, in other crops, and in the environment?" APHIS analyzed the production of all GR crops nationally, regionally, and locally with respect to where H7-1 sugar beet is being produced and concluded that the additional glyphosate use on H7-1 sugar beet could have cumulative impacts on the selection of GR weeds at the local level and identified those local areas. The commenter is not specific about how the agency should look at all 87 GE varieties that have been the subject of approved petitions nor how this would be any different than the analysis that APHIS conducted, which quantitated the amount of GR crops grown in all U.S. geographies where sugar beets are also grown. APHIS does not agree with the commenter's vague assertion that the analysis should be more rigorous and expansive. APHIS also disagrees with the notion that the agency can analyze the impacts of future sugar beet petitions when there are none before the agency.

Comment: APHIS asserts that H1-7 will only contribute "marginally" to the total amount of herbicide resistant crops and glyphosate use. However, in the Northwest, the total increase of herbicide resistant crops may be at least 31% under full or partial deregulation—bringing the total herbicide-resistant cropland to a total of 71%. This increase is not "marginal" by any account. Nevertheless, marginal or not, NEPA specifically requires that APHIS analyze the margin—that is, the "incremental" impact—because the impact of yet another seemingly marginal increase to the total amount of herbicide resistant crops may be greater the sum of its parts. A "meaningful cumulative impact analysis" must ensure that an action is not the proverbial straw that breaks the camel's back. *See Grand Canyon Trust v. FAA*, 290 F.3d 339, 345 (D.C. Cir. 2002). APHIS completely misses the point of cumulative impacts analysis when it concludes that the widespread adoption of glyphosate-resistant crops precludes the need to address the synergistic impacts of H1-7 deregulation.

Response: This comment mischaracterizes APHIS' analysis. APHIS did not conclude that full or partial deregulation would bring the total herbicide-resistant cropland to 71 percent in the Northwest. APHIS states that 40 percent of the cropland is used for crops that have herbicide-resistant varieties. In addition, APHIS never states that 40 percent of the cropland is planted to herbicide-resistant varieties. In fact, most of the cropland is used for alfalfa, which is primarily planted to conventional varieties. However, because a petition for nonregulated status for Roundup Ready® alfalfa has recently been approved, it is reasonably foreseeable that Roundup Ready® alfalfa adoption will increase in the near future. Based on the 50-percent adoption rate supplied by the alfalfa industry, APHIS predicts that about 23 percent of this cropland may someday be planted to herbicide-resistant alfalfa. This prediction is the same regardless of the regulatory decision for H7-1 sugar beet. Furthermore, APHIS states in the FEIS that while about 7 percent of the cropland is currently used to grow sugar beet, the maximum expected total of glyphosate resistant crops in the area is 31 percent—not 71 percent as the commenter calculated—if there is 100-percent adoption of H7-1 sugar beet.

APHIS never concludes in the DEIS or FEIS that H7-1 sugar beet would not have cumulative impacts because its production is small relative to the widespread adoption of GR crops. APHIS examined the production of H7-1 sugar beet at national, regional, and local levels. APHIS concluded that there would be no cumulative effect at the national level because variation in production of other GR crops exceeded the acreages of sugar beet planted at the national levels. However, at the local level, APHIS found areas where glyphosate use on H7-1 sugar beet could have cumulative impacts on the selection of GR weeds. APHIS has revised the FEIS based on information obtained from public comments and survey data published after the publication of the DEIS to describe cumulative impacts that might be measurable at a regional level as well.

Comment: APHIS is certain that H7-1 sugar beets will frequently be grown in rotation with, or proximity to, other glyphosate resistant crops. Increasingly simplified cropping systems (such as one based on the rotation of crops with identical genetic-engineered traits), have been shown to result in weed population shifts driven by ecological adaptation, evolved resistance, and selection for naturally resistant species. APHIS admits that conventional tillage practices and non-glyphosate herbicide applications will likely be needed to address the emergence of glyphosate resistance weeds, yet these forecasts are not

part of APHIS's final calculation. Consequently, H7-1 sugar beet production will significantly contribute to selection pressure for glyphosate resistant weeds. The DEIS must do a better job considering the cumulative impacts of adding another glyphosate dependent crop to the agro-environment.

Response: The commenter concludes that the forecasts of additional conventional tillage and use of non-glyphosate herbicides are not part of APHIS' final calculation. APHIS is not clear to what calculation the commenter is referring. The FEIS provides an extensive discussion of weed management practices, including tillage and the use of non-glyphosate herbicides.

Contrary to the commenter's assertion, the DEIS and FEIS contain an extensive analysis of GR weeds (see sec. IV.C.3). APHIS has updated the discussion of GR weed selection and spread in sections III.C.3, IV.C.3, and V based on information received during the public comment period on the DEIS and consultations with experts in weed science, including extension agents in sugar beet-growing areas. Unfortunately, there are no comprehensive surveys on the distribution and density of GR weeds on agricultural lands. Reports in current databases do not show the distribution, density, or even persistence of populations over time.

The commenter seems to focus on the uncertainty around the future selection and spread of GR weeds, suggesting that it is a flaw in the analysis. APHIS disagrees that it is a flaw to identify uncertainty in future outcomes. The selection and spreads of GR weeds is dependent on many factors, including the management practices adopted by growers. APHIS does not control which practices growers choose, so the agency can only discuss the potential outcomes under different management practices.

Comment: Containment of genetically engineered crop genes has proven ineffective due to human error and other reasons. Transgenic contamination has already occurred in multiple situations for several crops, including corn, rice, canola, soybean, and bentgrass. *Beta* species will suffer a similar fate. APHIS extensively covers the likelihood of cross pollination between beta species and remedies should that occur. Several things are mentioned as potential causes for transgenic contamination that are not thoroughly explored. For instance, transportation of seeds from the Willamette Valley to the Midwest, where most H7-1 root beets are grown, is done by truck. The DEIS does not mention what, if any, procedures are used by trucking companies to ensure that seed does not escape during these trips.

Response: The DEIS and FEIS describe the standard procedures, namely triple containment, used by trucking companies to ensure that seed does not escape. Seed is very valuable, and these precautions are also taken for conventional seed. In addition, no feral populations of sugar beet have established in the United States in the past century, so escape is not reasonably foreseeable.

Comment: Another concern is the potential for bees to transport pollen great distances. The DEIS mentions that bees can pollinate beet plants. Since one method of gene flow is pollen-mediated, this may create the potential for H7-1 genes to travel much further distances than they normally would by wind. The DEIS does not mention how often bees will visit beet flowers, how far they might travel after doing so, and what this could mean for nearby *Beta* species farming. APHIS also does not explain the consequences of contamination given a windstorm event or other above average windy condition. It seems from the size of the pollen clouds created by sugar beets that these consequences would be significant.

Response: Beets' normal route of pollination is by wind. Insect pollinator behavior and the distances over which cross-pollination can occur have been studied extensively on crops that depend on insects for pollination, such as cotton and alfalfa. In alfalfa pollinated by honey bees, cross-pollination was negligible at 3 miles. In cotton, 3 miles is also used as a stringent isolation distance. If 3 miles is an adequate isolation distance for crops that depend on insects for cross-pollination, it stands to reason that the same isolation distance will be adequate to mitigate insect pollination for a crop that is only occasionally pollinated by insects. The fact that 4 miles are used to isolate beets from wind pollination should indicate that this distance is also adequate to isolate these crops from insect pollinators. The FEIS does consider wind effects (sec. III.B.5), citing (Westgate, 2010) who modeled pollen dispersal and outcrossing between agricultural fields. The model used by (Westgate, 2010) takes into account wind and eddy patterns between fields. (Westgate, 2010) considered wind patterns in the Willamette Valley during flowering season from June 1 to July 8 for the past 5 years, which would include a typical range of weather conditions and still concluded that cross-pollination would be undetectable. (Pfender *et al.*, 2007) also note that "A calculation based simply on survival time and average windspeed may overestimate the distance for dispersal, however, because the pollen must be deposited from the air column to be effective in pollination. After reaching appreciable height, probability of immediate deposition decreases due to the relatively slow settling velocity of pollen." In other words, strong winds may increase the dispersal distance of pollen but may not make cross-pollination any more likely.

Comment: H7-1 contamination will have a significant environmental impact. Aside from understating the myriad ways transgenic contamination could occur, APHIS does not sufficiently analyze the impacts that contamination could have on conventional and organic *Beta* species farmers. A farmer's business, as well as his or her reputation, would suffer from contamination of their crops with H7-1 genes. Especially for growers of Swiss chard and Swiss chard seed, which is grown organically and in the same geographical region as H7-1 sugar beet seeds. Discovery of GE plants in a *Beta* crop would certainly lead to decreased business because the Swiss chard market is GE-intolerant. This means that customers that demand GE-free foods, and will not support farmers whose crops are genetically engineered. Farmers are then forced to test all of their seeds and crops for GE genes, adding substantial cost to their businesses solely based on the fear that GE genes will destroy their businesses.

Response: APHIS describes and fully analyzes the potential impacts of H7-1 sugar beet on the GE-sensitive marketplace in section IV.D.4.

Comment: Throughout the Draft EIS, APHIS refers to isolation distances as assurance that transgenic contamination will not be a problem for farmers in the Willamette Valley and elsewhere. It cites the use of "guidelines" by organizations like Willamette Valley Specialty Seed Association (WVSSA) and others, which instruct farmers in practices that will prevent transgenic contamination, see Table 3-3 below. First it must be noted that the guidelines in WVSSA, are "not mandatory." Second, participation in the such organizations is not required for all farmers. Third, the DEIS does not say what percentage of farmers are actually members of these organizations. Without this information, APHIS's analysis does not comply with NEPA.

Isolation distances are dependent on many things that may not be feasible for most farmers. For instance, not every farmer has enough land to create a one-mile to three-mile

radius around an H7-1 field. Additionally, for isolation distances to work, the farmer must ensure that no volunteer plants are growing in the isolation "buffer." Doing this requires manual inspection. Even the most well-intentioned farmer may miss volunteers in such a large buffer area, and that is assuming the farmer has time to manually inspect in the first place. The DEIS does not address the potential effects human error might have in the areas of composting, seed exchange, equipment sharing, or transportation. Further, while the DEIS does mention the fact that it would be impossible to apply these isolation distances to home gardeners, APHIS not mention how prevalent these gardeners are in areas where H7-1 beets might be grown and the extent of harm that contamination would have on home gardens.

Response: APHIS acknowledges that pinning guidelines are not mandatory, that participation in WVSSA is not required, and that the DEIS and FEIS do not indicate what percentage of farmers are actually members of this organization. APHIS disagrees with the commenter's assertion that the analysis does not comply with NEPA without this information included. APHIS obtained the information that it could by talking to local extension agents and all of the major vegetable beet and sugar beet seed producers in the region. APHIS also received a comment from a local organic grower who named several chard seed growers and APHIS contacted all of them. If APHIS missed any growers, they must grow very small acreages to not be noticed by their colleagues. If a farmer does not have enough land to maintain isolation distance, does not have priority, and plants a crop anyway, that grower will jeopardize the quality of both his and his neighbors' crops. Farmers need to maintain isolation distances to protect varietal purity anytime they grow different varieties of sexually compatible crops. Ideally, farmers will cooperate and work together to accommodate each other. The WVSSA has an arbitration process for growers who are in conflict. It is not APHIS' responsibility to work out these differences. APHIS acknowledges that growers can miss volunteers and discusses in the FEIS the possibility that unwanted cross-pollination can occur from abandoned fields. APHIS disagrees that it would be useful to speculate on the numerous ways that human error could introduce contamination but instead focuses on the best management practices used by the sugar beet industry to minimize human error. APHIS is aware that there are many ways that human error can cause admixing, but the agency does not believe they are likely to occur because of the process systems in place.

Comment: Finally, in order for APHIS to rely on isolation distances, NEPA requires that the agency give concrete data as to the effectiveness to date of these procedures. Additionally, APHIS should institute follow-up procedures to ensure that farmers are adhering to the standards they have promised to adopt. Even if APHIS conducted effectiveness studies and instituted follow-up procedures, there is nothing to indicate these procedures would continue should H7-1 be deregulated.

Response: APHIS does not rely on isolation distances for its decision. APHIS makes its decision on whether H7-1 sugar beet is a plant pest, not whether it is capable of pollinating a sexually compatible crop. In addition, APHIS describes extensively in the FEIS that cross-pollination between vegetable beet crops is obvious when it occurs and that the industry has decades of experience minimizing such cross pollination. This is concrete evidence that the guidelines in place are effective. Furthermore, all the growers need to maintain varietal purity. They do not need to be regulated to adhere to industry standards because their customers require that they meet those standards. Should APHIS approve the petition for nonregulated status of

H7-1 sugar beet, growers can still use the practices that they have developed to meet their market demands for varietal purity.

Comment: Although there are rules and arbitration procedures, pinning seems to be self-policing. This offers little assurance to the conventional farmer, the only party in this arrangement that stands to suffer from contamination. The pinning processes is also flawed in that it does not provide notice to seed producers, but instead relies on seed producers to actively explore the potential of transgenic contamination affirmatively. And once a farm has been "pinned" as containing GE plants, it forecloses opportunities for anyone else but GE seed producers to participate in the market. The failure of sufficient regulation in the pinning practices allows for monopolies in the beet seed production, as introducing a wind-carried pollen contaminant into the environment forecloses any competition to non-GE beet seed production with the GE production controlled by a single patent holder.

Response: APHIS disagrees with the above statement. First, it is false that only conventional farmers suffer from cross-pollination. There are three types of compatible beet crops produced in the Willamette Valley. As described in the FEIS, crosses between any of these different crops results in undesirable off-types. Pinning procedures were established to help enable these compatible crops to be produced in the same area. Second, quality control is the seed producer's responsibility. Pinning maps were never meant as a substitute for quality control. They are merely established to help growers coordinate with one another. Third, the pinning of GE sugar beet seed fields do not foreclose opportunities for anyone else. Whether seed fields have GE or non-GE seed, they need to maintain isolation distances in order to meet varietal purity standards. In addition, the commenter ignores the fact discussed in the EIS that 85 percent of the sugar beet acreage in the Willamette Valley produces conventional, not H7-1, pollen. While this percentage can change from year to year, the trend has been to decrease the use of H7-1 pollen parents (male fertile) in the Willamette Valley.

Comment: APHIS fails to analyze organic production commercial impacts. For Oregon table beet and Swiss chard producers, to be able to label their products as organic, they have to be produced in accordance with organic practices as well as be free from GE material, meaning sown from organic seed. Labeling products as organic is prohibited under the Organic Foods Production Act (OFPA) if the products contain any GE material. Seed producers in the Willamette Valley have few choices. Either the producer can choose not to label the products as organic and be shut out of that competitive market, or submit to costly testing of their products to determine if there is any GE material. This is a significant economic impact under NEPA, and APHIS's failure to consider the economic impacts to organic produce growers in seed production areas is insufficient.

Response: APHIS disagrees with this comment. Inadvertent levels of GE material do not violate organic labeling. APHIS analyzed the cost of testing for the GE-sensitive market and considered the economic impacts on organic produce growers. APHIS concluded there would be no impacts because they can obtain their seeds from a tested source or from an area outside of the Willamette Valley. As they produce vegetables, the vegetables cannot be cross-pollinated because they are harvested prior to flowering and production of seed.

Comment: This increased availability of small-scale commercial activity is missing from the analysis, as the increased popularity of non-traditional sources of "commercial" beets and Swiss chard available from Willamette Valley producers is an important aspect of local

agriculture production. Additionally, these producers do not participate in the "pinning" of their crops in relation of known GE seed crops. Because of the unknown nature of cross-pollinating crop locations, the introduction of GE sugar beet material into the environment will not be able to be contained. Additionally, the pinning process is unregulated and varies by state and region. Pinning could also completely prohibit organic seed production on a person's own land if it is within four miles of a "pin." This needs to be studied and evaluated prior to deciding any of the regulatory alternatives proposed.

Response: APHIS disagrees that small-scale commercial activity is missing from the analysis. APHIS gleaned information from declarants in the sugar beet litigation who can be considered small-scale commercial seed producers. It is neither feasible nor necessary for APHIS to have comprehensive information from every backyard gardener who might trade seeds. The fact that these producers choose not to pin compromises all beet seed producers in the area, not just GE beet seed producers. The organic certification agency would determine whether GE beet seed grown within 4 miles of the organic seed production field would be acceptable for the grower under their organic production plan. Prior to the sugar beet litigation, an organic vegetable beet seed producer sought to decrease the isolation distance between hybrid beet production and open-pollinated production from 4 miles to 3 miles, and it is possible that the organic certification agency would agree with this reduced isolation distance. APHIS agrees that pinning processes may vary by State or region. Because pinning is used by growers to establish and maintain a coexistence system that works for growers in the area, it would be expected that each group would adapt their system to meet their area's needs.

Comment: APHIS's reliance on voluntary industry stewardship to conclude that any contamination would be mitigated is arbitrary, capricious, and contrary to record evidence before the agency. Under APHIS's Preferred Alternative, the job of preventing gene flow falls to the actors least likely to take those precautions, namely those who do not care if contamination occurs. A full analysis of the likelihood that such practices will in fact be used is lacking. What little analysis APHIS does provide reveals the agency's reliance on voluntary measures to be wholly misplaced. After adopting a similar strategy to control glyphosate-tolerant weeds, APHIS admits that in some areas 13% of growers are not following best management practices. The DEIS acknowledges that non-adherence to best management practices is a "mechanism that could contribute to the unintended dispersal and movement of sugar beet seed." In the face of these and other similar admissions in the DEIS, the DEIS lacks a rational connection between APHIS's conclusion that transgenic contamination is not likely to occur and the facts before the agency.

Moreover, by now it is clear that usual practices and policy—now given APHIS's imprimatur— will not prevent contamination. Most of the voluntary industry practices that APHIS claims will prevent transgenic contamination are the same practices that were in place when the *Sugar Beets I* court determined that contamination was likely. The DEIS fails to acknowledge that (1) consistent compliance with industry stewardship/best management practices is unlikely, and (2) that even when in compliance, contamination occurs. APHIS's conclusion that transgenic contamination is not likely to occur is flatly contrary to the record evidence, and is therefore arbitrary and capricious. Transgenic contamination occurs with mandatory gene isolation measures in place, equivalent to those proposed in Alternative 3, and will obviously be more prevalent with full deregulation. As

will likelihood of contamination through human error, e.g., through composting and exchanging seeds.

Response: APHIS did not conclude that voluntary industry stewardship would mitigate all cross-pollination. However, APHIS did analyze and determine that voluntary industry stewardship measures do in fact reduce the potential for cross-pollination to a level below 1 in 10,000 (see secs. III.B.1.b.(11), III. B.5, IV.B.1.a., and IV.B.5). Finally, since cross-pollination is not a plant pest risk, applying mitigation measures to prevent it is outside of APHIS' authority under part 340 after APHIS has prepared a full plant pest risk assessment and found that H7-1 poses no plant pest risks.

APHIS describes current industry practices in the FEIS and is using them to analyze the environmental impacts of each of the alternatives. APHIS is not relying on industry practices to mitigate cross-pollination. Because the levels of off-types are market-driven, the industry has adopted practices to meet market demands. APHIS does not regulate one industry so that another can meet its market demands.

Comment: Transgenic contamination is a multifaceted harm, with a significant environmental as well as intertwined socioeconomic impact on farmers and the public. As several Courts have held: "the potential elimination of farmer's choice to grow non-genetically engineered crops, or a consumer's choice to eat non-genetically engineered food, and an action that potentially eliminates or reduces the availability of a particular plant has a significant effect on the human environment." Further, "Once the gene transmission occurs and a farmer's seed crop is contaminated with the Roundup Ready gene, there is no way for the farmer to remove the gene from the crop or control its further spread." Despite documented incidents of RRSB contamination, APHIS nevertheless concludes that granting nonregulated status to RRSB will not have significant impact on the human environment. This conclusion is contrary to the facts before the agency, and therefore violates NEPA.

APHIS's DEIS is deficient because it completely fails to consider and analyze an important aspect of the deregulation decision: the socioeconomic impacts on persons other than agricultural producers. Contamination will not only cost farmers their right to sow the crops of their choice, but also will deprive consumers of the right to feed their families non-GE food. The *Sugar Beets I* court, which ordered APHIS to prepare this EIS, expressly found that these were both cognizable harms pursuant to NEPA in its underlying order. APHIS's failure to analyze the full spectrum of socioeconomic impacts, including impacts on persons who are not agricultural producers, violates NEPA.

Response: This comment does not supply any information to challenge the analysis in the FEIS. Instead, it makes unsupported accusations that APHIS failed to analyze issues. APHIS disagrees with these assertions and refers the commenter to the FEIS. With regard to the economic analysis, APHIS refers the commenter specifically to sections III.D and IV.D. APHIS disagrees with the commenter's claim that H7-1 sugar beets will deprive consumers of the right to feed their families non-GE food (see sec. IV.D.4). APHIS analyzes cross-pollination between *B. vulgaris* varieties in sections III.B.5 and IV.B.5.

Comment: APHIS's analysis of the various alternatives' impacts on minorities fails to consider several significant factors. APHIS correctly notes that, when evaluating the impact that the alternatives will have on minorities, the main minority population to consider consists of farm workers.

However, the DEIS's analysis of the impacts that increasing reliance on Roundup Ready crop systems will have on farm workers contradicts itself. APHIS claims that there will be no differences between the alternatives when it comes to impacts on minorities, yet concludes elsewhere that adoption of RRSB will result in fewer health impacts on farm workers.

APHIS's analysis of the impacts on farm workers also treats changes in the size of the work force inconsistently without explaining why. APHIS concludes that fewer farm workers resulting from less need for hand-weeding is a positive impact because fewer farm workers means fewer health impacts stemming from exposure to pesticides. When it comes to beet factory workers, however, APHIS concludes that having fewer workers is a negative impact because it represents a loss of economic activity. APHIS reaches this conclusion despite its admission that beet factory work is dangerous relative to other jobs and results in injuries. The DEIS lacks any corresponding socioeconomic analysis of the impact of lost farm worker jobs, such as the number of jobs lost, the economic value of that lost income, and which minorities would be disproportionately affected. APHIS's failure to analyze the full socioeconomic effects on minorities, particularly farm worker populations, is arbitrary, capricious, and contrary to the mandates of NEPA.

Response: APHIS updated sections III.D.1 and IV.D.1 in the FEIS to estimate the values of lost wages from hand weeding fields. APHIS explains that a decrease in labor costs would likely result in a decrease in employment opportunities for some people under Alternatives 2 and 3.

Comment: The DEIS does not analyze seed market concentration. Yet, research and development suffer from seed market concentration, in that fewer crop varieties are offered to farmers. Seed companies have aggressively undermined independent researchers' ability to fully investigate their patented crops' performance. Seed companies often want the right to approve all publications, which researchers find unreasonable. This chills research on the performance and potential adverse impacts of GE crops.

The privatization and concentration of the world's seed supply is a serious and continuously evolving problem, compounded with each new GE crop deregulation. "It is estimated that the top ten seed corporations around the globe hold 49-51% of the commercial seed market, and the top ten agro-chemicals control 84% of the agrochemicals market. Likewise, all genetically modified (GM) seeds are bio-patented by multinational corporations and 13 commercial corporations own 80% of the GM food market." As the practical options become limited to varieties patented by Monsanto and the major seed companies, there are effects on the price of seed, and in this case, the price of sugar beets, the price of sugar, and the cost of groceries.

The domination of the seed industry by pesticide firms has driven the research and development agenda towards pesticide-promoting crops such as RRSB. Interestingly, KWS, Monsanto's German partner in development of RRSB, has entered into a collaboration with another pesticide company, Dow Agrosciences. Dow's biggest biotech innovation is corn and soybeans genetically engineered for resistance to 2,4-D, the toxic

chlorophenoxy herbicide that formed part of the Vietnam War defoliant Agent Orange. Dow is heavily marketing its 2,4-D-resistant crops as the false "solution" to glyphosate-resistant weeds. The evidence that RRSB, after just three years of widespread commercialization, is contributing to the glyphosate-resistant weed epidemic in North Dakota and Minnesota, suggests the likelihood that sugar beets resistant to other herbicides will be developed as pesticide-promoting "fixes" to glyphosate-resistant weeds. KWS's collaboration with Dow may well give birth to 2,4-D-resistant sugar beets, offered as the false "solution" to GR weeds in sugar beets tomorrow as it is being marketed for imminent use in soybeans and corn today.

In the longer term, price increases associated with biotech seed, coupled with dramatic increases in herbicide use and costs to combat multiple herbicide-resistant weeds, could well endanger the financial viability of sugar beet farms. Cotton farms face this exact issue are going under thanks largely to epidemic glyphosate-resistant weeds.

The Department of Justice has noticed the effects. In August of 2009, it announced that it would investigate anticompetitive conduct in the seed industry, the recent ability to patent seed having led to unprecedented seed industry concentration. The commercialization of RRSB further exacerbates Monsanto's influence over seed prices and market consolidation. The general public is adversely affected, as increased seed prices are reflected in the cost of food. Concentration of the seed industry "affects virtually every farmer in the country and in a very vital way," and has drawn large crowds at unprecedented hearings scheduled by the antitrust division of the Department of Justice and USDA.

For these and other reasons, the DEIS does not adequately address the cumulative impact of seed market concentration. The seed market concentration impacts of a deregulation of RRSB constitute a significant cumulative impact.

Response: The commenter fails to understand the sugar beet seed industry. APHIS describes the industry in section III.B.1 of the FEIS. The adoption of H7-1 has not changed the companies that grow sugar beet seed or the way that sugar beet seed is tested or marketed in the United States. The marketing and production of sugar beets has no effect on the marketing and production of cotton seed varieties or other GE seeds. In addition, the U.S. Patent and Trade Office—not APHIS—takes actions on patents. General issues regarding what can or cannot be patented is outside the scope of this EIS. Furthermore, APHIS' action on this petition does not affect what can or cannot be patented. The commenter speculates about future variety development. If other varieties are developed in the future, APHIS will analyze the impacts of those varieties if asked to take action on them.

Comment: Second, APHIS's default assumption is that cumulative effects from full deregulation of RRSB will be additive, when in fact some important effects are synergistic with past actions. As discussed further in CFS science comments, the cumulative effects of RRSB cultivation on evolution of glyphosate-resistant weeds are synergistic with, rather than additive to, the effects of pre-existing RR crop systems, at least in some areas and situations (e.g. where RRSB is rotated with other RR crops, which occurs on half of total sugar beet acreage). APHIS's bare mention of the potential for cumulative effects of RRSB cultivation to increase nonlinearly with respect to evolution of glyphosate-resistant weeds is not an analysis, much less a quantitative one, but merely the starting point for such an

analysis. APHIS's quantification of RR crop acreage at the county level is a helpful start, but is unmatched by any corresponding assessment of the relevant effects, increasing acreage infested by GR weeds and responses to those weeds.

Response: According to Merriam-Webster (http://www.merriam-webster.com/dictionary/synergism), synergism is defined as the interaction of discrete agencies (as industrial firms), agents (as drugs), or conditions such that the total effect is greater than the sum of the individual effects. APHIS has not identified any interactions that contribute to the development of herbicide-resistant weeds that are synergistic. The commenter fails to state which interactions he or she believes are synergistic or to supply any evidence to suggest that interactions are synergistic. APHIS has updated the cumulative impacts section in the FEIS to clarify the incremental contribution of each alternative to the cumulative effects of agriculture on physical, biological, and sociocultural resources. APHIS also discusses the incremental contribution of each alternative to the selection and spread of herbicide-resistant weeds.

Comment: RRSB is grown in rotation with one or more other RR crops. Because glyphosate resistance takes several years to evolve, glyphosate use with each of the RR crops in the rotation contributes to the selection pressure that triggers the evolution of the GR weed. Hence, it will in most cases never be possible to attribute the GR weed to the production of any single RR crop in a field where several are grown in rotation. This does not mean, and cannot be used as a pretext to assert, that RRSB is not contributing to the evolution of GR weeds. Further, a glyphosate- resistant waterhemp has recently been confirmed in hundreds of North Dakota fields covering thousands of acres planted to corn, soybeans and sugarbeets, likely a result of continuous glyphosate selection pressure acting on rotations involving two or three RR versions of each crop.

Response: APHIS has analyzed this issue in the cumulative impacts section of the FEIS and has concluded that on a local level H7-1 sugar beet contributes to the selection and spread of GR weeds. This local effect may contribute to an impact on a regional scale in areas with a high incidence of successive GR crops, including North Dakota, Minnesota, Michigan, Nebraska, and Colorado.

Comment: Third, APHIS fails to provide any structured assessment of the cumulative effects of glyphosate-resistance in weeds in combination with pre-existing resistances to other herbicides. In general, the adverse effects of acquisition of glyphosate resistance would increase disproportionately with the number of pre-existing resistances in the pertinent weed population, a synergistic cumulative effect in NEPA terms. Cumulative effects increase disproportionately as progressively more resistances shrink the universe of control options to the least desirable herbicide(s) – least desirable because, for instance, more expensive, more toxic, less effective, more time- consuming, more soil-eroding, etc. Synergism is at play in another sense: As the universe of effective herbicides diminishes with accumulation of resistances, more selection pressure will be exerted on weed populations to evolve resistance to the few remaining effective options than would be the case if a larger array of herbicidal alternatives were in play. Hence, as a general rule, each resistance a weed population acquires sets the stage for more rapid evolution of resistance to the remaining effective mode(s) of action.

Response: APHIS disagrees with the commenter's vague assertion that there are synergistic cumulative effects. The story told by the commenter is pure conjecture. Section IV.C.3 of the

FEIS discusses the control of multiply-resistant weeds. The FEIS concludes that glyphosate is an additional tool to control weeds, including those that are resistant to other herbicides. By controlling weeds that are resistant to other herbicides, glyphosate use can reduce the weed seed bank, thereby decreasing the availability of these weed biotypes to cross with other resistant biotypes. APHIS analyzes how the adoption of H7-1 sugar beet under Alternatives 2 and 3 could incrementally affect weed management costs. There is no evidence that the development of resistance to herbicides with one mode of action makes a weed more likely to become resistant to an herbicide with a different mode of action. In addition, data do not support the notion that a second resistance develops more quickly than the first.

Comment: The DEIS emphasizes the prevalence of sugar beet weeds resistant to non-glyphosate herbicides, but purely to stress the short-term benefits of RRSB-associated glyphosate use in controlling them. APHIS provides no analysis of the medium- to long-term impacts of glyphosate- resistance, particularly when already resistant weeds acquire additional resistance to glyphosate. Instead, APHIS merely acknowledges that use of non-glyphosate herbicides and tillage "may" increase "if" GR weeds become more prevalent due to RRSB cultivation, APHIS's hypothetical response disregards facts in the record, and is thus arbitrary and capricious.

Response: APHIS is unclear about which "facts in the record" the commenter refers. APHIS analyzes the medium- and long-term impacts of weed management under the different alternatives in the FEIS. These include the adoption of resistance management techniques, such as cover crops, residual herbicides, and tillage. APHIS has updated the cumulative impacts section to incorporate this analysis from section IV.

Comment: Regarding already-resistant weeds and their potential to acquire additional resistance to glyphosate, APHIS dismisses concerns as a matter of luck. However, the accumulation of resistances to different herbicide modes of action is clearly a very significant cumulative effect, in that it can transform a troublesome weed into a noxious weed, which can have numerous adverse impacts on the interests of agriculture, natural resources, and the environment. In Illinois, agronomists warn that if already quad-resistant waterhemp acquires resistance to the sole remaining post-emergence herbicide that can control it (glufosinate), which they think likely, growing soybeans may become "impractical" in some Midwestern fields. Palmer amaranth resistant to glyphosate and often to ALS inhibitors is wreaking havoc in the South, and a glyphosate-resistant population has recently been confirmed in Michigan.

Response: APHIS agrees that the selection of weeds resistant to multiple herbicides is a serious problem, and it is one that will continue under all three alternatives considered in this FEIS. Weed scientists believe that the best way to approach this problem is to develop new herbicide options and to follow best management practices, such as crop rotation, use of multiple herbicide chemistries (especially the use of residual herbicides), use of cultivation, use of cover crops, monitoring of weeds, and others management practices described in the FEIS (Tranel *et al.*, 2011) (see APHIS-2010-0047-4530). Contrary to the commenter's viewpoint, herbicide-resistant crops are part of the solution. If GR crops were not deployed, the situation that the commenter raises concerns about—namely that post-emergent herbicides would no longer be available to control waterhemp in soybean—would have occurred in 2000 when waterhemp developed resistance to three herbicides (PSII, ALS, and PPO inhibitors). The availability of GR and glufosinate-resistant crops has provided two additional herbicide options that have positively impacted agriculture, natural resources, and the environment. Moving forward, an important component will be educating growers about not relying on a single weed management strategy so that herbicide-resistant crop technology can be employed sustainably. Eliminating herbicide options for America's farmers would, through regulation, create the very scenario feared by the commenter. Herbicide-resistant crops coupled with growers' implementation of proactive strategies may allow control of multiple herbicide-resistant weeds. Therefore, Alternative 2 does the most to alleviate the commenter's concerns about control of herbicide-resistant weeds.

Comment: Glyphosate-resistant common ragweed is spreading exponentially in the sugarbeet growing counties of Minnesota and North Dakota. Since "[t]he majority of common ragweed populations in ND and MN contain some frequency of biotypes resistant to ALS-inhibiting herbicides," many of these GR weeds will have dual resistance, leaving just one effective herbicide option – clopyralid (Stinger) – to control glyphosate-resistant ragweed in sugar beets. Acquisition of resistance to that last herbicide could have serious socioeconomic impacts, as growers' fields become overrun with weeds unamenable to control, drastically reducing yields, making harvest difficult or uneconomic, and perhaps even putting farmers out of business. Andrew Kniss's admonition in his USDA NIFA research proposal, warned that RRSB will likely lead to "near total reliance on" glyphosate, which in turn "will almost surely lead to glyphosate resistant weeds," *leaving growers with "few acceptable management options."* (This statement is directly contrary to Mr. Kniss's declaration that APHIS relies on so heavily, See CFS Science Comments for further discussion and documentation).

Response: APHIS analyzed information supplied by the commenter's organization in comment number APHIS-2010-0047-4351. The commenter misinterpreted the data in the International Survey of Herbicide Resistant Weeds. Reports on the spread of common ragweed have not been verified, so it is premature to conclude that the populations are increasing exponentially. APHIS also pointed out that not using the "last herbicide" will have the same serious socioeconomic impacts as that future day when GR weeds have become "uncontrollable". The only difference is that the commenter argues for that day to be today and not at some future time.

The agency disagrees with the commenter's characterization of Dr. Andrew Kniss's statement. Dr. Kniss' point was that if growers totally rely on glyphosate, GR weeds will surely follow. Therefore, he recommends developing alternative management strategies and pursued the investigation of the use of ethofumesate in combination with glyphosate to introduce a second herbicide mode of action for weed control in H7-1 sugar beet. APHIS does not find Dr. Kniss's statement to be contradictory. This statement is consistent with best management practices advocated by the Weed Science Society of America. APHIS analyzes the development of GR weeds and their management in section III.C.3 and the socioeconomic impacts of weed management in section V.

X General comments on the sufficiency of the EIS

Comment: Under NEPA, agencies must ensure the professional integrity, including the scientific integrity, of the discussions and analyses in their environmental impact statements. In doing so, they must "discuss at appropriate points in the final statement any responsible opposing view which was not adequately discussed in the draft statement and shall indicate the agency's response to the issues raised." As noted above, the PPA also requires that APHIS decisions be based on "sound science."

APHIS's analysis of several critical issues avoids serious consideration of evidence that is contrary to its preferred outcome. The DEIS is arbitrary, capricious, and violates NEPA and the PPA because it relies on scientific and economic analyses that APHIS knows to have been discredited—judicially, by prior inconsistent statements, or by overwhelming scientific consensus. For instance, CFS submitted comments on the draft environmental assessment for partial deregulation of RRSB (hereinafter referred to as CFS Science Comments 2010, included in supporting materials) that provide evidence refuting and discrediting APHIS's unsound science with respect to glyphosate-resistant weeds, yet APHIS continues to rely on discredited views in the draft EIS.

Response: APHIS disagrees with the commenter. APHIS has in the DEIS and FEIS considered opposing views, has reviewed data submitted by those who oppose deregulation, and has not relied on discredited views. Further, APHIS' decision on the PPA regarding the plant pest risk posed by H7-1 is clearly based on sound science and does not rely on discredited views. APHIS responded to comments submitted by this commenter on the environmental assessment (EA) (USDA-APHIS, 2011a).

Comment: In assessing the socioeconomic impacts of the three alternatives on the sugar beet industry, the DEIS relies heavily on opinions by Dr. Sexton, an expert witness on behalf of industry Intervenor-Defendants in prior litigation regarding RRSB. In that litigation, Dr. Sexton provided opinions on the same topics as those discussed in the DEIS: the economic impacts of halting full scale production of RRSB. However, the district court in *Sugar Beets II* found Dr. Sexton's opinions to be unreliable. Dr. Sexton's estimates regarding the net economic benefit of adopting H7-1 are based on hearsay: self-reported data from industry groups either involved in pending RRSB litigation or with economic interests in its outcome. Dr. Sexton also did not consider the impacts of fluctuating commodity prices on profitability or on a farmer's choice of crops, or the cost of Monsanto's technology fee for its patented seed in the costs of producing RRSB. Dr. Sexton's methodologies are unreliable and cannot be used to support the DEIS's conclusions about economic impacts. .

Response: APHIS disagrees with this comment because APHIS has included an extensive analysis of the socioeconomic impacts of each of the three alternatives evaluated in the DEIS and FEIS. APHIS used the best available information from various sources, including Dr. Sexton. APHIS disagrees that Dr. Sexton used unreliable methodologies. The criticism is that he obtained his data from industry groups that have an economic interest in the outcome. However, the industry groups are the only source of the data. Dr. Sexton did a sound analysis using the best information available. Growers, beet processors, and others indirectly affected by the beet industry commented on the DEIS, and their comments are consistent with the analysis in the DEIS and FEIS, namely that they derive a significant economic benefit from producing H7-1 sugar beet. Samples of these comments are included earlier in this Response to Comments section. In addition, Dr. Sexton's analysis that economic harm under Alternative 1 might result in closure of additional sugar beet processing plants is in accord with the history of sugar mill and refinery closings over the last 15 years, during which 13 mills closed and none have opened (FEIS table 3-31). The commenter does not suggest any additional socioeconomic impacts that are not included in the DEIS.

Comment: In its analysis of the likelihood that RRSB will hasten the emergence of glyphosate-resistant weeds, the DEIS also relies on opinions by Andrew Kniss. These opinions are contrary to evidence before the agency. Specifically, the DEIS relies on weed control practices contradicted by record evidence and Mr. Kniss's own prior inconsistent statements. The DEIS also fails to acknowledge contradictory and inconsistent evidence. It does not meet NEPA's requirements regarding professional and scientific integrity in the decision making process.

Response: APHIS disagrees with this comment. APHIS has reviewed Andrew Kniss's declarations and papers and, contrary to the commenter's assertion, has found them to be consistent amongst themselves and with weed science papers and weed science experts' recommendations. Because the commenter fails to specify examples of contradictory and inconsistent evidence, APHIS cannot further assess the validity of this assertion.

Comment: Although APHIS makes repeated claims that pollen flow from RRSB is "not likely to occur," APHIS has not measured the likelihood or possibility of pollen flow from RRSB to sexually compatible *Beta* crops at the 4-mile isolation distances the industry is meant to observe. APHIS instead relies on analysis and studies with, at best, a tenuous connection to observational data. APHIS's reliance on overly derivative and unreliable scientific analysis here is therefore arbitrary, capricious, and contrary to NEPA and the PPA.

Response: APHIS has relied on the best available scientific studies and observations of growers in the Willamette Valley, which support the conclusion that cross-pollination is not likely to occur (see sec. IV.B.5).

Comment: The DEIS states that "[d]espite testing over 3 years, no evidence of H7-1 gene flow has been detected." APHIS supports this statement with a reference to a declaration in prior *Sugar Beets* litigation, without providing further context. Critically, the DEIS fails to disclose the existence of confidential evidence before the agency, introduced during *Sugar Beets I, II* and *III*, revealing that H7-1 gene flow has occurred, and continues to occur. APHIS's conclusion to the contrary disregards facts before the agency. Failure to address this contrary evidence is arbitrary, capricious, and violates NEPA and PPA's mandates concerning professional and scientific integrity.

Response: We disagree with the commenter's characterization of the information, which, as the commenter notes, is confidential and thus APHIS cannot explicitly discuss or disclose this information in this Response to Comments section. However, APHIS has fully analyzed, considered, and reviewed the confidential evidence referenced and has concluded that the information does not controvert or call into question APHIS' analysis regarding H7-1 gene flow as examined and analyzed in the DEIS and FEIS.

Comment: The DEIS claims that, should growers rely on a single herbicide (glyphosate) to control weeds, glyphosate-resistant weeds would nevertheless take five or more years to develop. CFS rebutted this erroneous prediction, including discussion of the sources APHIS cited, in comments on the draft environmental assessment for partial deregulation (CFS Science Comments 2010). APHIS also fails to acknowledge contrary evidence introduced at all stages of the *Sugar Beets* litigation that glyphosate-resistant weeds are currently infesting fields where RRSB is grown.

Failure to address this contrary evidence known to APHIS is arbitrary, capricious, and violates NEPA and PPA's mandates concerning professional and scientific integrity.

Response: APHIS disagrees with this comment. APHIS addressed this comment in the Response to Comments for the draft EA (USDA-APHIS, 2011a). APHIS has considered and reviewed all evidence regarding glyphosate that was discovered and presented during the Sugar Beet I and II litigation. Furthermore, the specific instance of whether weeds would develop resistance in 5 years in sugar beet refers to selection of a new biotype, not the movement of a GR weed from another crop into sugar beet fields that would happen under any of the alternatives. The commenter conflates the two instances. The FEIS clearly distinguishes these two possibilities and analyzes them in section IV. C.3. In areas where other GR crops are not being grown extensively, GR weeds have not been identified as a problem in sugar beet crops although H7-1 sugar beet has been grown for 4 years.

XI Other Environmental Laws

Comment: To the limited extent APHIS claims to have "consulted" with the U.S. Fish and Wildlife Service (FWS), APHIS did not follow mandatory procedures under the Endangered Species Act (ESA). These failures are significant because glyphosate—directly stemming from APHIS's approval of the Roundup Ready Sugar Beet crop system -- is known to be highly toxic to several listed species that may be present where RRSB will be grown and therefore affected.

APHIS must make a written request to FWS for a list of the listed species (or species proposed to be listed) in the proposed action area that may be present. This request is crucial to the ESA decision process, because only a determination by FWS "based on the best scientific and commercial data available" can decide whether or not APHIS must then prepare a biological assessment. Here, Appendix F indicates that APHIS did not make any such request, much less prepare a biological assessment.

Additionally, APHIS violated Section 7(a)(2) of the ESA by failing to consult with FWS—informally or formally—about the effects of RRSB deregulation on listed species and critical habitat. Under ESA, there is only one determination that can conclude 7(a)(2) consultation: whether the proposed action is "likely to adversely affect" listed species or critical habitat. APHIS and FWS may not decline to consult, or prematurely terminate consultation, without performing any analysis at all, simply based on their (erroneous) conclusion that any adverse effects are some other agency's problem to solve.

The increase in glyphosate use resulting from full deregulation of RRSB will create direct, indirect and interrelated impacts on several endangered species. As Appendix E reveals, there are myriad plant and animal species listed as endangered or threatened where this anticipated increase in glyphosate is to occur and that therefore may be affected by the agency's action. ESA requires APHIS to solicit information about the potential adverse impacts to these species, and if they may be affected by the agency's proposed action, to consult with the expert agency, so that APHIS may then tailor its action to avoid any such harms.

By failing to complete Section 7(a)(2) consultation based on an erroneous legal assumption regarding its duties under the ESA, APHIS based its analysis on factors Congress did not intend for it to consider. Deregulating RRSB without completing consultation would therefore be arbitrary, capricious, and contrary to the mandates of the ESA.

Response: APHIS disagrees with the commenter's statements that glyphosate use directly stems from APHIS' approval of the H7-1 sugar beet cropping system and is known to be highly toxic to, and will affect, several listed T&E species that may be present where sugar beet will be grown. If APHIS decides that it is appropriate for H7-1 sugar beet to have nonregulated status because it does not pose a plant pest risk, that regulatory decision removes H7-1 sugar beet from being regulated under part 340; it does not in any manner legally approve—nor require—farmers who choose to grow H7-1 sugar beet to use or apply glyphosate on their planted H7-1 sugar beet.

APHIS likewise disagrees with the commenter's characterization of how it should or must consult with the U.S. Fish and Wildlife Service (USFWS) as well as with the commenter's statement that APHIS must prepare a biological assessment analyzing the impacts of glyphosate use on H7-1 sugar beet.

In USFWS' Section 7 Consultation technical assistance instructions (see http://www.fws.gov/midwest/endangered/section7/s7process/7a2process.html), USFWS explains that Federal agencies must review their actions and determine whether the action may affect Federally listed and proposed T&E species or proposed and designated T&E critical habitat. To accomplish this review, Federal agencies must request from USFWS a list of T&E species and critical habitat that may be in the project area or request USFWS' concurrence with their species list. Once a species list is obtained or verified as accurate, Federal agencies need to determine whether their actions may affect any of those T&E species or their critical habitat. If T&E species and their critical habitat are unaffected, no further consultation is required. If Federal agencies determine that any of those T&E species or their critical habitat are or may be affected, then consultation with USFWS is required. This consultation will conclude either informally with written concurrence from USFWS or through formal consultation with an issuance of a biological opinion provided by USFWS to the Federal agency.

APHIS began an analysis of any possible impacts on T&E species that could result from growing and harvesting RRSB by obtaining a list of all T&E species in the different U.S. regions where sugar beets are or may most likely be grown (see app. E). APHIS uses a specifically developed "decision tree" to perform its Endangered Species Act (ESA) reviews and to indicate what issues topics and questions need to be brought to the USFWS for either formal or informal consultation. APHIS completed an analysis of potential impacts on T&E species and determined that H7-1 sugar beet plants would have no impact on any T&E species or critical habitat in any U.S. regions likely to have H7-1 production sites.

APHIS concluded that the H7-1 sugar beet plant would have "no effect" on any T&E species or on their critical habitat (nor on any species proposed to be listed as T&E or on their critical habitat) in those regions of the country where H7-1 sugar beet is, or most likely will be, grown.

On June 15, 2011, APHIS met with USFWS officials to discuss whether APHIS has any obligations under the ESA to analyze the impacts of herbicide use associated with all GE crops on T&E species. As a result of these joint discussions, USFWS and APHIS agreed that it is not necessary for APHIS to perform an ESA effects analysis on herbicide use associated either with H7-1 sugar beet or other currently planted GE crops.

The registration and all approved uses of glyphosate are under EPA's legal jurisdiction and control. APHIS has no legal jurisdiction to regulate, control, restrict, or approve any registration or uses of glyphosate or any other pesticide. The EPA-approved label provides specific use requirements for the application of glyphosate to H7-1 sugar beet that must be complied with by anyone who uses glyphosate on them.

Under APHIS' current part 340 regulations, APHIS only has the authority to regulate H7-1 sugar beet or other GE organisms if the agency believes they may pose a plant pest risk. APHIS has no regulatory jurisdiction over any other risks associated with GE organisms, including risks resulting from the use of herbicides or other pesticides on those organisms. Nevertheless, based on assessments provided by EPA and information in peer-reviewed scientific literature, APHIS is aware that there may be potential environmental impacts resulting from the use of glyphosate on H7-1 sugar beet, including potential impacts on T&E species and critical habitats. APHIS provides this information in the FEIS.

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