## Appendix 1. USDA Notifications and States Approved for Environmental Releases of DAS-40278-9 corn, DAS-68416-4 soybean, and DAS-44406-6 soybean

**Table 1-1. USDA Notifications and States Approved for Environmental Releases of DAS-40278-9 corn**

| USDA Notification Number | Notification Authorization Date | Notification Expiration Date | State(s) |
|---|---|---|---|
| 09-086-105n | 4/20/2009 | 4/20/2010 | IL, IN, IA, MN, MO, NE, WI |
| 09-090-107n | 4/21/2009 | 4/21/2010 | CA, GA, IL, IA, IN, KS, MI, MN, MO, OH, NE, NJ, OK, PA, TX |
| 09-075-106n | 3/26/2009 | 3/26/2010 | HI, IA, IL, IN, MN, NE, NE, SD, WI |
| 09-061-005n | 4/6/2009 | 4/6/2010 | IA, MN, MS, NY, OH |
| 09-005-107n | 1/15/2009 | 1/15/2010 | HI, IL, IN, IA, NE, PR |
| 08-259-103n | 10/15/2008 | 10/15/2009 | HI |
| 08-133-107n | 6/1/2008 | 6/1/2009 | IL (1), TX (1) |
| 08-021-110n | 4/1/2008 | 4/1/2009 | IA |
| 08-021-104n | 3/20/2008 | 3/20/2009 | IL (7), IN (11), IA (6), MN (4), MS (1), NE (4), WI (3) |
| 07-242-103n | 10/15/2007 | 10/15/2008 | HI |
| 06-338-101n | 1/29/2007 | 1/29/2008 | HI |
| 05-308-03n | 12/13/2005 | 12/13/2006 | HI |

**Table 1-2. USDA Notifications and States Approved for Environmental Releases of DAS-68416-4 soybean**

| USDA Notification Number | Notification Authorization Date | Notification Expiration Date | State(s) |
|---|---|---|---|
| 09-259-105n | 9/25/2009 | 9/25/2010 | PR |
| 09-086-101n | 5/30/2009 | 5/30/2010 | IL, IN, IA, MN, MO, NE, WI |
| 09-084-110n | 4/15/2009 | 4/15/2010 | AL, AR, CA, GA, IL, IN, IA, MI, MN, MO, MS, NE, OH |
| 09-075-105n | 4/15/2009 | 4/15/2010 | HI, IN, IA, PR |
| 09-068-101n | 4/13/2009 | 4/13/2010 | AR, IL, IN, IA, MD, MI, MO, ND, NE, OH, PR, WI |
| 09-061-104n | 4/6/2009 | 4/6/2010 | AR, IL, IN, IA, MN, MS, NY, OH, TN |
| 09-005-108n | 1/1/2009 | 1/1/2010 | HI |
| 08-323-102n | 12/3/2008 | 12/3/2009 | PR |
| 08-254-110n | 9/26/2008 | 9/26/2009 | PR |
| 08-170-103n | 6/26/2008 | 6/26/2009 | MO |
| 08-137-103n | 6/5/2008 | 6/5/2009 | MD |
| 08-121-103n | 5/14/2008 | 5/14/2009 | IA |
| 08-121-102n | 5/15/2008 | 5/15/2009 | IL, IN, MO, NE, OH |
| 08-071-107n | 4/14/2008 | 4/14/2009 | CA, IL, IN, IA, MN, MN, NE |
| 07-242-107n | 9/30/2007 | 9/30/2008 | PR |
| 06-292-105n | 12/1/2006 | 12/1/2007 | IN |

**Table 1-3. USDA Notifications and States Approved for Environmental Releases of DAS-44406-6 soybean**

| USDA Notification Number | Notification Authorization Date | Notification Expiration Date | State(s) |
|---|---|---|---|
| 11-095-105n | 4/29/2011 | 4/29/2012 | MS |
| 11-087-114n | 4/20/2011 | 4/20/2012 | AL, AR, GA, IL, IN, MD, NE |
| 11-067-105n | 3/30/2011 | 3/30/2012 | AR, CA, IA, IN, IL, LA, MN, MO, MS, OH, WI |
| 10-243-104n | 9/30/2010 | 9/30/2011 | PR |
| 10-085-103n | 4/19/2010 | 4/19/2011 | GA, IA, IN,IL, MI, MO, NE |
| 10-083-105n | 4/22/2010 | 4/22/2011 | IA, IN, MO,MS |
| 10-077-107n | 4/14/2010 | 4/14/2011 | GA, IA, IN,IL, MD, MO,NE, OH, PR |
| 09-259-108n | 10/5/2009 | 10/5/2010 | PR |
| 09-068-103n | 4/1/2009 | 4/1/2010 | IN, PR |
| 08-254-109n | 9/30/2008 | 9/30/2009 | PR |

[1]Pending reports as of June 21, 2011 to be submitted within six months of the notification expiration date.

# Appendix 2. Summary of Public Comments on the Petitions, draft EAs, and EIS Notice of Intent

**Public Scoping Comments**

Members of the public were invited to participate in the scoping process for this draft EIS through an announcement of a notice of intent (NOI) to prepare an environmental impact statement (EIS) in connection with making a determination on the status of DowAgrosciences (DAS) petitions 09-233-01p (event DAS-40278-9 corn), 09-349-01p (event DAS-68416-4 soybean), and 11-234-01p (event DAS-44406-6 soybean). APHIS published a Notice of Intent (NOI) to prepare an EIS for the three petitions and requested public comments for scoping the EIS in the Federal Register on May 16, 2013. The 60-day public comment period closed on July 17, 2013. The docket file was published at http://www.regulations.gov/#!docketDetail;D=APHIS-2013-0042.

In this NOI, APHIS asked for comments, data, and information regarding 18 broad, overlapping issues. APHIS also requested the public to provide suggestions for other issues to be discussed or alternatives to be analyzed in the draft EIS. During this comment period, APHIS received 41 comments (see summary in Table 2-1) with an additional 9 comments from the virtual public meetings (see summary in Table 2-2). Comments were made by interest groups, industry representatives, industry trade organizations, growers, private individuals, scientists, agronomists and crop specialists, and a Federal agency. Full text of the comments received during the open comment period is available online at www.regulations.gov.

In addition to posting written comments directly to the docket, members of the public were given opportunities to provide their comments directly to APHIS during public meetings held on June 26 and 27, 2013. Transcripts of the public meetings are available as follows:

For the June 26, 2013, virtual meeting:

http://www.aphis.usda.gov/biotechnology/downloads/VPM/062613/VPM_062613_transcript.pdf

For June 27, 2013, virtual meeting:

http://www.aphis.usda.gov/biotechnology/downloads/VPM/062713/VPM_062713_transcript.pdf

In all, a total of 50 public comments were received with 41 public comments submitted to the docket folder on the NOI for the preparation of an EIS on 2,4-D-resistant corn and soybean and an additional 9 comments were given on the NOI during the virtual meetings.

APHIS used the public comments to identify issues to be considered in development of the Draft EIS. A number of commenters indicated they object to APHIS Notice of Intention to prepare an EIS, finding the level of analysis performed in the EAs scientifically sufficient. These commenters felt preparing an EIS unnecessarily keeps valuable traits and tools currently needed by growers battling herbicide-resistant weeds.

Overall, the comments submitted echoed the issues previously raised in the public comments made on the petitions and/or draft EAs for the three events. Most of the comments continued to voice concern over the potential increased use of 2,4-D by growers with adoption of the three deregulated events. While APHIS recognizes these concerns, APHIS does not regulate pesticide use. EPA is reviewing and analyzing the information DAS has submitted in support of the registration of their new 2,4-D choline salt formulation. This includes assessing the physical and chemical properties of, fate and transport of, and impacts to the environment and human health from the new formulation. APHIS has no input into the decision of permitting the use of the new 2,4-D formulation; therefore, those issues are not analyzed in this EIS.

The public comments on the NOI, the two draft EAs, and the petitions were grouped into several main themes. Below is a summary of the issues identified in the public scoping comments.

**1. Alternatives**

- Consider an alternative involving mandatory weed resistance management.
- Provide an assessment of Integrated Weed Management (IWM) systems or non- chemical tactics as an alternative to deregulation of DAS-68416-4 soybean for the stated purpose of Dow's product, to provide a means to control glyphosate-resistant weeds
- The statement of purpose and need is missing from the notices. To what need and for what purposes are *petitioners* responding in developing and commercializing their products? The answer to this question largely determines the range of reasonable alternatives the agency must consider in the NEPA process.
- Granting (with or without conditions) or denying petitions does not constitute "alternatives" to be considered in NEPA's environmental impact statement process; rather, they are decision options for the agency (see my earlier comment for explanation). Alternatives that must be considered under NEPA relate directly to the purposes of and need for proposed actions.

**2. Inserted Genes/Plant Composition**

- Degree of resistance conferred by the transgene in different plant parts and stages of development.
- APHIS did not take into account the potential toxicity of DAS-40278-9 corn, DAS-68416-4 soybean, and DAS-44406-6 soybean to listed species that might eat leaves, roots, stems, or flower parts. Migrating birds, for example, eat parts of the soybean plant. Bees consume the pollen and nectar, and presumably other insects do as well. Soybean detritus washes into wetlands.
- APHIS should initiate consultations with FWS and NMFS concerning the approval of DAS-40278-9 corn, DAS-68416-4 soybean, and DAS-44406-6 soybean.
- Assess the characteristics of DAS-40278-9 corn conferred by the activity of the novel enzyme AAD-1 and potential impacts.
- Analyze composition of the AAD-1 protein in the crop after exposure of DAS-40278-9 corn to 2,4-D or quizalofop.
- Perform additional research and information regarding any impacts to the nutritive value of DAS-68416-4 soybean compared to non-GE soybean. The commenter stated that the U.S. Food and Drug Administration (FDA) noted several differences in the compositional analysis of DAS soybean. Although the FDA recognized DAS-68416-4 Soybean as safe, the commenter requested a description of the differences, including supporting data, to confirm the DAS soybean is as safe as conventional soybean varieties. The commenter also requested additional research beyond the initial 15-day study to determine the safety of the

AAD-12 protein to confirm the nutritional differences would not affect human or animal health.

- More research must be done to show that these nutritional differences do not result in any functional differences that could affect human or animal health when this corn is present in food or animal feed.
- Information on the degree of resistance conferred by the transgene in different plant parts and stages of development should be available for review by APHIS and the public.
- Information on the expression of the transgene in pollen, nectar; levels of herbicide residues and metabolites in pollen, nectar should be available for review by APHIS and the public.

**3. Miscellaneous**

- Prove the deregulation will neither jeopardize any species nor harm any critical habitat anywhere the crop system may be grown.
- The conversion of natural areas and Conservation Reserve Program lands to corn production and the resultant increase in herbicide use would result in adverse impacts to listed threatened and endangered species, because these areas have not been previously farmed and are likely to support native species.
- Tillage can greatly reduce selection pressure on herbicides and thus aid in prevention of herbicide resistance. Tillage can also aid in management of resistant weeds once they become a problem. Tillage, however, is not an option in most cases. Our growers have worked hard to make no-till a success on their farms. They adopted no-till partly because of conservation compliance requirements in the past several farm bills. But regardless of conservation compliance, the major driving force was economics. Savings in fuel, labor, and equipment through no-till production helped growers remain competitive. A return to tillage would be a step backwards in terms of productivity and environmental protection. Moreover, growers simply do not have the labor and equipment to go back to tillage.
- Address the cumulative impact of seed market concentration. The seed market concentration impacts of a deregulation of 2,4-D resistant corn constitute a significant intertwined socioeconomic impact that is reasonably foreseeable.
- Assess economic impact of the higher cost of 2,4-D resistant corn to farmers.
- APHIS should find or develop studies that explore the extent to which pricing strategies for HR crop systems (e.g. high-priced seed, low-cost herbicide) reinforce herbicide use patterns that foster resistance in the case of 2,4-D-resistant corn and soybeans.
- Consider the possible impacts that yet another genetic trait can have on farmers in Mexico and around the world where native maize and wild corn relatives are not only grown, but an indispensable part of their culture and the economy.
- Conduct a larger analysis of domestic socioeconomic impacts given that biotech soybeans are more costly than non-biotech seeds and would increase costs for farmers.
- Herbicide tolerant crops have made the no-till system much more timely and cost effective for our operation. The no-till system is so effective at controlling erosion in our area that if we had to go back to tillage to control resistant weeds, the long-term cost would be very high in soil loss alone.
- Biotechnology has allowed plant breeders to develop soybeans that are tolerant to herbicides, thus allowing soybean farmers to better control weeds and implement no-till

and conservation tillage practices that save fuel, reduce erosion, and protect the environment.

- APHIS must assess 2,4-D-resistant corn and soybeans as crop systems comprising the herbicide-resistant crop itself and associated use of 2,4-D.
- APHIS should examine both short-term and long-term impacts of the proposed herbicide-resistant crop systems in the light of what has been learned from real-world experiences with previously approved herbicide-resistant crop systems. What are the likely similarities and differences in terms of environmental, health and economic concerns?
- APHIS has often claimed that, although individual farmers may be affected by releasing genetically engineered organisms in the area, when examined in total, none of the potential business losses is expected to be so severe as to amount to a significant impact. This determination fails to recognize that environmental "significance" exists at all levels—"society as a whole (human, national), the affected region, the affected interests, and the locality."
- The USDA's Environmental Impact Statement must include, at a minimum research on how the ingestion of foods manufactured from these crops will affect human health and how the continued use of the herbicide in agriculture could endanger agricultural workers and the general public.
- Thus, 92% of Georgia cotton growers hand-weed 52% of the crop with an average cost of $23 per hand-weeded acre, which is an increase of at least 475% as compared to hand weeding costs prior to resistance. In addition to increased herbicide use and hand weeding, growers in Georgia have indicated that they are using mechanical, in-crop cultivation (44% of acres), tillage for the incorporation of pre-plant herbicides (20% of the acres), and deep turning (19% of the acres every three years) to aid in Palmer amaranth control. Current weed management systems are extremely diverse, complex, less environmentally friendly, and costly when compared to those systems employed only a decade ago. Growers are in desperate need of new technologies that will aid in the management of glyphosate-resistant Palmer amaranth, and other problematic weeds, for long term sustainability.
- The introduction of soybeans tolerant to 2,4-D will allow an additional mode of action to be used in the system, allowing for better weed control and harvested soybeans with less foreign material from weed seeds, a valuable characteristic for processors.
- APHIS should assess the socioeconomic consequences of 2,4-D-resistant corn and soybeans, in terms of increased land and rental prices from increased competition for land, increased average size of farms, and accelerated exit of small- to medium-size farmers from agriculture.

## 4. Herbicide Resistant Weeds

- Provide analysis of the prevalence/emergence of glyphosate-resistant weeds.
- Weed resistance is a well understood scientific phenomenon that is not unique to biotechnology or any other form of agriculture. Different herbicides attack weeds by different methods or "modes of action."
- Overuse of any herbicide technology leads to selection pressure for development of resistance to that technology. Resistance to other herbicides was problematic previously and thus will continue to present management problems for growers in terms of herbicide

alternatives that remain as effective options. New cases of weed resistance will evolve in response to current soybean weed management programs.

- Science has clearly shown that there is a risk of resistance development to all herbicides, and 2,4-D and dicamba are no exception. In fact weeds have evolved resistance to nearly all forms of weed control including herbicides, tillage, mowing and hand weeding.
- The greatest risk for developing herbicide resistance is actually occurring right now with the PPO herbicides and glufosinate. These products are being over-used in certain cropping systems as farmers have no other effective herbicide options. The 2,4-D and dicamba resistant crops could be used to delay resistance development to the PPO herbicides and glufosinate and, in turn, weed management systems could be developed using the PPO herbicides, glufosinate, 2,4-D and dicamba, extending the life of each of these chemistries.
- Growers need multiple modes of action to help manage herbicide-resistant weeds.
- Because of the resistance threat, growers are now more likely than ever to utilize multiple weed management strategies (tillage, row spacing, cover crops, residual herbicides, mechanical cultivation, hand-weeding) in combination with herbicide-resistant crops.
- APHIS provides no empirical assessment of farmer use of resistant weed mitigation measures at all, but rather flaccidly relies on Dow's stewardship program, which is quite similar to Monsanto's stewardship program for RR crops.
- APHIS fails to provide any critical assessment of Dow's stewardship plan.
- Evaluate the potential for the increased use of 2,4-D associated with the adoption of DAS corn and soybean events to exacerbate the problems of herbicide-resistant weeds by accelerating the evolution of 2,4-D resistant weed populations.
- The Enlist™ technology will not be an exclusive answer to resistance development, but will be an extremely important tool in the development of comprehensive, science-based approaches to resistance management.
- APHIS fails to provide any assessment of the special proclivity of HR crop systems, or DAS-68416-4 soybean in particular, to trigger evolution of resistant weeds. The rapid emergence of GR weeds in RR crop systems is evidence of the resistant weed-promoting effect of HR crop systems in general and a proper analysis would have provided APHIS with important insights into the risks of resistant weed evolution in the context of the DAS-68416-4 soybean system.
- Evaluate the potential for 2,4-D-resistant weeds in 2,4-D resistant cropping systems. APHIS must take into account the reasonably foreseeable impact of future 2,4-D resistant crop deregulations in analyzing the development of superweeds that are resistant to 2,4-D and "fop" herbicides. Multiple resistance will develop in response to widespread use of 2,4-D in corn and soon, if approved, in soybean and cotton.
- Without effective herbicide options for controlling resistant weeds, growers are left with no choice but to re-introduce intensive tillage systems for weed management.
- Resistance to auxin herbicides has not been prevalent throughout the world (relative to other commonly used herbicides such as atrazine, imazethapyr, or glyphosate) due to at least three main reasons: (l) auxin herbicides have a complicated mode or action with multiple target sites (Kelley and Riechers, 2007), (2) weeds that evolve resistance to auxin herbicides have typically displayed a 'fitness cost', which means that the plant is less physiologically fit or less competitive in the absence of the herbicide in relation to wildtype (i.e., sensitive to 2,4-D) plants, and (3) auxin herbicides have rarely been used by themselves but are instead typically applied in tank mixtures.

- Resistance to 2,4-D and dicamba represents no more a threat to agricultural production than resistance to other critical herbicides and the likelihood that it will be used in a manner consistent with best management practices is good.
- Stacking 2,4-D and dicamba tolerance with that of glyphosate, glufosinate, and other herbicide tolerant traits will further facilitate the use of these herbicides in a diversified program. Stacking herbicide traits does not in itself promote the evolution of resistance to more than one herbicide since, just as for individual herbicides, the evolution of resistance is a function of how the herbicides are used rather than a function of the selectivity of the crop to multiple herbicides.

### 5. Impacts Resulting from the Increase of Resistant Weeds

- Assess the reasonably foreseeable impact of increased tillage, soil erosion, and herbicide use to control weeds that become resistant to 2,4-D, quizalofop and/or glyphosate.
- APHIS provides no meaningful assessment of the costs to farmers or U.S. agriculture from the reasonably foreseeable evolution of weeds resistant to 2,4-D or glufosinate.
- Provide assessment of the impacts or costs to farmers of past herbicide resistance that it has triggered pattern of weed control, the use of herbicides, and the increased cost to farmers.
- Discuss the increasing costs and labor to combat resistant weeds that persist and spread in fields.
- Because the development of herbicide-resistant weeds and volunteer corn are reasonably foreseeable impacts of 2,4-D resistant corn cultivation, the analysis needs to consider the negative impacts on conservation tillage.
- Herbicide-resistant weeds lead directly to adverse impacts on farmers, the environment and public health. Adverse impacts include the increased costs incurred by growers for additional herbicides to control them, greater farmer exposure to herbicides and consumer exposure to herbicide residues in food and water, soil erosion and greater fuel use and emissions from increased use of mechanical tillage to control resistant weeds, environmental impacts from herbicide runoff, and in some cases substantial labor costs for manual weed control. These are some of the costs of unsustainable weed control practices, the clearest manifestation of which is evolution of herbicide-resistant weeds.
- As the spread of glyphosate-resistant weeds occurred, the adoption of tillage, including deep tillage with a moldboard plow has once again become more common. The return of conventional tillage has led to increased wind and water erosion. Neither 2,4-D nor dicamba technologies would eliminate tillage, but they would greatly reduce the need for deep tillage allowing many farmers to return to more reduced tillage production systems.
- APHIS must assess the potential for 2,4-D crop systems to foster resistance, not only to 2,4-D, but also to dicamba, and the impacts such cross- resistant weeds (against a background of resistance to glyphosate, ALS inhibitors and/or other herbicides), would have on weed control in soybeans, corn and other crops. Known weed biotypes with resistance to either 2,4-D or dicamba should be tested for tolerance to the other, to help establish the potential for such cross- resistance.
- APHIS must assess the potential for 2,4-D crop systems to further increase soil erosion through increased use of tillage to control the 2,4-D-resistant weeds that will be generated by these crop systems.

## 6. Weed Resistance Management

- Evaluate in detail the farmer use of resistant weed mitigation measures or effectiveness of the mitigation measures.
- Provide an assessment of weed resistance stewardship, including the flaws of past stewardship plans or how they might be improved.
- APHIS failed to consider that the value of crop rotation for suppressing weeds is undermined when rotated crops are resistant to the same herbicides.
- New and expanded uses of existing herbicides are needed for integrated weed management programs in order to mitigate weed resistance and meet our current and future crop production needs.

## 7. Volunteer Corn/Soybean

- Estimate the cost to farmers for controlling volunteer DAS- 40278-9 corn which will become a problematic "resistant weed" in its own right by virtue of its resistance to two to four herbicides.
- Assess the dispersal of herbicide resistance traits via pollen or seed dispersal or its implications for stewardship practices.
- Dow discusses the potential for DAS-68416-4 soybean to cross with soybeans possessing other herbicide resistance traits to produce soybean volunteers with resistance to additional herbicides. Indeed, three different GE soybean events with resistance to dicamba (Monsanto), the HPPD inhibitor isoxaflutole (BASF), and imidazolinone herbicides (Bayer) are presently pending deregulation decisions by USDA (APHIS Pending Dereg 2012). Such crossing could result in volunteer soybeans resistant to four or more classes of herbicide.
- Soybean is primarily a self-pollinating crop, but the potential for perhaps considerable cross-pollination is suggested by the frequency with which pollinators – bees (honeybees and wild bees), wasps and flies – visit soybean fields (Anonymous 2012, O'Neal & Gill 2012). Insect pollinators are known to effect pollination at considerable distances from the source plants, including from primarily self-pollinating crops (e.g. Pasquet et al. 2008).
- Even if soybean cross-pollination is relatively uncommon, it could give rise to problematic volunteer HR soybean control problems where it does occur, with the adverse consequences noted above.
- APHIS should consider scenarios with volunteers that have stacked resistance. The assessment should include increased costs of control, increased use of herbicides, increased weed resistance risks from a narrowing of herbicidal control options and increased reliance on those (few) herbicides still effective.
- HR corn volunteers produce lower levels of Bt toxin and thereby promote Bt resistance in corn rootworm; the more HR traits in the corn volunteers, the less likely they will be managed adequately, and hence the more likely they will contribute to Bt resistance.

## 8. Impacts on Organic and Non-GE Crops

- Assess the socioeconomic impacts of transgenic contamination on the entire organic industry.

- Complete a full analysis of the economic impacts due to GE contamination for organic and non-GE growers. GE crops can cross-pollinate with non-GE crops, contaminating conventional or organic crops. This contamination can result in a rejection of loads by the Organic Trade Association, resulting in economic losses for farmers, previously estimated at 40 million dollars annually. APHIS needs to reevaluate the effect of DAS-40278-9 corn on organic corn, as cross-pollination may pose a plant pest risk.
- Include an analysis of the cost of testing, tracing and separating DAS- 40278-9 corn and DAS-68416-4 soybeans to avoid contamination of non-GE crops and the subsequent impact on exports.
- Assess the potential impacts of deregulating 2,4-D-resistant corn on the supply of organic corn feed.
- Genetic admixture is an environmental concern that can cause the alteration of a plant's deoxyribonucleic acid (DNA) by transmitting a GE gene to a non-GE plant, in turn, causing a loss of biodiversity that could result in the potential elimination or reduction of conventional and organic corn varieties.
- Evaluate the impact of deregulating 2,4-D resistant corn and the subsequent transgenic contamination on both the public's and the grower's ability to choose non-GE corn; consider individual choice or the social or economic impact of eliminating that choice.
- Evaluate the impacts of GE admixture through feed and food products on animal and human food chains, and related human health impacts.

## 9. Cumulative Impacts

- Address the potential cumulative environmental impacts resulting from reasonably foreseeable future crops with "stacked" genetic traits.
- Consider the cumulatively significant impacts of all synthetic auxin herbicide-tolerant crops.
- Impact analysis should consider drift not only from 2,4-D resistant corn, but also the use of 2,4-D in other reasonably foreseeable 2,4-D-resistant GE crop systems that are now pending before APHIS.
- Assessment of the resistant weed impact of DAS-68416-4 soybean grown in rotation with Enlist™ corn.
- Dow plans to sell this GE 2-4,D soy "stacked" with resistance to glyphosate and glufosinate herbicides, yet neither Dow nor USDA has analyzed the potential synergistic or cumulative impacts that these planned combinations pose. Glufosinate has both reproductive and neurological toxicity to mammals, and on this basis is slated to be banned in the EU by 2017.
- Assess the cumulative impacts of growing multiple HR crops, including changes in herbicide use patterns, weed resistance, human health effects, environmental effects from herbicide drift and runoff, and harm to wildlife, in particular threatened and endangered species and their critical habitats.
- APHIS must take into account any reasonably foreseeable impacts of conferring multiple herbicide-resistant traits via stacking of different resistance traits in the same crops, growing crops with different resistance traits in the vicinity of each other within a given year, and using the same resistance traits in rotation crops, for example.

The following issues related to herbicide use were identified from public comments. As noted, above, herbicide use is regulated by EPA. EPA is evaluating DAS' submission for their new 2,4-D choline salt formulation and will be making those assessments available to public. Therefore, these issues are listed here but for the most part are not being addressed in this EIS. When these issues are covered they are included in the Appendices.

**10. Herbicide Use and Impacts from Herbicide Use**

- Examine the potential for increased use of 2,4-D, glyphosate, glufosinate, and quizalofop associated with deregulation of DAS-40278-9 corn, DAS-68416-4 soybean, and DAS-44406-6 soybean. Consider the rate applied per application, number of applications per season, and number of acres planted.
- Project the shift in herbicide use patterns associated with DAS-40278-9 corn, DAS-68416-4 soybean, and DAS-44406-6 soybean.
- USDA has not thoroughly assessed the environmental risks associated with many of these transgenic crops. 2,4-D is a volatile herbicide, which can easily drift onto nearby crops, vegetables and flowers. In fact, a comparative risk assessment found that 2,4-D was 400 times more likely to cause non--target plant injury than glyphosate.
- The transgene confers resistance to 2,4-D, glufosinate, and glyphosate, and in conjunction with the insertion site and genetic background of the host plant, determines how much 2,4-D, glufosinate, and glyphosate can be applied and when during the growing season without injuring the crop. Thus the pattern of tolerance to the herbicide(s) is event-specific and should be described by the applicant in the Petition, and the implications rigorously explored by APHIS in a robust analysis pursuant to the National Environmental Policy Act (NEPA) and the Plant Protection Act.
- Compare increased herbicide use to conventional varieties.
- APHIS must disclose and analyze the impacts of herbicides used on a deregulating DAS-40278-9 corn on both organic and conventional non-GE corn.
- Fully address impacts from the shift of use rates among different herbicides that may accompany deregulation of DAS-40278-9 corn, DAS-68416-4 soybean, and DAS-44406-6 soybean.
- Provide a detailed examination of the cumulative effects of stacking 2,4-D resistant corn with other herbicide tolerances.
- Acreage likely to shift in herbicide use from glyphosate to synthetic auxin herbicides is not identified.
- If an engineered crop is immune to injury even at rates higher than allowed by label or at later times in development, experience has shown that growers will push or exceed the label limits in situations where there is weed pressure. APHIS needs to explore the implications of removing biological constraints to herbicide use in their assessments.
- USDA must consider the biological opinion of the National Marine Fishery Service regarding 2,4-D registration.
- Benefits of 2,4-D technology for the Georgia cotton grower would include: 1) Improved weed control; 2) Prevention of additional herbicide resistance development; 3) Reduction in herbicide use; and 4) Reduction in tillage, wind erosion, and soil erosion.

- An enormous amount of research by the registrants and other weed scientists around the world has been conducted to develop methods to minimize the potential for off-target movement. These efforts include 1) improving herbicide formulations, thereby reducing volatility and/or drift, 2) improving application equipment techniques and application methods, thereby reducing drift, and 3) developing educational materials to assist growers in reducing off target movement when making pesticide applications. There is no question these research efforts will greatly minimize off-target movement of all pesticides, not just 2,4-D and dicamba, and will greatly improve the ability of a grower to apply pesticides that stay in the targeted area.
- APHIS must project the impact of 2,4-D-resistant corn and soybean systems (with additional resistance to glyphosate and/or glufosinate) in further reducing populations of milkweed in agricultural fields and thus exacerbating the decline in Monarch populations.
- APHIS must assess the impacts of 2,4-D-resistant corn and soybean systems (with additional resistance to glyphosate and/or glufosinate) on amphibian populations.

**<u>Herbicide Use - General</u>**

- Any questions or concerns about the use of 2,4-D in a 2,4-D-tolerant soybean cropping system should continue to be addressed through the authority of the Environmental Protection Agency (EPA) to regulate the safe use of registered herbicides.
- Assess potential impacts to animals in fields of DAS-68416-4 soybean in light of the foreseeable increase in exposure to herbicides and their metabolites based on realistic use scenarios and a wide range of relevant independent scientific studies in order to compare alternatives.
- Assess the potential of the Enlist™ corn and soybean systems to increase drift-related crop injury as well as potential mitigation measures.
- Assess the negative environmental impacts of pesticide drift associated with the prevalence of glyphosate-resistant weeds.
- Assess cumulative impact of a combination of herbicides on water resources, including the impacts to surface water from off-site movement of herbicides.
- APHIS should consider late, off-label treatment of crops, and include protection of insects, birds, reptiles, amphibians or other animals.
- Examine impacts that increased herbicide use in DAS-68416-4 soybean would have on those nearby habitats.
- The potential impact on the plant population diversity within treated fields of DAS-40278-9 corn and the resulting impacts to animals from those changes should be evaluated.
- Concerns about the impacts to plant and animal biodiversity in and around cornfields from increased pesticide use due to implementation of DAS-40278-9 crop systems.
- The estimated increase in herbicide use would likely jeopardize species and critical habitats protected under the Endangered Species Act (ESA). A “failure by USDA to recognize the risks of jeopardizing endangered species and adversely modifying their critical habitats would not be in compliance with the statutory requirements of the National Environmental Policy Act (NEPA).”
- Dow plans to sell this GE 2-4,D soy “stacked” with resistance to glyphosate—the active ingredient in Roundup—and glufosinate herbicides, yet neither Dow nor USDA has

analyzed the potential synergistic or cumulative impacts that these planned combinations pose.

- The ability to effectively control weeds is one of the most important factors in profitable crop production. The use of glyphosate in Roundup Ready crops was a highly cost-effective approach to weed control for many years, but heavy reliance on glyphosate-only weed control programs eventually led to the development of glyphosate resistant weeds, including marestail, waterhemp, Palmer amaranth, kochia and giant ragweed, that are difficult to control with current technologies.
- Weed management will be much more successful if postemergence 2,4-D treatments are used in conjunction with preemergence residual herbicides that can provide extended control. The use of preemergence herbicides as part of an integrated approach has increased in recent years due to the difficulties of controlling glyphosate resistant weeds and because of the improved commodity prices. This approach helps minimize potential for early season weed competition and provides more flexibility and better efficacy with the postemergence treatment. The other huge benefit is that by utilizing more herbicide modes of action, the risk of developing herbicide resistant weeds is greatly diminished.

**<u>Herbicide Use - 2,4-D</u>**

- Assess impacts associated with the potential increases in use of 2,4-D, quizalofop, and their metabolites on non-target animal communities, particularly on the honeybee population.
- Thoroughly evaluate the likely increase in 2,4-D application, along with the associated environmental and public health impacts.
- Adequately account for the unique risks associated with 2,4-dichlorophenoxyacetic acid (2,4-D) herbicides.
- Evaluate health risks posed by drift of 2,4-D onto unsuspecting victims. There is no worse herbicide for drifting long distances and damaging fruit and vegetable plants than 2,4-D, and the introduction of these resistant varieties will make it far more likely that such drift will be occurring with increasing frequency in the future. For some growers, it will make their livelihoods untenable and for homeowners in the country, they will see increasing damage of their gardens and trees of 2,4-D drift.
- APHIS and EPA must assess the increased incidence of disease to be expected with the substantial increase in 2,4-D use accompanying introduction of these crop systems.
- Farmers have a long history of successfully using proper equipment and application procedures to avoid and minimize off-target movement of herbicides. Similarly to other herbicide products, off-site movement of 2,4-D can be prevented through proper stewardship, application techniques, equipment settings and consideration of environmental conditions during application, such as wind speed….. newer 2,4-D formulations have been developed to substantially reduce volatility compared to first-generation products. We are also pleased that the petitioner has addressed the potential for off-site movement by prohibiting aerial applications and implementing specific environmental and equipment application requirements on the 2,4-D label, including a wind-directional buffer when sensitive areas are present, and the use of low volatility 2,4-D formulations.
- Adequately assess the potential for an increased health risk to farmers and farmworkers using 2,4-D.

- APHIS needs to reconsider potential risks to animal communities from eating DAS-68416-4 soybean tissues or drinking runoff containing residues of 2,4-D and the unique metabolites.
- The developer in the future may petition the EPA for an increased tolerance for 2,4-D simply because residues increase with increased 2,4-D use, and that APHIS should consider the health implications of such higher levels of 2,4-D likely to be found in food. USDA must consider the effects that higher 2,4-D residues in food would have on human health.
- Account for the risks associated with 2,4-D and their severity relative to the potential harm associated with other herbicides.
- Increase in 2,4-D use would increase the amount of herbicide in surface waters, adversely impacting drinking water quality. This will have implications for fragile wetland areas, especially those under conservation.
- Impacts need to be assessed not only for the direct toxicity of the herbicides (2,4-D and quizalofop) and their metabolites on animal communities, but also for animals that may be indirectly exposed by over-spraying, brushing up against newly sprayed foliage, or feeding on corn leaves that may receive a higher dose of herbicide, as well as drinking surface water potentially impacted from surface runoff containing the herbicides.
- APHIS must comprehensively assess the increased drift damage that would occur with various 2,4-D-resistant corn and soybean adoption scenarios, both in terms of lost yield and income, broken down by major crop (e.g. soybeans, cotton) or crop category (e.g. vegetables). APHIS should further assess the extent to which 2,4-D-resistant crop adoption would reduce plantings of susceptible crops (e.g. vegetables, grapes) and/or shift acreage to 2,4-D- tolerant crops that could withstand drift level doses (e.g. corn).
- APHIS must account for the inevitable use of more drift-prone 2,4-D formulations (e.g. because likely to be cheaper than the choline salt), and not presume an ideal world scenario where only potentially less drift-prone formulations are used.

**<u>Herbicide Use – Glufosinate</u>**

- Analyze the health impacts stemming from the expected increase in use of glufosinate.
- Glufosinate poses significant ecological risks to nontarget plants and animals and the implications from increased use as a result of the determination of nonregulated status of DAS-68416-4 Soybean should be included in the EA.
- Analyze the potential impact from the metabolite of glufosinate, methylphosphinicopropionic acid (MPPA), which could also pose human health risks, especially to pregnant women and their fetuses. Research should be completed on this metabolite to ensure that it will not be detrimental to wildlife, especially those plants and animals protected by the Endangered Species Act.

**<u>Herbicide Use – Quizalofop</u>**

- Need complete information on the environmental impacts of 2,4-D and quizalofop.
- Perform human health assessment of the occupational exposure to quizalofop
- Assess impacts associated with the potential increases in use of 2,4-D, quizalofop, and their metabolites on non-target animal communities, particularly on the honeybee population.

- Impacts need to be assessed not only for the direct toxicity of the herbicides (2,4-D and quizalofop) and their metabolites on animal communities, but also for animals that may be indirectly exposed by over-spraying, brushing up against newly sprayed foliage, or feeding on corn leaves that may receive a higher dose of herbicide, as well as drinking surface water potentially impacted from surface runoff containing the herbicides.
- Synergistic effects of the combined use of 2,4-D and quizalopfop have not been considered for the increased ecological risks.

**Herbicide Use - Dioxin Impurities in 2,4-D**

- USDA and EPA should conduct an assessment of the greatly increased exposure to dioxins that would be triggered by Enlist™ soybeans and corn in light of EPA's ongoing review of dioxin toxicity, both cancer and non-cancer risks.
- Include analysis for the health impacts from dioxin contamination in 2,4-D. Impacts to human reproduction and to workers from exposure to dioxin (especially 2,3,7,8-TCDD) have not fully been considered and analyzed and request that these impacts be analyzed.
- Assess potential short- and long-term impacts on animals from the dioxin impurities, as well as 2,4-D.
- Evaluate potential effects of the dioxin impurities on treated pollen from DAS-40278-9 corn on honeybees and other animal populations that are in contact with/collect pollen.
- Need cumulative effects on human health and environment from dioxin and potential effects on surface water quality and non-target plants and animals (including endangered species).
- Assess the increased dioxin emissions and exposure associated with incineration of unrinsed 2,4-D containers that would result from the vastly increased use of 2,4-D with Enlist™ soybeans and corn.
- USDA should conduct or commission independent dioxin testing of 2,4-D formulations.

**Herbicide Use - 2,4-D Metabolites**

- APHIS failed to fully consider the impacts of increased 2,4-D use, related DCP-conjugates, and increased glyphosate.
- APHIS needs to consider the impacts to human health of exposure to DCP and DCP conjugates that are a result of the activity of the engineered AAD-12 enzyme in DAS-68416-4 soybean.
- The types and levels of DCP and DCP conjugates in DAS-68416-4 soybean forage and hay after 2,4-D applications need to be compared with independent research on 2,4-D and DCP metabolism in conventional soybeans (Pascal-Lorber et al. 2003), and any differences explained.
- DCP conjugates were not included in the evaluation of whether DAS-40278-9 corn will meet tolerance requirements in forage and fodder, and suggested that, if DCP conjugates had been included, with the assumption of similar toxicity to free DCP, tolerance levels would be exceeded
- APHIS should consider levels of all expected toxic residues and metabolites; and assess impacts to non-target organisms of the novel, potentially toxic constituents expected to

result when 2,4-D with DAS-68416-4 soybeans under a variety of anticipated application scenarios.

- Evaluate potential impacts of pollen containing residues and metabolites not found in conventional pollen that might make it toxic to organisms that come in contact with it.
- APHIS did not take into account independent research and Dow studies showing that potentially toxic metabolites do occur as a result of the engineered trait. USDA should carefully consider the impacts of the accumulation of novel molecules with similarity to known toxins in DAS-68416-4 soybean. APHIS needs to know if the AAD-12 enzyme alters *metabolism* in DAS-68 416-4 soybean such that the plants have a new composition after 2,4-D is used, and thus have the potential to harm non-target species. APHIS must consider whether DCP and its conjugates are present in soluble fractions of DAS-68416-4 soybeans after AAD-12 enzyme acts upon 2,4-D in order to fully assess the impacts to non-target organisms and on human health.
- APHIS should consider whether DCP and its conjugates are present in soluble fractions of DAS-40278-9 corn after the AAD-1 enzyme acts upon 2,4-D in order to fully assess the "plant pest risks" to non-target organisms
- Consider the possible toxicity of the metabolites that are present in DAS-40278-9 corn exposed to herbicide substrates of the ADD-1 protein, and the impact of this toxicity to listed species, requiring formal USFWS consultation.
- Information on the herbicide residues and metabolites in plant tissues from the time of application through post-harvest should be available for review by APHIS and the public

**Table 2-1. EIS Public Scoping Comments Submitted Online**

| Comment # | Comment ID | Commenter | Comment Excerpt | Topic Area |
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| 1 | APHIS-2013-0042-0002 | Jean Public | The American Public wants this permit denied. Monsanto and Dow are releasing harmful items to the American Public with these unregulated soybean and corns. | N/A |
| 2 | APHIS-2013-0042-0003 | Carl Bausch | Undertaking the National Environmental Policy Act process for the identified petitions is both wasteful and superfluous. | N/A |
| | | | Granting (with or without conditions) or denying a petition does not constitute “alternatives” to be considered in the NEPA process; rather, they are decision options for the agency. Alternatives that must be considered under NEPA relate directly to the purpose and need for a proposed action, the statement of which, again, is missing from the notice. | |
| 3 | APHIS-2013-0042-0004 | Illinois Farm Bureau (IFB) – Philip Nelson | These traits have already gone through USDA's rigorous regulatory review protocol and there have been no scientific, findings to warrant additional EIS. On behalf of nearly 83,000 Illinois farmers, I write today to request-that, APHIS move expeditiously when completing this seemingly superfluous regulatory review. | |
| | | | Biotechnology has produced vast improvements in farm production practices, permitting farmers to do more with less. Herbicide-tolerant seeds are simply another tool for our producers to utilize towards helping feed the world's ever increasing population. These technologies will have a positive impact on farming and the food that we produce. | |
| 4 | APHIS-2013-0042-0006 | U.S. Department of Interior, National Park Service – Roxanne Runkel | The National Park Service supports the objective identified or development of science that addresses the Environmental Issues for Consideration identified o pages 28799 [of the Federal Register notice]. The NPS is concerned about the indirect effects on the soil and water quality in NPS areas as a result of increased herbicide use. We believe the indirect effects on soil and water quality as a result of increased herbicide use of the products proposed to be de-regulated, be evaluated. | Herbicide use - effects on soil and water |
| 5 | APHIS-2013- | Louis Metzman | I implore you to not approve release of 2,4-D resistant plants. I have | Herbicide drift |

| Comment # | Comment ID | Commenter | Comment Excerpt | Topic Area |
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| | 0042-0007 | (grower) | had colateral damage from 2,4-D drift to my fruit orchard and my 5 acre tree planting and to landscape plants at my house 6 times over the past 14 years - this is a very dangerous herbicide that tends to vaporize and cause damage to neighboring plants. This damage is all too common with this particular herbicide.<br><br>Forester Mike Warner, with Mike Warner ARBORTERRA Consulting, tells me he has been asked to check on 15 claims of what he feels are 2,4-D damage so far this year. I can only imagine the damage we will see with more widespread use of this very dangerous chemical. It causes damage very far away to plants - how will we know who did the damage, and how will we hold them responsible? And, with no accountability, they can spray with impunity. Also, perhaps in future years we will find out it was also harmful to the people who are also exposed to it. | |
| 6 | APHIS-2013-0042-0009 | David Ortman | • The EIS should include an alternative prohibiting field testing of herbicide resistant corn and soybeans.<br>• The EIS should provide an estimate and analysis of the quantities of 2,4-D and glyphosate that would enter watercourses and waterbodies, including within our nation's coastal zone, under alternatives that would ban herbicide resistant corn and soybeans; that would continue herbicide resistant corn and soybeans as regulated articles; and under Dow AgroSciences LLC's request for nonregulated status.<br>• The EIS should set out a testing protocol for determining the level of Glyphosate and 2,4-D in water bodies in order to establish a baseline for future evaluations of Glyphosate and 2,4-D use due to "herbicide resistant" corn and soybeans.<br>• The EIS should set out a testing protocol for determining the level of Glyphosate residues in shellfish and fish to assure that residue tolerances are not exceeded and to ensure that | |

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| | | | 2,4-D residues are not present. | |
| 7 | APHIS-2013-0042-0011 | Carl Bausch | • Where specifically in chapter 104 of title 7 of the United States Code is APHIS authorized to regulate the introduction (importation, interstate movement, or release into the environment) of genetically engineered organisms and products?<br>• Why does APHIS feel it is necessary to undertake a costly (to industry and taxpayers), unnecessary environmental impact statement process when a conventional risk assessment establishes that the organism is not a plant pest and that APHIS therefore lacks jurisdiction (see my earlier comment for explanation)?<br>• The statement of purpose and need is missing from the notices. To what need and for what purposes are *petitioners* responding in developing and commercializing their products? The answer to this question largely determines the range of reasonable alternatives the agency must consider in the NEPA process.<br>• Granting (with or without conditions) or denying petitions does not constitute “alternatives” to be considered in NEPA’s environmental impact statement process; rather, they are decision options for the agency (see my earlier comment for explanation). Alternatives that must be considered under NEPA relate directly to the purposes of and need for proposed actions.<br>• APHIS NEPA documents are not written in plain language, as required by the NEPA implementing procedures (40 C.F.R. § 1502.8).<br>• Monitoring, which is an essential component of the NEPA process (40 C.F.R. § 1505.3), should be employed in biotechnology permitting to confirm assumptions made in NEPA documents and respond to many unanswered, but oft- | |

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| | | | repeated questions.<br>• APHIS has often claimed that, although individual farmers may be affected by releasing genetically engineered organisms in the area, when examined in total, none of the potential business losses is expected to be so severe as to amount to a significant impact. This determination fails to recognize that environmental "significance" exists at all levels—"society as a whole (human, national), the affected region, the affected interests, and the locality." 40 C.F.R. § 1508.27(a).<br>• APHIS tends to rely on the United States Environmental Protection Agency's (EPA) consideration of environmental effects in the context of the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) registration process, as well as FDA's determinations under its enabling legislation. The regulatory and review processes of EPA and FDA cannot be relied upon to relieve APHIS from considering in the context of the National Environmental Policy Act (NEPA) process any and all effects associated with release into the environmental of petitioners' products.<br>• In the past, APHIS appears to have placed a great deal of reliance on petitioners in complying with NEPA. Agencies have a responsibility under NEPA to independently investigate and assess the environmental impacts of proposals under consideration (40 C.F.R. § 1506.5(a) and (b)).<br>• There is considerable uncertainty regarding potential environmental effects of releasing genetically engineered organisms. Although an agency is not precluded from approving a particular proposal involving substantial uncertainty, it must disclose all areas of uncertainty. *Save Our Ecosystems v. Clark*, 747 F.2d 1240, 1246 (9th Cir. | |

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| | | | 1984).<br>• The taxpayer and the agricultural biotechnology industry would be better served if APHIS announced it would no longer "regulate" agricultural biotechnology because there has not been a proven plant-pest risk associated with the technology in decades, perhaps ever. | |
| | APHIS-2013-0042-0010 | Carl Bausch | Duplicate of comment APHIS-2013-0042-0003 | N/A |
| 8 | APHIS-2013-0042-0012 | Tess Cramer | Once GMO's are introduced into the environment, there is no way to recall them OR their genetic pollution to organic crops. | N/A |
| 9 | APHIS-2013-0042-0013 | Arthur Tesla | These plants will turn up as volunteer weeds in other farmers fields | Plant Communities |
| 10 | APHIS-2013-0042-0014 | MS | Lower glyphosate and Round Up now. Do not do what you're planning on doing, EPA and raise the limits. It's already at very toxic levels and raising the limits of poison is not only going to be doing the exact opposite of what you're supposed to be in your job but the very exact opposite. Do not allow your ethics and conscience from deep within to be override by greed and money. Do what's right for the environment and protect it. | Herbicide use – glyphosate limit |
| 11 | APHIS-2013-0042-0015 | Renae Hockaday | • Why is nonregulation even being considered?<br>• There's too much impact on people's health and neighboring (organic and non) producers.<br>• To put GMO into foods without being listed as GMO in the ingredients is blatant dishonesty. At the very least products from GMO must be listed in the ingredients label. | FDA - labeling |
| 12 | APHIS-2013-0042-0016 | Jordan Scheibel (grower) | • There is no worse herbicide for drifting long distances and damaging fruit and vegetable plants than 2,4-D, and the introduction of these resistant varieties will make it far more likely that such drift will be occurring with increasing frequency in the future. For some growers, it will make their livelihoods untenable and for homeowners in the country, they | Herbicide use - drift |

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| | | | will see increasing damage of their gardens and trees of 2,4-D drift.<br>• The introduction of these varieties is an implicit admission that glyphosate resistant varieties are failing, weeds are becoming resistant, and stronger herbicides are needed. I shudder to think what herbicides will be necessary in 5 or 10 years as herbicide resistance continues to grow and the regulatory bodies that are supposed to be considering the long term implications of introducing these herbicide resistant varieties continue to rubber stamp them. | |
| 13 | APHIS-2013-0042-0017 | Martin Johnstone | As there is no actual requirement for GM food, what makes you think you have the right to impose it upon the people without asking them if they want it? Is this the case: Ask the people if they want GM products. You will never ask, because you know the answer will be no. Therefore you continue without asking, forcing people to 'accept' your products? You don't have the right to do that. | N/A |
| 14 | APHIS-2013-0042-0018 | Arthur Tesla | History has shown these crops will appear as volunteer weeds in farmers fields and be difficult to control because they are herbicide resistant/ They are plant pests!<br>They are also plant pests to consumers who don't want to eat these Dangerous genetically engineered foods. | Plant communities - volunteers |
| 15 | APHIS-2013-0042-0019 | Anonymous Against Crop Oppression | America does not want to purchase biotechnology as a food source or fuel source. Europe does not want to purchase biotechnology as a food source or fuel source. The rest of the world does not want to have biotechnology as a food or fuel source imposed on them. There is no market for genetically modified, genetically engineered, genetically enhanced or altered food crops used for food or fuel. | N/A |
| 16 | APHIS-2013-0042-0020 | Klaas Raater | Please consider the environmental impact of every country in the world hating America for its corporate fascism. I am already boycotting every American product. The same goes for my family and my friends. You have alienated yourself from the rest of the world. Way to go America! | N/A |

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| | | | And i will not even spend a single holiday at your country anymore for the rest of my life. You want war with the rest of the world? No problem, you got it! I'd rather die than eat your Frankenfoods! | |
| 17 | APHIS-2013-0042-0021 | Doris Headley | For some time now, knowing that what I purchase was produced in North America or the UK was my only safety net. If you take that away, I shudder to think what I could be consuming. | N/A |
| 18 | APHIS-2013-0042-0022 | Marina Vrouvlianis | Stop poisoning the world | N/A |
| 19 | APHIS-2013-0042-0023 | Tanya Molyneux | Weeds are becoming resistant to the chemicals we treat them with and the answer to just apply more herbicide is poisoning our ground and drinking water, the food that we feed to our animals and the food we are eating. Stop the insanity before its too late for the human race. | N/A |
| 20 | APHIS-2013-0042-0024 | JS Deran | I am against any increase in herbicide resistant corn and soybeans. I don't think these crops should be allowed at all. I have seen the non-biased reports from France and read of problems on farms and ranches in many countries that used GE crops. I think that all the herbicide resistant corn and soybeans should be banned from use. There is so much evidence that shows these crops to be detrimental to people AND animals that to allow further use should be criminal. | N/A |
| 21 | APHIS-2013-0042-0025 | Donna Deran | Weeds treated with Glyphosate have become stronger from exposure so now they want to treat the SUPER weeds with more Glyphosate and then what will we have? Toxic wastelands with FRANKENWEEDS that nothing can kill!!! When will this madness stop? Our land and food are already contaminated with this chemical and now they want to make it worse by increasing allowable toxic exposure!!! JUST SAY NO !!! The EPA's first job is supposed to be protecting people from harmful toxins, not selling us out for the BIG BUCKS, from BIG CHEMICAL companies. | N/A |
| 22 | APHIS-2013-0042-0026 | Dale Moore - American Farm Bureau Federation (Farm Bureau) | Farm Bureau respectfully asks APHIS to abide by the Ninth Circuit's interpretation of its legal obligations under the PPA and NEPA and reconsider its decision to prepare EISs for the herbicide tolerant crops identified in the Notices. Farm Bureau asks APHIS to | Oppose preparation of EIS |

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| | | | act expeditiously to finalize the deregulation process for these crops in keeping with the Ninth Circuit's recent RRA decision and the APHIS regulations governing deregulation petitions. | |
| 23 | APHIS-2013-0042-0027 | Drew Kershen (The University of Oklahoma, College of Law) | • If these seeds and plants are not plant pests, USDA-APHIS should deregulate without further study.<br>• In the Notices for both docket items, USDA-APHIS indicates that concerns about weed resistance related to herbicide usage is the driver behind the Notice to complete EISs. Yet, under statutory authority, EPA, through FIFRA, has the authority to regulate herbicides, including taking into account the environmental impact of weed resistance issues. EPA has exercised its authority under FIFRA and has authorized dicamba and 2,4-D has herbicides. When EPA exercises its authority under FIFRA, the EPA has performed an environmental analysis that is "functionally equivalent" to an EIS under NEPA. | Oppose preparation of EIS |
| 24 | APHIS-2013-0042-0028 | A. Stanley Culpepper - University of Georgia, Weed Scientist, and grower | Cotton weed management programs in Georgia have undergone, and are continuing to undergo, significant changes. Currently recommended programs are complex, costly, and challenging to implement in a timely fashion. Growers are desperately in need of new technologies to improve control of Palmer amaranth, reduce the potential for further herbicide resistance development to currently used tools, and to reduce the economic burden that Palmer amaranth is placing on the agricultural industry.<br><br>We admire and respect the desire of USDA and EPA to be certain that no agriculture technology will negatively impact the consumer, the user, or the environment in which we and our children live. Our request is simple, if deemed safe please assist in the movement of all new technologies to our growers as rapidly as feasible. | |
| | APHIS-2013-0042-0028 | A. Stanley Culpepper - | • Herbicide-resistance has significantly changed agriculture forever in the Southeast; especially for cotton growers. To | |

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| | | University of Georgia, Weed Scientist, and grower | combat this pest, growers have relied heavily on herbicides, tillage, and hand weeding. Herbicide use in cotton has increased sharply with 2.5-times more herbicide active ingredient applied to cotton following the confirmation of glyphosate resistance in Palmer amaranth as compared to before documented resistance. Although grower herbicide input costs have more than doubled following the evolution and spread of glyphosate resistance, Palmer amaranth control is still not adequate. Thus, 92% of Georgia cotton growers hand-weed 52% of the crop with an average cost of $23 per hand-weeded acre, which is an increase of at least 475% as compared to hand weeding costs prior to resistance. In addition to increased herbicide use and hand weeding, growers in Georgia have indicated that they are using mechanical, in-crop cultivation (44% of acres), tillage for the incorporation of preplant herbicides (20% of the acres), and deep turning (19% of the acres every three years) to aid in Palmer amaranth control. Current weed management systems are extremely diverse, complex, less environmentally friendly, and costly when compared to those systems employed only a decade ago. Growers are in desperate need of new technologies that will aid in the management of glyphosate-resistant Palmer amaranth, and other problematic weeds, for long term sustainability. | |
| | APHIS-2013-0042-0028 | A. Stanley Culpepper - University of Georgia, Weed Scientist, and grower | **Benefits of 2,4-D or Dicamba Technologies For the Georgia Cotton Grower:**<br>***1. Improved Weed Control:*** Neither dicamba nor 2,4-D are consistently effective in controlling Palmer amaranth larger than 4 inches when applied alone (Culpepper et al. 2010; Culpepper et al. 2011; Merchant et al. 2011); however, weed management systems including these herbicides are more consistently effective than current standards (Braxton et al. | |

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| | | | 2010; Beckie 2011; Merchant et al. 2013; Richburg et al. 2012; Shaw and Arnold 2012). Weed management programs including 2,4-D or dicamba would improve a grower's ability to manage this problematic weed in the following ways: 1) improved consistency in weed control especially on dryland production acres where residual herbicides often are not activated with rainfall at planting time, 2) more flexibility with herbicide application timings because glufosinate plus dicamba or 2,4-D will consistently control Palmer amaranth up to 6 inches in height (at least 2 inches larger than todays standards), 3) less herbicide carryover to subsequent crops because growers would be less dependent on long lasting residual herbicides, and 4) less yield loss from Palmer amaranth crop competition for light, nutrients, and water (Coetzer et al. 2002; Culpepper et al. 2010; Merchant et. al 2013; MacRae et al. 2013).<br>2. ***Prevention of Additional Herbicide Resistance Development:*** USDA has voiced concerns that growers may adopt 2,4-D or dicamba technologies and rely too heavily on these herbicides thereby developing an even greater weed resistance scenario. Science has clearly shown that there is risk of resistance development to all herbicides; dicamba and 2,4-D are no exception. In fact, weeds have developed resistance to nearly all forms of weed management including herbicides, tillage, mowing and even hand weeding. Our data and surveys contrast the assumption that rapid development of resistance to 2,4-D or dicamba would occur in Georgia cotton. First, our data notes that since these auxin herbicides control only very small Palmer amaranth then they must be applied in tank mixtures with other herbicides such as glufosinate. Second, even mixtures of glufosinate plus 2,4-D or dicamba will only control Palmer amaranth less than six inches in height and since Palmer | |

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| | | | amaranth can grow as much as two inches per day selective residual herbicides must be used throughout the season. Simply put, data throughout the belt supports the fact that over-use and/or over-dependence of 2,4-D or dicamba in cotton would equal poor weed control and eventual crop failure which is a practice no grower would follow. Dicamba and 2,4-D would be an additional tool to include in the weed management program. The greatest risk for developing herbicide resistance is actually occurring at this moment with the PPO herbicides and glufosinate. These products are being over used as growers have no other effective herbicidal options. New technologies such as dicamba or 2,4-D could be used to delay resistance development to the PPO herbicides and glufosinate and, in turn, systems could be developed using the PPO herbicides, glufosinate, 2,4-D, and dicamba extending the life of each of these chemistries.<br>It is also critical to stress that, at least in Georgia, no weed management program relies exclusively on herbicides. The University of Georgia Weed Science Extension Team stresses to growers at more than 50 meetings each year that herbicides are only one part of the weed management program. Sustainability is only possible with the adoption and implementation of diverse management programs and Georgia growers have accepted this message as fact (Sosnoskie and Culpepper 2013). Growers are using programs that are complex and diverse integrating herbicides, hand weeding, and tillage or cover crops. Neither dicamba nor 2,4-D would change this approach but would simply be an additional tool to add into these management systems.<br>***3. Reduction in Herbicide Use:*** Glyphosate-resistant Palmer amaranth has increased herbicide pounds of active ingredient applied in Georgia cotton by a factor of 2.5 when compared to | |

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| | | | herbicide use prior to resistance (Sonoskie and Culpepper 2013). Programs developed by the University of Georgia for 2,4-D or dicamba technologies suggest the pounds of herbicide active ingredient may be able to be reduced by at least 30% while actually providing better weed control; similar results are also noted in other areas across the cotton belt (Edwards et al. 2013; Merchant et al. 2013; Smith and Hagood 2013; Steckel et al. 2013).<br>***4. Reduction in Tillage, Wind Erosion, and Soil Erosion:*** As the spread of glyphosate-resistant Palmer amaranth occurred, the adoption of tillage including deep turning of the land with moldboard plows has become common (Sosnoskie and Culpepper 2013). The return of conventional tillage has led to increased wind and water erosion. Neither 2,4-D nor dicamba technologies would eliminate tillage, but they would greatly reduce the need for deep tillage allowing many growers to return to more reduced tillage production systems. This opportunity to return to reduced tillage systems would be in response to a more consistently effective management program. | |
| | APHIS-2013-0042-0028 | A. Stanley Culpepper - University of Georgia, Weed Scientist, and grower | **Concerns With 2,4-D- or Dicamba-Resistant Technologies:**<br><br>*1.* ***Off-Target Movement:*** Off target movement of 2,4-D and dicamba pose the greatest limitation to the adoption of either auxin technology. Although it is currently unknown what restrictions will be in place to minimize off-target movement by herbicide labels, an enormous amount of research by the registrants and other scientists across the world is being conducted to develop methods to minimize the potential for off-target movement. These efforts include 1) improving herbicide formulations, thereby reducing volatility and/or drift, 2) improving application equipment techniques and application methods, thereby reducing drift, and 3) developing educational materials to assist growers in reducing off target movement when | |

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| | | | making pesticide applications (Bagley 2013, Huff et al. 2013; Kendig et al. 2013; Magidow et al. 2013; Newsom et al. 2013; Reynolds et al. 2013, Sandbrink et al. 2013). Benefits from these efforts will be monumental in minimizing off-target movement of ALL pesticides, not just 2,4-D and dicamba, and will greatly improve the ability of a grower to apply pesticides that stay in the targeted area. In Georgia, the University of Georgia and the Georgia Department of Agriculture are currently developing additional methods to further minimize off-target movement of auxin herbicides and other pesticides. Also, a cooperative effort between The University of Georgia, Georgia Department of Ag, Agronomic Industry leaders, and Horticultural Industry leaders is underway to further define methods to minimize off-target movement. | |
| 25 | APHIS-2013-0042-0029 | Andrew LaVigne - American Seed Trade Association | The Notices of Intent published on May 16 identify two issues that led APHIS to conclude that EISs were required by NEPA – the development of herbicide-resistant weeds (i.e., weed resistance) and increased herbicide use. Both of these issues relate solely to the herbicides, such as 2,4-D and Dicamba, that would be available for use in conjunction with the crops modified to tolerate their application. As such, these issues are subject to the exclusive jurisdiction of the U.S. Environmental Protection Agency ("EPA") under the Federal Insecticide, Fungicide, and Rodenticide Act ("FIFRA") and are decidedly *not* subject to APHIS's jurisdiction under the Plant Protection Act ("PPA").<br><br>ASTA and its members support a science-based, federal environmental review process for new biotechnology seed products. That process must recognize the distinct products, federal actions, and statutory mandates of the regulatory agencies involved. We are concerned, however, that by basing its decision to prepare EISs on the potential environmental effects of the herbicides rather than the associated herbicide tolerant crops, APHIS has failed to recognize those | Oppose preparation of EIS |

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| | | | distinctions. Moreover, the EIS preparation process will unnecessarily delay issuance of determinations of nonregulated status for these crops with no additional benefit to the environment. | |
| 26 | APHIS-2013-0042-0030 | Danny Murphy - American Soybean Association | Soybean farmers need new technologies such as 2,4-D-tolerant soybeans to increase yields, manage weed resistance and maintain profitability. In light of the recent ruling by the Ninth Circuit Court of Appeals on the Roundup Ready alfalfa case -- which confirmed that issues relating to the use of herbicides are the responsibility of the Environmental Protection Agency (EPA), not USDA – ASA strongly urges USDA to reconsider its decision to require an EIS. According to the Notice of Intent, USDA's basis for conducting the EIS all relate to herbicide uses, and the recent Ninth Circuit decision made clear the Framework[1] under which regulatory authority is allocated among USDA, Food and Drug Administration (FDA) and EPA, and where USDA has no jurisdiction over herbicides nor for consideration of herbicide impacts related to its obligations under the Plant Protection Act. Conducting a time-consuming analysis already within the responsibilities of other federal agencies will cause a significant delay in bringing needed technologies to growers and is not consistent with the Plant Protection Act and the Administrative Procedure Act. The Ninth Circuit decision leaves no doubt that USDA does not need to analyze herbicide resistance or other impacts related to herbicide use in connection with petitions to deregulate herbicide-tolerant crops. It remains EPA's responsibility to prescribe the conditions in which it may be used.<br><br>Further, the Ninth Circuit made clear that APHIS' regulatory jurisdiction ceases once APHIS determines that a crop is unlikely to | Oppose preparation of EIS |

[1] Congress allocated regulatory authority of biotechnology derived crops under the Coordinated Framework. 51 Federal Register 23302-09. June 26, 1986.

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| | | | pose a plant pest risk. The Court ruled, "If APHIS concludes that the presumptive plant pest does not exhibit any risk of plant pest harm, APHIS must deregulate it since the agency does not have the jurisdiction to regulate organisms that are not plant pests." APHIS already has determined that Enlist™ soybeans are unlikely to pose a plant pest risk. Thus, proceding with an EIS would be contrary to the decision of the Ninth Circuit. | |
| | APHIS-2013-0042-0030 | Danny Murphy - American Soybean Association | With mounting pressure to manage resistant weeds, soybean growers need new multiple-mode-of-action weed management tools not only to preserve yields, but also to maintain the economic and non-pecuniary benefits realized from using the glyphosate-tolerant systems. Weed resistance is a well understood scientific phenomenon that is not unique to biotechnology or any other form of agriculture. Different herbicides attack weeds by different methods or "modes of action." The delay that will result from preparation of the EISs as proposed by APHIS will deny growers the tools they need to prevent and combat weed resistance and maximize yields through the use of herbicides that have been shown to operate with differing modes of action. The proposed use of these herbicides in conjunction with the associated herbicide tolerant plants also supports the continued use of environmentally sustainable practices such as no-till and low-till farming.<br><br>The introduction of soybeans tolerant to 2,4-D will allow an additional mode of action to be used in the system, allowing for better weed control and harvested soybeans with less foreign material from weed seeds, a valuable characteristic for processors. | Oppose preparation of EIS<br><br>Soybean growers need new multiple-mode-of-action weed management tools<br><br>Soybeans tolerant to 2,4-D will allow an additional mode of action |
| | APHIS-2013-0042-0030 | Danny Murphy - American Soybean Association | While ASA appreciates concerns about off-target movement of 2,4-D, we are confident that farmers have a long history of successfully using proper equipment and application procedures to avoid and minimize off-target movement of herbicides. Similarly to other herbicide products, off-site movement of 2,4-D can be prevented through proper | |

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| | | | stewardship, application techniques, equipment settings and consideration of environmental conditions during application, such as wind speed. ASA is pleased that newer 2,4-D formulations have been developed to substantially reduce volatility compared to first-generation products. We are also pleased that the petitioner has addressed the potential for off-site movement by prohibiting aerial applications and implementing specific environmental and equipment application requirements on the 2,4-D label, including a wind-directional buffer when sensitive areas are present, and the use of low volatility 2,4-D formulations. ASA believes that when recommended label practices are followed, farmers of various crops can co-exist and prosper. | |
| 27 | APHIS-2013-0042-0031 | Wenonah Hauter – Food & Water Watch | The USDA's Environmental Impact Statement, must include, at a minimum:<br>• An analysis on how 2,4-D-tolerant corn and soybeans will facilitate more use of 2,4-D, leading to the evolution of 2,4-D-resistant weeds and the abandonment of conservation tillage practices;<br>• Data on the levels of dioxin that will likely be released due to an increase in 2,4-D use, and the potential cumulative effects on human health and the environment;<br>• Studies on the effects of increased application of 2,4-D on surface water quality and impacts on non-target plants and animals, including endangered species;<br>• A hard look at how the volatility of 2,4-D will result in more occurrences of pesticide drift into neighboring fields, affecting plant health and costing nearby farmers;<br>• Research on how the ingestion of foods manufactured from these crops will affect human health and how the continued use of the herbicide in agriculture could endanger agricultural workers and the general public; and<br>• A detailed examination of the cumulative effects of stacking | • Herbicide use<br>• Evolution of 2,4-D-resistant weeds<br>• Human health – ingestion<br>• Cumulative effects of stacking on cost of contamination and 2,4-D- and glyphosate-resistant weeds to non-GE farmers |

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| | | | 2,4-D-tolerant corn and soybeans with other herbicide tolerances, including the costs of contamination to non-GE farmers and the costs that 2,4-D and glyphosate resistant weeds will impose on these growers. | |
| | APHIS-2013-0042-0031 | Wenonah Hauter – Food & Water Watch | USDA's Environmental Assessments for 2,4-D-tolerant corn and soybeans were inadequate for these genetically engineered traits because they failed to thoroughly cover the cumulative effects that the use of these chemicals under realistic projections. The chemical treadmill model cannot be continued indefinitely. Weed resistance to these chemicals will continue to abound and the application of more noxious herbicides will increase exponentially. These new corn and soybean varieties are not only unsafe and inefficient, but are a completely unsustainable solution to the broader problems caused by high-input production agriculture and associated environmental pressures. | Herbicide use |
| 28 | APHIS-2013-0042-0032 | Pam Johnson - National Corn Growers Association | USDA has not offered any new scientific reason to justify the decision to prepare an EIS. APHIS identifies two issues for consideration in an EIS, namely possible development of weed resistance and increased herbicide use. However, APHIS' regulatory authority is based in the Plant Protection Act and the agency's oversight is limited to evaluating the potential for the GE plant to pose a plant pest risk. Triggering an EIS based on the justification stated in the Federal Register notice is therefore outside the scope of APHIS' jurisdiction. The U.S. Environmental Protection Agency (EPA) has jurisdiction over pesticide use under the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA). In addition, a recent ruling in the U.S. Court of Appeals for the Ninth Circuit (*Center for Food Safety v. Vilsack*, 9th Cir. May 17, 2013) explicitly clarified USDA is not responsible for assessing herbicide use or resistance development under the PPA.<br>Growers need new tools for weed management. With additional modes of action, growers will be able to more effectively manage | Oppose preparation of EIS |

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| | | | glyphosate-resistant and conventional weeds. Based upon APHIS' assessment, 2,4-D tolerant corn and soybeans do not pose a plant pest risk. Therefore, USDA should immediately convey nonregulated status on these traits and make them available to U.S. growers. | |
| 29 | APHIS-2013-0042-0033 | Dallas Peterson - Kansas State University Department of Agronomy | The ability to effectively control weeds is one of the most important factors in profitable crop production. The use of glyphosate in Roundup Ready crops was a highly cost-effective approach to weed control for many years, but heavy reliance on glyphosate-only weed control programs eventually led to the development of glyphosate resistant weeds, including marestail, waterhemp, Palmer amaranth, kochia and giant ragweed, that are difficult to control with current technologies. New technologies such as 2,4-D tolerant crops would provide an additional tool that could be incorporated into an integrated weed management program to improve overall weed management, including glyphosate resistant weeds. | |
| | APHIS-2013-0042-0033 | Dallas Peterson - Kansas State University Department of Agronomy | The introduction of 2,4-D tolerant soybeans would likely increase the potential for developing 2,4-D resistant weeds, but I feel the potential benefits of helping to control existing herbicide resistant weeds far outweighs the risk of developing 2,4-D resistant weeds. I also believe the risk of developing 2,4-D resistant weeds if this technology is introduced is much lower than what has occurred with glyphosate in recent years.<br>Glyphosate plus 2,4-D is not a viable stand-alone approach to successful weed management. Timing is very critical to effective control of most weeds with postemergence herbicides. 2,4-D needs to be applied to small actively growing weeds for good control. Many problematic weeds, especially waterhemp and Palmer amaranth germinate over an extended period of time, so later flushes of weeds will not be controlled by postmergence herbicides like glyphosate and 2,4-D. Consequently, weed management will be much more successful if postemergence 2,4-D treatments are used in conjunction with | |

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| | | | preemergence residual herbicides that can provide extended control. The use of preemergence herbicides as part of an integrated approach has increased in recent years due to the difficulties of controlling glyphosate resistant weeds and because of the improved commodity prices. Although growers were successful with multiple postemergence applications of glyphosate before the development of glyphosate resistant weeds, I think farmers now realize the many benefits of using a preemergence herbicide in conjunction with a postemergence treatment. This approach helps minimize potential for early season weed competition and provides more flexibility and better efficacy with the postemergence treatment. The other huge benefit is that by utilizing more herbicide modes of action, the risk of developing herbicide resistant weeds is greatly diminished.<br>Finally, I believe farmers and crop advisers now realize that relying simply on a single technology such as glyphosate in Roundup Ready crops is not a sustainable practice and will eventually lead to the development of herbicide resistant weeds and the loss of an effective tool for weed management. | |
| 30 | APHIS-2013-0042-0034 | Cathleen Enright - Biotechnology Industry Organization (BIO) | In developing its implementing biotechnology regulations under the Federal Plant Pest Act and Plant Quarantine Act, APHIS acknowledged that its oversight of the Introduction of genetically engineered (GE) plants and other organisms would be In accordance with NEPA. The assessment of potential environmental effects has always been an important element of the federal regulatory process for products of biotechnology whether for plants and other organisms under NEPA at APHIS or for pesticides under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) at EPA. The basis for the APHIS Notices, however, was not any potential environmental impacts associated with the plants under review. Rather, the Notices identify two issues for consideration In an EIS - the potential selection of herbicide resistant weeds and increased herbicide use. As discussed in greater detail herein, the law is clear that potential impacts associated | Oppose preparation of EIS |

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| | | | with herbicide use are EPA's responsibility under FIFRA and are neither subject to APHIS's jurisdiction under the Plant Protection Act (PPA) nor an appropriate basis for preparation of an EIS for an action proposed under the PPA.<br>BIO and its members are also concerned that the decision to prepare EISs for the crops identified by APHIS will unnecessarily delay Issuance of determinations of nonregulated status, causing significant harm to American farmers and the developers of the crops without any additional environmental benefit. APHIS's regulations require a petition for determination of nonregulated status to either be approved in whole or in part or denied within 180 days of the Agency's receipt of the completed petition. Yet, the earliest deregulation petition for the subject crops was filed with APHIS nearly four years ago and declared complete shortly thereafter, and none of the pending petitions for which an EIS would be prepared has yet to be resolved. APHIS estimates completing the two EISs in the summer of 2014 at the earliest, nearly five years after the earliest deregulation petition was filed with APHIS and over four years after APHIS's own regulatory deadline.<br>The delay that will result from preparation of the EISs will deny American farmers the new tools they need to prevent and combat herbicide-resistant weeds and maximize yields. BIO members have submitted applications to EPA that would authorize use of their herbicides on the associated herbicide tolerant crops identified In the APHIS Notices. These herbicides have differing modes of action, enhancing the ability of growers to address weed problems and supporting the continued use of environmentally sustainable practices such as no-till farming.<br>Delays inherent in the EIS process will also put U.S. corn, soybean and cotton growers at a particular disadvantage in relation to their counterparts in other nations that are now completing their review processes for GE crops on a far more timely basis than the United | |

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| | | | States. In addition, the developers of these crops will suffer further delay in commercializing and offering valuable new products for sale and other developers of Innovative products may reconsider whether to Invest in the U.S. market. Because the APHIS Notices failed to provide a satisfactory legal or scientific justification for opting to prepare an EIS for the subject products, developers of future products also lack predictability as to whether APHIS will opt to prepare an EA or an EIS, which Significantly affects the deregulation timeline and product development decisions. | |
| 31 | APHIS-2013-0042-0035 | - Agricultural Retailers Association<br>- American Farm Bureau Federation<br>- American Seed Trade Association<br>- American Soybean Association<br>- American Sugarbeet Growers Association<br>- Biotechnology Industry Organization<br>- National Association of Wheat Growers | Our members, who produce the vast majority of commodity crops in America, must be able to utilize the very best available methods to combat weed resistance problems. Weed resistance is a well understood scientific phenomenon that is not unique to biotechnology or any other form of agriculture. Different herbicides attack weeds by different methods or “modes of action.” The delay that will result from preparation of the EISs as proposed by APHIS will deny growers the tools they need to prevent and combat weed resistance and maximize yields through the use of herbicides that have been shown to operate with differing modes of action. The proposed use of these herbicides in conjunction with the associated herbicide tolerant plants also supports the continued use of environmentally sustainable practices such as no-till and low-till farming.<br>Additionally, the delays inherent in the EIS process proposed by APHIS will put American growers at a further disadvantage to corn, soybean and cotton growers in other nations that are now completing their review processes for biotechnology-derived crops on a far more timely basis than the United States. Any further delay is unacceptable, particularly when APHIS’s own regulations require APHIS to respond to a petition for determination of nonregulated status within 180 days of the Agency’s receipt of the petition. 7 C.F.R. § 340.6(d)(3). | Oppose preparation of EIS |

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| | | - National Corn Growers Association<br>- National Cotton Council | Our members support a science-based, federal environmental review process for new agricultural biotechnology products. The Notices of Intent issued by APHIS, however, identify two issues for consideration in an EIS (i.e., weed resistance and increased herbicide use), both of which are subject to the sole jurisdiction of the U.S. Environmental Protection Agency ("EPA") under the Federal Insecticide, Fungicide, and Rodenticide Act ("FIFRA"). These pesticide issues are unequivocally *not* subject to APHIS's jurisdiction under the Plant Protection Act. | |
| 32 | APHIS-2013-0042-0036 | Dow Agrosciences, LLC (DAS) | DAS supports a science-based, federal environmental review process for those products. That process must of necessity recognize that the crops and herbicides are subject to the jurisdiction of two different regulatory agencies operating under their own independent statutory mandates and differing environmental review standards. DAS is concerned that APHIS's planned preparation of an EIS for the determinations of nonregulated status requested by DAS for its herbicide tolerant crops fails to recognize these distinctions.<br>Moreover, the EIS preparation process contemplated by APHIS will unnecessarily delay issuance of determinations of nonregulated status (deregulation) for these crops resulting in irreparable harm to farmers and DAS with no additional benefit to the environment. Indeed, delays inherent in the EIS preparation process will likely force many com and soybean growers to use less sustainable weed management practices resulting in soil runoff and other adverse environmental effects. Most significantly, these delays will deny growers the new tools they need to combat weeds and maximize yields.<br>Weed resistance is a well understood scientific phenomenon that farmers must manage. [1] It is not unique to biotechnology or any other form of agriculture. Different herbicides attack weeds by different methods or "modes of action." Reliance on a single herbicide and its unique mode of action is certainly a contributor to development of weed resistance. The applications submitted to EPA by DAS and other | Oppose preparation of EIS |

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| | | | companies for use of their herbicides with the associated herbicide tolerant crops are intentionally designed to provide growers with herbicides that act by different modes of action, significantly enhancing growers' ability to address weed problems, increase yields and maintain environmentally preferable, no-till and low-till agricultural practices.<br>Delays inherent in the EIS process will also place U.S. growers at a further disadvantage to com, soybean and cotton growers in other nations that are now completing their regulatory reviews for biotechnology-derived crops on a far more expedited basis than the United States. Finally, the decision to prepare a EIS will also be costly to DAS, forcing the company to continue producing seed under the burdensome APHIS permitting process, in addition to suffering a further delay in commercializing and offering its new herbicide tolerant crops for sale. For all of these reasons DAS objects to the preparation of an EIS for deregulation of its crops. | |
| 33 | APHIS-2013-0042-0037 | Rachel Lattimore, Senior Vice President, General Counsel, Secretary - CropLife America | On May 16,2013, APHIS published in the Federal Register notices announcing its intention to conduct Environmental Impact Statements (EISs) related to several new technologies: dicamba tolerant soybeans, dicamba tolerant cotton, 2,4-D tolerant corn, and 2,4-D tolerant soybeans.[1] APHIS's declared intent to conduct these EISs focuses solely on pesticide issues regulated by the United States Environmental Protection Agency (EPA). We strongly urge you to reconsider the need for EISs for these technologies due to clear limitations on APHIS's Congressional mandate and in light of a recent ruling by the Ninth Circuit Court of Appeals clarifying EPA and APHIS's respective jurisdictions in this area.[2] The proposed EISs would introduce unnecessary regulatory redundancy and potential regulatory confusion by analyzing the proposed use of herbicides that are under active review by EPA and outside the jurisdictional purview of APHIS.<br>Congress's well-established distribution of regulatory authority over | Oppose preparation of EIS |

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| | | | agricultural technologies and recent Ninth Circuit case law establish that APHIS's proposed EISs are unnecessary, redundant, and potentially in conflict with EPA's authority. In light of these concerns and the substantial cost and delay that would be incurred due to such a review, CropLife America strongly urges APHIS to reconsider its decision to conduct these EISs. | |
| 34 | APHIS-2013-0042-0038 | Steve Smith, Chairman - Save Our Crops Coalition | We urge the granting of approval for the Dow 2,4 D Enlist™ system but maintain grave concerns (as addressed in comments specifically on the dicamba petition) about the widespread use of dicamba on the environment, which prompted our original petition. Monsanto continues to promote practices that will be of great environmental risk if widespread use of dicamba is approved without the reasonable restrictions that Dow recognized and implemented. | Support approval of Dow petitions |
| 35 | APHIS-2013-0042-0039 | Joyce Dillard | We request that more thorough studies occur on bees and colony collapse, birds and the watershed ecosystems as well as viruses that spread through migration related to watershed ecosystem connectivity. Water contamination is a problem in a watershed not necessarily in the vicinity of the crops, so all avenues need to be studied.<br>The liabilities of the Clean Water Act should not be placed on other watershed systems. | Herbicide use |
| 36 | APHIS-2013-0042-0040 | Lee Van Wychen, Director Science Policy - WSSA | Science has clearly shown that there is a risk of resistance development to all herbicides, and 2,4-D and dicamba are no exception. In fact weeds have evolved resistance to nearly all forms of weed control including herbicides, tillage, mowing and hand weeding. Some of our members have voiced concerns that growers may adopt 2,4-D and dicamba technologies and rely too heavily on these herbicides thereby developing an even greater weed resistance situation. However, the majority of our member scientists view 2,4-D and dicamba resistant crops as an additional weed management tool to include in an integrated weed management program. The greatest risk for developing herbicide resistance is actually occurring right now with the PPO herbicides and glufosinate. These products are being over-used in | |

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| | | | certain cropping systems as farmers have no other effective herbicide options. The 2,4-D and dicamba resistant crops could be used to delay resistance development to the PPO herbicides and glufosinate and, in turn, weed management systems could be developed using the PPO herbicides, glufosinate, 2,4-D and dicamba, extending the life of each of these chemistries. | |
| | APHIS-2013-0042-0040 | Lee Van Wychen, Director Science Polidy - WSSA | Weed management is ultimately the responsibility of farmers and farm advisors. However, the weed science community, including industry, academics, crop commodity groups and others who reach out to farmers, must recommend robust and effective stewardship programs espousing the basic principles of good weed management and encourage adoption of these practices. By doing so, evolution of resistance to our herbicide resources and new options such as 2,4-D and dicamba resistant crops will be minimized. | |
| | APHIS-2013-0042-0040 | Lee Van Wychen, Director Science Polidy - WSSA | Research indicates that 2,4-D and dicamba will fit best in a fully diversified program and such a program is particularly important when glyphosate resistant palmer pigweed and waterhemp are the targets. | |
| | APHIS-2013-0042-0040 | Lee Van Wychen, Director Science Polidy - WSSA | Resistance to 2,4-D and dicamba represents no more a threat to agricultural production than resistance to other critical herbicides and the likelihood that it will be used in a manner consistent with best management practices is good. | |
| | APHIS-2013-0042-0040 | Lee Van Wychen, Director Science Polidy - WSSA | Stacking 2,4-D and dicamba tolerance with that of glyphosate, glufosinate, and other herbicide tolerant traits will further facilitate the use of these herbicides in a diversified program. Stacking herbicide traits does not in itself promote the evolution of resistance to more than one herbicide since, just as for individual herbicides, the evolution of resistance is a function of how the herbicides are used rather than a function of the selectivity of the crop to multiple herbicides. | |
| | APHIS-2013-0042-0040 | Lee Van Wychen, Director Science Polidy - WSSA | The ability of farmers to use 2,4-D and dicamba in diversified weed management programs in soybeans, corn, and cotton is not expected to significantly change current farming practices. These herbicide tolerant crops will, however, provide valuable new postemergence options that | |

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| | | | will allow farmers to most effectively manage their weeds when practicing conservation tillage even in the presence of glyphosate resistant populations. Farmers have clearly shown a preference for postemergence weed control in conservation tillage systems and 2,4-D and dicamba can be an important part of this system.<br><br>As the spread of glyphosate-resistant weeds occurred, the adoption of tillage, including deep tillage with a moldboard plow has once again become more common. The return of conventional tillage has led to increased wind and water erosion. Neither 2,4-D nor dicamba technologies would eliminate tillage, but they would greatly reduce the need for deep tillage allowing many farmers to return to more reduced tillage production systems. | |
| | APHIS-2013-0042-0040 | Lee Van Wychen, Director Science Polidy - WSSA | New and expanded uses of existing herbicides are needed for integrated weed management programs in order to mitigate weed resistance and meet our current and future crop production needs. | |
| | APHIS-2013-0042-0040 | Lee Van Wychen, Director Science Polidy - WSSA | Off target movement of 2,4-D and dicamba pose the greatest limitation to the adoption of either auxin technology. An enormous amount of research by the registrants and other weed scientists around the world has been conducted to develop methods to minimize the potential for off-target movement. These efforts include 1) improving herbicide formulations, thereby reducing volatility and/or drift, 2) improving application equipment techniques and application methods, thereby reducing drift, and 3) developing educational materials to assist growers in reducing off target movement when making pesticide applications. There is no question these research efforts will greatly minimize off-target movement of all pesticides, not just 2,4-D and dicamba, and will greatly improve the ability of a grower to apply pesticides that stay in the targeted area. | Herbicide use - drift |
| 37 | APHIS-2013-0042-0041 | Kenneth Isley, Vice President, General Counsel, Secretary - | Dow AgroSciences LLC ("DAS") respectfully submits this petition to the United States Department of Agriculture ("USDA"), Animal and Plant Health Inspection Service ("APHIS"), amending and requesting | |

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| | | Dow Agrosciences, LLC (DAS) | that APHIS immediately grant DAS's pending petitions for determination of nonregulated status for DAS-40278-9 Corn (Petition No. 09-233-01 p), DAS-68416-4 Soybean (Petition No. 09-349-0lp), and DAS-44406-6 Soybean (Petition No. 11-234-01 P ) (collectively, the "Enlist™ Plants"). *See* 7 C.F.R. § 340.6(a).<br>Under the unique circumstances presented here, DAS respectfully requests that APHIS:<br>• immediately grant DAS's pending petitions for determination of nonregulated status for the Enlist™ Plants; and<br>• immediately reconsider and withdraw its decision to prepare an EIS as to the Enlist™ Plants and terminate the NEPA process.<br>APHIS's unwarranted delay in the issuance of determinations of nonregulated status for the Enlist™ Plants has caused and will continue to cause significant harm to American farmers and DAS. This harm will be especially acute, and irreparable, in the event that determinations of<br>nonregulated status are not issued before the fall 2013 harvest. Thus, DAS respectfully requests that APHIS respond to this petition within the next thirty (30) days, by July 18, 2013. | |
| 38 | APHIS-2013-0042-0042 | Center for Food Safety | Copy of comments submitted to USDA-APHIS under Docket No APHIS-2012-0019 (DAS 68416-4 soybean) – Comments to USDA APHIS on Draft Environmental Assessment and Draft Plant Pest Risk Assessment for Dow AgroSciences Petition (09-349-01p) for Determination of Nonregulated Status of Event DAS-68416-4: 2,4-D -and glufosinate-resistant soybean | |
| Attachment | APHIS-2013-0042-0043 | Center for Food Safety | Copy of comments submitted to U.S. EPA - Comments to EPA on Notice of Receipt of Applications to Register New Uses of 2,4-D on Enlist™ AAD-1 Corn and Soybean | |
| 39 | APHIS-2013-0042-0044 | Center for Food Safety | Copy of comments submitted to USDA-APHIS under Docket No APHIS-2012-0103 (DAS-40278-9 corn) | |
| 40 | APHIS-2013-0042-0045 | Center for Food Safety | **2,4-D-resistant crops must be viewed as weed control systems**<br>In preparing the EIS, APHIS must assess 2,4-D-resistant corn and | |

| Comment # | Comment ID | Commenter | Comment Excerpt | Topic Area |
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| | | | soybeans as crop systems comprising the herbicide-resistant crop itself and associated use of 2,4-D. Monsanto describes its Roundup Ready (RR) crops as RR crop systems. Dow describes 2,4-D-resistant crops as the “Enlist™ weed control system.” “System” is defined as “a set or arrangement of things so related or connected as to form a unity or organic whole,”[1] meaning there is no need for elements not encompassed by the system to accomplish its purpose. Exclusive or near-exclusive use of glyphosate as the sole weed control measure with Roundup Ready crop systems is a major factor in the epidemic of glyphosate-resistant in U.S. agriculture. A similar dynamic will be in play with 2,4-D-resistant crop systems, so they must be assessed as systems. | |
| | APHIS-2013-0042-0045 | Center for Food Safety | **Impacts of 2,4-D-resistant crop systems on herbicide use** For all practical purposes, 2,4-D-resistant corn and soybeans eliminate the severe biological constraints on use of this herbicide with all other types of corn and soybeans ever developed or grown. Label rates of 2,4-D coincide roughly with rates that begin to cause crop damage, and the imperative to avoid crop damage is as or more effective than the label in keeping 2,4-D use within bounds. Once the crop injury constraint is lifted, there is no biological reason for the farmer to follow the label. From a modestly used pre- -emergence herbicide in soybeans and early POST herbicide in corn, 2,4-D will become one of the major herbicides for weed control in Enlist™ crop systems (likely with additional use of glyphosate, ACCase inhibitors and/or glufosinate if stacked with resistance to these herbicides). APHIS must assess the shift in 2,4-D use patterns to be expected in various crop adoption scenarios. APHIS should assess both the change in amount applied, per acre per crop, and the shift in use pattern (i.e. amount used pre-emergence vs. post-emergence). APHIS should also assess the impact of 2,4-D crops on overall herbicide use, keeping in mind that 2,4-D would likely displace little if any glyphosate, which has a broader spectrum of activity, including (unlike 2,4-D) activity on grass | |

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| | | | family weeds. We refer APHIS to our comments, where CFS makes such projections. | |
| | APHIS-2013-0042-0045 | Center for Food Safety | **Features of HR crop systems that promote HR weeds** As discussed in our comments, HR crop systems promote not only (near-) exclusive reliance on the associated herbicide(s), but also more frequent use over a broader application window that extends much further into the crop season than would otherwise be possible. Resistant weeds with Roundup Ready crops are too often treated superficially as simply the result of excessive glyphosate use, but as Paul Neve has pointed out, the post-emergence use pattern of glyphosate with RR crops is another, independent factor promoting weed resistance, beyond exclusivity and frequency of glyphosate use. In other words, the timing as well as the exclusivity and frequency of herbicide use is a factor in promoting weed resistance. In practice, applications are often made late post-emergence to larger weeds, increasing resistance risks still more. Additional evidence comes from weed resistance to ALS inhibitor herbicides, many of which were and are used post-emergence. ALS inhibitor-resistant weeds arose in 1987 just five years after the first ALS inhibitor herbicide was introduced, and became extremely prevalent in less than a decade; in fact, by undermining the efficacy of widely used ALS inhibitors (especially in soybeans), resistant weeds provided much of the impetus for adoption of RR crops (as a means to kill ALS inhibitor-resistant weeds), just as glyphosate-resistant weeds have become the rationale for 2,4-D-resistant crop systems. We emphasize that while a post-emergence herbicide use pattern is certainly not a necessary condition for weed resistance to evolve (e.g. atrazine used primarily pre-emergence and early post-emergence in corn led to substantial weed resistance), it does appear to be a facilitating factor where present. APHIS must assess the post-emergence weed control paradigm that is a central feature of HR crop systems for its resistance-promoting potential in the case of 2,4-D-resistant crops and weeds, in addition to the more | |

| Comment # | Comment ID | Commenter | Comment Excerpt | Topic Area |
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| | | | obvious factors of exclusivity and frequency of use. | |
| | APHIS-2013-0042-0045 | Center for Food Safety | **Socioeconomic factors associated with HR crops and HR weeds** As discussed in our comments, pricing strategies influence farmer weed management decisions in such a way as to contribute to evolution of weed resistance. Companies charge fees for HR traits that are substantial enough to create a strong incentive for the farmer to make full use of the trait(s) through total reliance on the associated herbicide(s). APHIS should find or develop studies that explore the extent to which pricing strategies for HR crop systems (e.g. high-priced seed, low-cost herbicide) reinforce herbicide use patterns that foster resistance in the case of 2,4-D-resistant corn and soybeans. RR crops' major and closely intertwined "benefits" are reduced labor needs for weed management (at least until resistant weeds emerge) and the simplicity of glyphosate-only weed control. In addition, glyphosate's superior ability to control large weeds relative to other herbicides broadens the application window for acceptable weed control. These factors together facilitate increased farm size, since more land can be managed for weeds with the same labor, and labor needs for weed control are a major limiting factor on farm size. One can expect 2,4-D- resistant crops to have similar impacts. APHIS should assess the socioeconomic consequences of 2,4-D-resistant corn and soybeans, in terms of increased land and rental prices from increased competition for land, increased average size of farms, and accelerated exit of small- to medium-size farmers from agriculture. | |
| | APHIS-2013-0042-0045 | Center for Food Safety | **HR crops and drift damage** HR crop systems entail a pronounced shift in herbicide use to much later in the season when neighboring crops have leafed out and are more vulnerable to drift damage (from early season herbicide use when drift poses much less risk). Glyphosate has become a leading cause of drift damage in the era of Roundup Ready crops, despite the fact that it is not a volatile or drift-prone herbicide. This is not merely because its use has increased so dramatically, but also because its use has shifted | |

| Comment # | Comment ID | Commenter | Comment Excerpt | Topic Area |
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| | | | heavily to later in the season. 2,4-D is much more volatile than glyphosate, and is particularly prone to vapor drift. APHIS must comprehensively assess the increased drift damage that would occur with various 2,4-D-resistant corn and soybean adoption scenarios, both in terms of lost yield and income, broken down by major crop (e.g. soybeans, cotton) or crop category (e.g. vegetables). APHIS should further assess the extent to which 2,4-D-resistant crop adoption would reduce plantings of susceptible crops (e.g. vegetables, grapes) and/or shift acreage to 2,4-D- tolerant crops that could withstand drift level doses (e.g. corn). In conducting this assessment, APHIS must account for the inevitable use of more drift-prone 2,4-D formulations (e.g. because likely to be cheaper than the choline salt), and not presume an ideal world scenario where only potentially less drift-prone formulations are used. | |
| | APHIS-2013-0042-0045 | Center for Food Safety | **Crop volunteers resistant to 2,4-D, ACCase inhibitors, glyphosate, glufosinate, etc. as weeds**<br>RR crop volunteers have been repeatedly noted as problematic weeds, particularly corn, but also cotton and soybeans; and particularly where RR crops are rotated (see comments). SmartStax corn is even more problematic, since glufosinate as well as glyphosate are eliminated as control options. APHIS must assess the increased weediness of volunteers of corn and soybeans resistant to 2,4-D, ACCase inhibitors, glyphosate, and/or glufosinate. Further, since cross-pollination with other prospective herbicide-resistant cultivars will be possible (e.g. dicamba-resistant corn), APHIS should consider scenarios with volunteers that have stacked resistance. The assessment should include increased costs of control, increased use of herbicides, increased weed resistance risks from a narrowing of herbicidal control options and increased reliance on those (few) herbicides still effective. | |
| | APHIS-2013-0042-0045 | Center for Food Safety | **Interplay between HR traits and Bt resistant pests**<br>2,4-D-resistant corn will be offered mainly in stacks with Bt traits. Research described in the 2,4-D comments shows that HR corn | |

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| | | | volunteers produce lower levels of Bt toxin and thereby promote Bt resistance in corn rootworm; the more HR traits in the corn volunteers, the less likely they will be managed adequately, and hence the more likely they will contribute to Bt resistance. See discussion in 2,4-D-comments. | |
| | APHIS-2013-0042-0045 | Center for Food Safety | **Cross-resistance between 2,4-D, dicamba and other synthetic auxin herbicides** In our comments, we discuss evidence that certain weeds resistant to 2,4-D (e.g. waterhemp) also exhibit increased tolerance to dicamba; and that dicamba-resistant crops have increased tolerance to chlorophenoxy herbicides like 2,4-D. In view of their common mechanism of action, these findings strongly suggest the potential for evolution of cross-resistance in weeds to dicamba and phenoxy herbicides. Most weed biotypes resistant to either dicamba or 2,4-D have not been tested for resistance to the other. APHIS must assess the potential for 2,4-D crop systems to foster resistance, not only to 2,4-D, but also to dicamba, and the impacts such cross- resistant weeds (against a background of resistance to glyphosate, ALS inhibitors and/or other herbicides), would have on weed control in soybeans, corn and other crops. Known weed biotypes with resistance to either 2,4-D or dicamba should be tested for tolerance to the other, to help establish the potential for such cross- resistance. | |
| | APHIS-2013-0042-0045 | Center for Food Safety | **Non-target effects of 2,4-D-resistant crops** Roundup Ready crop systems have dramatically increased use of one of the most effective plant-killing compounds ever developed. Glyphosate is particularly noted for its efficacy against perennial weeds, which most other herbicides have difficulty controlling. Glyphosate use with Roundup Ready crops is a major factor in the dramatic decline in Monarch butterfly populations over the past two decades (see 2,4-D-resistant soybean comments to USDA). Glyphosate has decimated milkweed populations in Midwest corn and soybean fields; and milkweed in such fields is the major breeding ground for | |

| Comment # | Comment ID | Commenter | Comment Excerpt | Topic Area |
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| | | | migratory Monarchs that overwinter in Mexico. APHIS must project the impact of 2,4-D-resistant corn and soybean systems (with additional resistance to glyphosate and/or glufosinate) in further reducing populations of milkweed in agricultural fields and thus exacerbating the decline in Monarch populations. | |
| | APHIS-2013-0042-0045 | Center for Food Safety | Many glyphosate formulations are extremely toxic to various species of frogs. Massive glyphosate use accompanying Roundup Ready crops has been posited as a likely factor in the global decline of amphibian populations. APHIS must assess the impacts of 2,4-D-resistant corn and soybean systems (with additional resistance to glyphosate and/or glufosinate) on amphibian populations. | |
| | APHIS-2013-0042-0045 | Center for Food Safety | **Impact of HR crop systems on sustainable weed control**<br>Please assess the impact that Roundup Ready crop systems have had on efforts to advance adoption of sustainable weed management techniques (e.g. crop rotation, cover crops); and based on this analysis, similarly project the impacts that 2,4-D-resistant crops (with additional resistance to ACCase inhibitors, glyphosate and/or glufosinate) would have on the same. | |
| | APHIS-2013-0042-0045 | Center for Food Safety | **Health impacts of increased 2,4-D use with 2,4-D-resistant crop systems**<br>Medical scientists have found 2,4-D use associated with increased risk of non- Hodgkin's lymphoma and other adverse human health impacts (for discussion see human health section of 2,4-D comments to EPA). Dioxins continue to contaminate 2,4-D, and EPA has failed to collect comprehensive, independent data on the dioxin content of the many 2,4-D formulation used by farmers. CFS projects a many-fold increase in use of 2,4-D with introduction of either or both 2,4-D crop systems, and thus a further increase in exposure to and disease from this toxic herbicide. APHIS and EPA must assess the increased incidence of disease to be expected with the substantial increase in 2,4-D use accompanying introduction of these crop systems. | Human health – 2,4-D use |
| | APHIS-2013- | Center for Food | **2,4-D-resistant crops and tillage** | 2,4-D-resistant |

| Comment # | Comment ID | Commenter | Comment Excerpt | Topic Area |
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| | 0042-0045 | Safety | Roundup Ready crops have not, as popularly imagined, fostered increased use of conservation tillage. The major gains in conservation tillage adoption came in the 1980s and early 1990s, in consequence of 1985 and 1990 Farm Bill provisions that tied subsidies to use of soil-conserving practices. In fact, adoption of conservation tillage actually stagnated in the decade of Roundup Ready crop adoption. Instead, the glyphosate-resistant weeds generated by RR crop systems have led to increased tillage for weed control and hence greater soil erosion. CFS has presented a detailed analysis to support these conclusions in the 2,4-D-resistant soybean comments. APHIS must assess the potential for 2,4-D crop systems to further increase soil erosion through increased use of tillage to control the 2,4-D-resistant weeds that will be generated by these crop systems. | weed development – impacts on tillage and soil erosion |
| | APHIS-2013-0042-0045 | Center for Food Safety | APHIS should also require the applicants to supply information necessary for meaningful risk assessments that is not in their petitions, or better yet undertake appropriate research to fill in the gaps. For example, the following information should be available for review by APHIS and the public:<br>• Proposed herbicide application regime: how much herbicide, how often, window of application.<br>• Degree of resistance conferred by the transgene in different plant parts and stages of development.<br>• Expression of the transgene in pollen, nectar; levels of herbicide residues and metabolites in pollen, nectar.<br>• Herbicide residues and metabolites in plant tissues from the time of application through post-harvest. | |
| | APHIS-2013-0042-0045 | Center for Food Safety | APHIS needs to analyze the following areas:<br>• Agricultural production impacts, including and not limited to burden on organic and non-transgenic agricultural production and potential harms to non---target crops from the adoption of the HR crop system.<br>• Environmental impacts, including but not limited to: | |

| Comment # | Comment ID | Commenter | Comment Excerpt | Topic Area |
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| | | | - Herbicide use and changes in herbicide use patterns;<br>- Gene flow from 2,4-D-resistant corn and soybeans to compatible varieties and the resulting increased weediness;<br>- Agricultural practices, including herbicide use, effects on tillage; and<br>- Weed resistance and volunteers.<br>• Socioeconomic impacts, such as:<br>- Transgenic contamination and their effects on both domestic and export markets, as well as, consumers and farmers' right of choice<br>- Changes in seed industry market concentration and their impacts,<br>- Effects on the methods and costs of weed control<br>• Human health impacts, such as:<br>- Herbicide use, including impacts on farm workers; and<br>- Safety of food products<br>• Livestock health, such as:<br>- Herbicide use; and<br>- Safety of animal feed.<br>• Threatened and endangered species, such as:<br>- Herbicide use; and<br>- Quality of crop tissues as food sources.<br>• Disease and pest impacts stemming from 2,4-D-resistant soybeans and corn and the associated herbicide use. | |
| 41 | APHIS-2013-0042-0046 | Center for Food Safety | Comments to USDA APHIS on Environmental Assessment for the Determination of Nonregulated Status of Herbicide-Tolerant DAS-40278-9 Corn, *Zea mays*, Event DAS-40278-9 - Center for Food Safety, Science Comments II<br><br>See Comment Summary for DEA for DAS-40278-9 Corn | |
| Attachment | APHIS-2013-0042-0047 | Center for Food Safety | Comments to USDA APHIS on Draft Environmental Assessment and Draft Plant Pest Risk Assessment for Dupont-Pioneer's Petition (11- | |

| Comment # | Comment ID | Commenter | Comment Excerpt | Topic Area |
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| | | | 244-01p) for Determination of Nonregulated Status of Insect-Resistant and Herbicide-Resistant Pioneer 4414 Maize: Event DP-004114-3 | |

**Table 2-2. Public Scoping Comments Submitted During Virtual Public Meeting**

| Commenter | Affiliation | Concern/Issue | |
|---|---|---|---|
| **June 26, 2013** | | | |
| Ray Gaesser | grower and First Vice President of the American Soybean Association | They [2,4-D and dicamba] will allow us, on our farm at least, to continue to no till. If we don't have those products, we may have to go back to tillage to deal with some of the weeds that we have. | Agronomic practices |
| | | We use them [2,4-D and dicamba] on our farms. I've been farming 25 years now, and I've had experience using both of those products in a different formulation for all that time. And, really, I've never had any problems with it, (static - cell interference) response to our own crop or our neighbor's. As the previous speaker said, we are tested in Iowa. As is required of all of our applicators that come from the co-ops and from the industry, are tested, and understand the need and the right way to apply herbicides. | Herbicide use |
| | | We used to use a lot of those products, and now with glyphosate, we use less in order to address the issues of weed resistance in particular, and the real need for multiple modes of actions. All of our universities are saying that we need multiple modes (indiscernible) of action to avoid weed resistance. So I would urge you to move forward with both of these applications. | Herbicide use |
| David Shaw | Past President, Weed Science Society of America (WSSA) | Biotechnology has allowed us to maximize yields in economics, to be able to mitigate the potential development of herbicide resistance, and to be able to effectively gain tremendously with the development of conservation tillage practices in the United States. | N/A |
| | | Herbicide resistance has developed substantially over the last few years, but is not a new phenomenon. In fact, it has been recorded and noted for over 40 years now. | Herbicide-resistant weeds |

| Commenter | Affiliation | Concern/Issue | |
|---|---|---|---|
| | | One of the primary practices that we scientists recommend in managing proactively herbicide resistance is the ability to use a wide diversity of mechanisms of actions with different herbicides that affect plants in different ways. We need more herbicide options to be able to manage these and to be able to preserve the utility of those that we already have. The ability to effectively use dicamba and 2,4-D in soybean and cotton will help fill this critical need.<br><br>We have seen the development of herbicide resistant plants most notably in the last few years with glyphosate resistance in (indiscernible) crops. This problem has become widespread, in several of our major commodities. And dicamba and 2,4-D, also the ability to use a different mechanism of action than what is currently available in these crops to be able to more effectively and proactively mitigate and delay the evolution of herbicide resistance. | |
| | | There are a number of factors that come into play in the evolution of herbicide resistant weeds and crops. However, we scientists understand that this is a function of managing the practices and the herbicides that are available for weed management. It is as such not a plant biotechnology issue. It is a use of the technology and the rotation and a development of an overall plan using various management practices that have been identified.<br><br>Weed management is ultimately the responsibility of farmers and farm advisors that requires the entire community of weed scientists, industry, academia, crop | |

| Commenter | Affiliation | Concern/Issue | |
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| | | commodity, and others to be able to effectively steward herbicide resistance management. By using the development of resisted crops that have the tolerance to dicamba and 2,4-D, this represents no greater threat than the development of any herbicide technology that has hurt in the past. | |
| | | It is also noted that one of the major challenges that we have with the development of herbicide resistance is the losses that we are now experiencing in conservation tillage acres. Dicamba and 2,4-D tolerance will certainly allow us to help preserve these valuable gains and the preservation of our soils in the United States. | |

# Appendix 3. Weed Management and Herbicide Use

## Weed Management and Herbicide Use

Weed control programs are important aspects of corn and soybean production intended to prevent the establishment of plants other than the intended crop. In crop production systems, these plants, identified as weeds, are controlled using a number of tactics to maximize the production of food, fiber, and fuel (Green and Martin, 1996). The goal of weed management is to reduce weed populations, allowing for more efficient use of herbicides and other cultural practices to control weeds.

Each field has a finite amount of resources, i.e., light, nutrients, and moisture, available for the growth and development of crops. Weeds allowed to compete with crops can ultimately result in crop yield loss. Once the critical period of weed control (CPWC) has been reached, if weed control is delayed, the yield loss can increase fairly rapidly. Knezevic concluded that delaying the time of weed removal after the starting point of CPWC will cost corn and soybean producers an average of 2% in yield loss per every leaf stage of delay (Knezevic *et al.*, 2003). According to Iowa State University research, uncontrolled weeds of 3-4 inches in corn at the V-3 to V-4 growth stage have been shown to decrease yields by about 3 bushels per acre per day (Rosenberg, 2013).

Weeds species present varying degrees of competitiveness. Table 3-1 shows the potential yield losses associated with specific weed species present at two different densities. The impacts to yield are based on normal weather conditions and adequate soil moisture and assume that the weeds emerged with the crop. Crops under drought conditions or other stresses may have higher yield losses. According to the data, at higher densities annual broadleaf weeds impact yields more than annual grasses (Ontario Ministry of Agriculture and Food, 2009).

**Table 3-1. Soybean and Corn Yield Losses Due to Weeds at Known Populations**

| Weed | Percent Yield Loss (%) | | | |
|---|---|---|---|---|
| | Corn | | Soybean | |
| | (1 plant/$m^2$) | (5 plants/$m^2$) | (1 plant/$m^2$) | (5 plants/$m^2$) |
| **Annual Broadleaves** | | | | |
| Giant ragweed | 13 | 36 | 14 | 40 |
| Lamb's-quarters | 12 | 35 | 13 | 38 |
| Pigweed | 11 | 34 | 12 | 36 |
| Cocklebur | 6 | 22 | 15 | 41 |
| Ragweed | 5 | 21 | 10 | 33 |
| Wild mustard | 5 | 18 | 5 | 18 |
| Velvetleaf | 4 | 15 | 4 | 15 |
| Lady's thumb | 3 | 13 | 4 | 15 |
| Wild buckwheat | 2 | 10 | 4 | 15 |
| Eastern black nightshade[1] | 2 | 7 | 14 | 40 |
| **Annual Grasses** | | | | |
| Giant foxtail | 2 | 10 | 3 | 12 |

| Weed | Percent Yield Loss (%) | | | |
|---|---|---|---|---|
| | Corn | | Soybean | |
| | (1 plant/m$^2$) | (5 plants/m$^2$) | (1 plant/m$^2$) | (5 plants/m$^2$) |
| Proso millet | 2 | 10 | 3 | 12 |
| Fall panicum | 2 | 10 | 2 | 10 |
| Barnyard grass | 2 | 7 | 3 | 12 |
| Green foxtail | 2 | 7 | 2 | 8 |
| Yellow foxtail | 1 | 5 | 1 | 5 |
| Old witch grass | 1 | 5 | 1 | 4 |
| Crabgrass | 1 | 3 | 1 | 4 |
| Volunteer corn | -- | -- | 4 | 15 |

[1] Eastern black nightshade in soybeans reduces its quality.
Note: Crop losses assume that the weeds have emerged with the crop.
Adapted from www.wedpro75.com (Ontario Ministry of Agriculture and Food, 2009)

Yield loss information on weeds at different weed and crop growth stage is available through the use of the WeedSOFT™ yield loss calculator (see http://weedsoft.unl.edu, click on "tools-calculators") (Weed Soft, 2013).

The degree of yield loss for a crop can be related to:

- Environmental conditions (e.g., temperature, moisture, etc.),
- The distribution of weed species within a given field;
- Weed density; and
- The timing of weed emergence (i.e., weed height) relative to the crop growth stage (Knezevic, 2007).

Therefore, weed management programs should not only focus on minimizing weed density and yield reductions, they should also include approaches to minimize weed seed banks. Eliminating weeds before seed production diminishes contributions to the weed seed bank and provides the best assurance for improving future weed management.

Weed control programs vary by crop, weed problem, geography, and cropping system (e.g. no-till, conventional-till, etc.). Many growers use a combination of weed control techniques including cultural, mechanical, and chemical. Practices that establish a dense, vigorous crop canopy quickly (e.g. higher seeding rates, optimum soil fertility, proper seedbed preparation, seeding depth) provide competition to smother weeds.

The keys components to successful weed management are:

- Knowing the exact identity of all weeds in the field;
- Treating (if necessary) while the weeds are small;
- Tailoring control measures to the type of weed and its size (Linker *et al.*).

Although weed control typically involves an integrated approach that includes herbicide use, crop rotation, weed surveillance, and weed monitoring (Farnham, 2001; IPM, 2004; 2007;

Hartzler, 2008; University of California, 2009), currently, herbicides are the most common and efficient tactic to manage weeds within agroecosystems (Gianessi and Reigner, 2007). Various strategies utilized for weed management are discussed in the following sections.

## Chemical Control - Herbicides

Herbicides are chemicals that move into a plant and disrupt vital biological process. Herbicides have been the primary tactic used to manage weed communities in corn and soybean since the mid-1960s and will continue to be an important feature of row crop weed management for the foreseeable future. One study, which examined aggregated data on crop yield losses and herbicide use, estimated that even if additional tillage and hand weeding labor replaced the use of herbicides, U.S. crop production would decline by 20 percent with a $16 billion loss in value if herbicides were not used (Gianessi and Reigner, 2007). Herbicide use is not regulated by APHIS but rather by EPA under FIFRA and its amendments.

Before selecting a herbicide program, growers should know what weeds are present or expected to appear, the soil texture and organic matter content, capabilities and limitations of the various herbicides, and how to best apply the herbicides (York and Culpepper, 2000). Additionally, when selecting an herbicide, a grower must consider, among other factors, whether an herbicide can be used on the crop (herbicides are registered by EPA for specific uses and crops), potential adverse effects on the crop, residual effects that can limit crops that can be grown in rotation, effectiveness on expected weeds, and cost.

To be effective, herbicides must (1) adequately contact plants, (2) be absorbed by plants, (3) move within the plants to the site of action without being deactivated, and (4) reach toxic levels at the site of action (Penn State Extention, 2013).

Herbicides are classified according to their effects on plants as either selective or nonselective. Selective herbicides will kill weeds without significant damage to desirable plants. Nonselective herbicides kill or injure all when applied at an adequate rate (Penn State Extention, 2013). Herbicide action is either contact or systemic. Contact herbicides kill only plant tissue contacted by the chemical. Systemic herbicides are absorbed from the point of application, either the roots or foliage, and move within the plant to other plant parts. Systemic herbicides may be effective against both annual and perennial weeds, but are particularly effective for control of established perennial weeds. However, systemic movement of an herbicide in perennial weeds can vary seasonally (NC State University, 1998).

Applications of herbicides to a crop or weed are described according to when they are applied:

- Pre-plant (i.e., burndown): applied to soil before the crop is planted. For pre-plant incorporated, herbicides are applied to soil and mechanically incorporated into the top 2 to 3 inches of soil before the crop is planted. In burndown, generally herbicides are used in combination such that there is no selectivity. Burndown applications in both corn and soybean often incorporate glyphosate, dicamba, and 2,4-D and may include paraquat or glufosinate to control weeds prior to planting the crop.

- Pre-emergence: applied after the crop is planted, but prior to emergence of weeds. Pre-emergent herbicides are generally not effective after weeds have established. They may be used prior to or after crop emergence.
- Post-emergence: applied after the weeds and crop emerges. Early post emergence application occurs when the crop has just emerged and the weeds are small. Post-emergent herbicides selectively target weeds relative to the crop. The post materials have activity when applied to leaves and can be used over the top of crops if the crop is resistant to the active ingredient.

Most herbicides used as pre-plant and pre-emergent applications are residuals, herbicides that remain active for several weeks and theoretically work continuously after application. These types of herbicides are finding increasing use in the management of glyphosate-resistant weeds. (See Appendix 4, Herbicide Use Trends, for more details). Examples include acetochlor, trifluralin, metolachlor, metolachlor-S, pendimethalin, atrazine and alachlor. These herbicides work by controlling weeds before they germinate or emerge. Usually residual herbicides need to be activated by water (Hager and McGlamery, 1997). In rainfed crops, residual herbicides may fail to become activated during drought. When weather complicates the timing of herbicide applications with planting, growers may plant and apply the residual herbicide in a mix with a foliar applied product (Monsanto, 2010). The foliar product controls emerged weeds while the residual material controls weeds prior to germination or emergence.

When herbicides are applied, biochemical pathways that control the growth and development of plants are interrupted and plant death and injury occurs (Sosnoskie and Hanson). These biochemical pathways control the growth and development of plants; when herbicides are applied, these processes are constrained and plant injury and death will occur. Most herbicides bind to, and thereby block the action of, a specific enzyme. Herbicides are classified according to their mode of action, which is the overall manner in which the herbicide affects a plant at the tissue or cellular level. The Weed Science Society of America (WSSA) has classified herbicides by group number, based on their mode of action. Brief descriptions of these groups are provided (Sosnoskie and Hanson) :

**Group 1:** herbicides inhibit the action of acetyl CoA carboxylase (ACCase) needed for the synthesis of lipids. Grasses, but not broadleaf weeds, are affected.

**Group 2:** herbicides inhibit the action of acetolactate synthase (ALS) needed for the synthesis of three amino acids (isoleucine, leucine, and valine).

**Group 3:** herbicides inhibit cell division (mitosis inhibitors).

**Group 4:** herbicides are growth regulators. At low concentrations, they mimic the plant growth hormone auxin and are referred to as synthetic auxins. At high concentration they produce distinctive symptoms on broadleaf weeds; twisted and curled stems, malformed flowers, thickened or stunted roots, and cupped, strapped or otherwise deformed leaves. Grasses are usually resistant.

**Group 5, 6, and 7:** herbicides inhibit photosynthesis leading to a buildup of highly reactive free radicals that damage chlorophyll and cell membranes.

**Group 8:** herbicides inhibit fatty acid and lipid biosynthesis but not ACCase ( Group 1).

**Group 9:** herbicides inhibit the action of the enzyme enolpyruvyl shikimate-3-phosphate synthase (EPSPS) needed for the synthesis of three aromatic amino acids (tryptophan, phenylalanine, and tyrosine) that are produced through the shikimate pathway.

**Group 10:** herbicides inhibit glutamine synthetase. These herbicides stop the conversion of glutamate and ammonia to glutamine which causes ammonia to accumulate in the plant, inhibiting photosynthesis and destroying plant cells.

**Group 12:** herbicides inhibit carotenoid biosynthesis. Lack of carotenoids results in destruction of chlorophyll, which is needed for plant photosynthesis.

**Group 14:** herbicides inhibit protopophyrinogen oxidase (PPO). PPO inhibitors block the production of chlorophyll and cause reactive molecules to form in the cell, resulting in the destruction of existing chlorophyll molecules, carotenoids and cell membranes.

**Group 15:** herbicides block mitosis by inhibiting the synthesis of very long chain fatty acids.

**Group 20, 21, 29:** herbicides inhibit the synthesis of cellulose needed for the synthesis of cell walls.

**Group 22:** herbicides inhibit photosystem I (PSI) forming reactive molecules that destroy lipids, eventually breaking down plant cell membranes.

**Group 27:** herbicides inhibit 4-hydroxyphenyl-pyruvate-dioxygenase needed for the synthesis of carotenoids.

Herbicides with a common chemistry are grouped into "families." Also, two or more families may have the same site of action, and thus can be grouped into "classes." Table 3-2 provides WSSA herbicide groups with information on modes of action, chemical families, and example active ingredients and herbicides.

**Table 3-2. Herbicide Groups with Example Active Ingredients and Herbicides**

| | Site of Action Group (WSSA Group) | Site of Action | Number of Resistant Weed Species in U.S. | Chemical Family | Active Ingredient | Herbicide |
|---|---|---|---|---|---|---|
| Lipid Synthesis Inhibitors | 1 | ACCase Inhibitors (acetyl CoA carboxylase) | 15 | Aryloxyphenoxy propionate ("FOPs") | fenoxaprop | Puma |
| | | | | | diclofop | Hoelon |
| | | | | | fluazifop | Fusilade |
| | | | | | quizalofop | Assure II |
| | | | | Cyclohexanedione ("DIMs") | clethodim | Select |
| | | | | | sethoxydim | Poast |
| | | | | Phenylpyrazoline ("DENs") | pinoxaden | Axial XL |

| | Site of Action Group (WSSA Group) | Site of Action | Number of Resistant Weed Species in U.S. | Chemical Family | Active Ingredient | Herbicide |
|---|---|---|---|---|---|---|
| Amino Acid Synthesis Inhibitors | 2 | ALS Inhibitors (acetolactate synthase) | 44 | Sulfonylurea (“SUs”) | chlorimuron | Classic |
| | | | | | foramsulfuron | Option |
| | | | | | halosulfuron | Permit |
| | | | | | iodosulfuron | Autumn |
| | | | | | nicosulfuron | Accent |
| | | | | | primisulfuron | Beacon |
| | | | | | prosulfuron | Peak |
| | | | | | rimsulfuron | Resolve |
| | | | | | thifensulfuron | Harmony |
| | | | | | tribenuron | Express |
| | | | | | metsulfuron | Ally |
| | | | | | triasulfuron | Amber |
| | | | | | chlorsulfuron | Glean |
| | | | | | sulfofsulfuron | Maverick |
| | | | | | mesosulfuron | Osprey |
| | | | | Imidazolinone (“IMIs”) | imazamox | Beyond |
| | | | | | imazaquin | Scepter |
| | | | | | imazapic | Cadre |
| | | | | | imazethapyr | Pursuit |
| | | | | Triazoloyrmidine | flumetsulam | Python |
| | | | | | chloransulam-methyl | FirstRate |
| | | | | | pyroxysulfam | PowerFlex |
| | | | | | diclosulam | Strongarm |
| | | | | Triazolinones | thiencarbazone | Component of Caperno |
| | | | | Pyrimidinyl(thio) benzoate | pyrithiobac | Staple |
| | | | | Sulfonylaminocar bonyl-triazilonones | flucarbazone | Everest |
| | | | | | propoxycarbazone | Olympus |
| | 9 | EPSP Synthase Inhibitor | 13 | | glyphosate | RoundUp |
| Growth Regulators (Synthetic Auxins) | 4 | Specific Site Unknown | 10 | Phenoxy | 2,4-D | |
| | | | | | 2,4-DB | Butyrac |
| | | | | | MCPA | |
| | | | | Benzoic acid | dicamba | Banvel |
| | | | | Carboxylic acid | chlopyralid | Stinger |
| | | | | | fluroxypr | Starane |
| | | | | | picloram | Tordon |
| | 19 | Auxin Transport | 0 | Semicarbazone | diflufenzopyr | Component of Status |
| Photosynthesis Inhibitors | 5 | Photosynthesis II Inhibitors (binding sites other than 6 and 7) | 24 | Triazine | prometryn | Caparol |
| | | | | | atrazine | Aatrex |
| | | | | | simazine | Princep |
| | | | | Triazinone | hexazinone | Velpar |
| | | | | | metribuzin | Sencor |

| | Site of Action Group (WSSA Group) | Site of Action | Number of Resistant Weed Species in U.S. | Chemical Family | Active Ingredient | Herbicide |
|---|---|---|---|---|---|---|
| | 6 | Photosynthesis II Inhibitors (binding sites other than 5 and 7) | 1 | Nitrile | bromoxynil | Buctril |
| | | | | Benzodiazole | bentazon | Basagran |
| | 7 | Photosynthesis II Inhibitors (binding sites other than 5 and 6) | 7 | Ureas | | Lorox |
| Nitrogen Metabolism | 10 | Glutamine Synthesis Inhibitor | | Phosphonic Acid | glufosinate | Liberty |
| Pigment Inhibitors | 13 | Diterpene Synthesis Inhibitors | 1 | Isoxazolidinone | clomazone | Command |
| | 27 | HPPD Inhibitors | 1 | Isoxazole | isoxaflutole | Balance |
| | | | | Pyrazolone | topramezone | Impact |
| | | | | Triketone | mesotrione | Callisto |
| | | | | | tembotrione | Laudis |
| Cell Membrane Disruptors | 14 | PPO Inhibitors | 2 | Diphenylether | acifluoron | Blazer |
| | | | | | fomasefen | Reflex |
| | | | | | lactofen | Cobra |
| | | | | | oxyfluorfen | Goal |
| | | | | N-Phenylphthalamide | flumiclorac | Resource |
| | | | | | flumioxazin | Valor |
| | | | | Aryl triazinone | sulfentrazone | Spartan |
| | | | | | carfentrazone | Aim |
| | | | | | fluthiacet-ethyl | Cadet |
| | 27 | Photosystem I Electron Diverter | 5 | Bipyridium | paraquat | Gramoxone Inteon |
| | | | | | diquat | Reglone |
| Seedling Root Growth Inhibitors | 3 | Microtubule Inhibitors | 6 | Dinitroaniline | ethalfluralin | Sonalan |
| | | | | | pendamethalin | Prowl |
| | | | | | trifluralin | Treflan |
| Seedling Shoot Growth Inhibitors | 8 | Lipid Synthesis Inhibitors | 8 | Thiocarbamate | butylate | Sutan + |
| | | | | | EPTC | Eradicane |
| | 15 | Long-chain Fatty Acid Inhibitors | 1 | Chloroacetamide | acetochlor | Harness |
| | | | | | alachlor | Intrro |
| | | | | | metalochlor | Dual |

| | Site of Action Group (WSSA Group) | Site of Action | Number of Resistant Weed Species in U.S. | Chemical Family | Active Ingredient | Herbicide |
|---|---|---|---|---|---|---|
| | | | | | dimethanamid | Outlook |
| | | | | Oxyacetamide | flufanacet | Define |
| | | | | Pyrazole | pyroxasulfone | Zidua |

Sources: (Armstrong, 2009; Glyphosate Stewardship Working Group, 2012).

## Mechanical Weed Control – Tillage

Prior to planting, the soil must be stripped of weeds that would otherwise compete with the crop for space, water, and nutrients. Tillage is used to prepare a seedbed, address soil compaction, incorporate fertilizers and herbicides, manage water movement both within and out of a production field, and control weeds (Heatherly *et al.*, 2009). Soil cultivation or tillage can be very valuable in many situations and should be considered as an alternate weed control practice where appropriate:

- Tillage serves as another way to control weeds and break certain weed patterns
- Tillage reduces complete reliance on herbicides
- Periodic tillage is a reliable cultural practice that also provides the benefits of removing trash build-up on the soil surface and levels ruts or rough spots in fields.

Some form of conservation tillage is utilized by the majority of corn and soybean growers. Tillage can supplement chemical control (i.e., herbicides) and, in the case of light weed infestations, could provide sufficient control if used alone. Cultivation should be shallow to reduce crop root damage and to avoid breaking through any residual herbicide layer and bringing up untreated soil and weed seed. Use of tillage is optimized when weeds are small and should not be practiced for a week prior or after post-emergence herbicide application (York and Culpepper, 2000).

Tillage can be a useful weed control method in some situations but may not be appropriate for all producers or areas. For example, tillage is not a good practice where soils are susceptible to erosion. Also, no-till soybean production is less successful in heavier, cooler soils more typical of northern latitudes (Kok *et al.*, 1997; NRC, 2010).

Although tillage may control weeds, fuel costs and machine maintenance may represent substantial farm expenditures (NRC, 2010). This fact and the availability of herbicide technology have driven producers to increasingly adopt chemical management strategies. For example, in 2012, 98 percent of soybean acreage was treated with synthetic herbicides (USDA-NASS, 2013).

## Cultural Weed Control

The successive planting of different crops on the same land is known as crop rotation. In contrast, the planting of the same crop on the same field in successive years is known as continuous crop production. Crop rotations are used to optimize soil nutrition and fertility, reduce pathogen loads, control volunteers (carry over in successive years), and limit the potential for weeds to develop resistance to herbicides (IPM, 2004; 2007; USDA-ERS, 2010a).

Crop rotation is also a key element of successful weed control as it often reduces the populations of weeds that closely mimic the appearance of the young crop or are tolerant to herbicides often used in these crops. Crop rotation should be an integral component of a weed management program. Crop rotation generally leads to healthier crops that are more competitive with weeds. Moreover, certain weeds are more easily or more economically managed in one crop than in another. In general, most weeds are more easily managed in corn or soybeans than in other agronomic or horticultural crops. Good control in corn can reduce weed problems in rotational crops. Additionally, crop rotation allows use of different herbicide chemistries on the same field in different years. This can prevent weed population shifts (changes in the species composition), avoid selection of herbicide resistant weeds, and help to keep the overall weed population at lower levels.

Since 1991, 75 percent of corn planted acreage has been in some form of rotation (USDA-ERS, 2010b). Corn can be grown successfully in a conservation tillage system if rotated with other crops such as wheat and soybeans, which will reduce some of the problems encountered with conservation tillage (IPM, 2007). Crops used in rotation with corn vary regionally and include oats, peanut, soybean, wheat, rye, and forage (USDA-APHIS, 2010). Alternative rotations are an important aspect of overall management strategies, and could theoretically reduce the cycle of herbicide applications associated with corn/soybean rotations (DAS, 2010). However, the impact of these rotations does not appear to have been studied in detail.

Consecutive plantings of corn frequently require at-planting or pre-plant pesticide treatments to control corn pests and pathogens as well as supplemental fertilizer treatments (IPM, 2004; Erickson and Lowenberg-DeBoer, 2005; Sawyer, 2007; Stockton, 2007). Corn-to-corn rotations also may require a change in tillage practices. Corn-to-corn cultivation may produce substantially greater quantities of field residue, requiring additional tillage prior to planting (Erickson and Lowenberg-DeBoer, 2005). The increased adoption of corn-to-corn rotation, mainly in conventional and GE production systems, has been attributed to rising corn demand and prices (Hart, 2006; Stockton, 2007).

Crop rotation is a common practice on U.S. soybean fields, with approximately 95 percent of the soybean acreage planted in some form of a crop rotation system since 1991 (USDA-ERS, 2011). A variety of crops may be rotated with soybean. In terms of acreage however, corn is the most commonly rotated crop. In a survey of major corn/soybean production states, corn and soybean were alternated on 72 to 80 percent of acreage, other rotations were grown on 16 to 20 percent of acreage, and soybean was grown continuously on 5 to 12 percent of acreage between 1996-2002 (Sandretto and Payne, 2006). Other crops that may be rotated with soybean include wheat, cotton, rice, sorghum, barley, oats, and dry beans.

The mitigation of pest cycles on an agricultural field is one of the primary benefits of crop rotation. The rotation of other crops following soybean production may disrupt pest life cycles that are more adapted to soybean field cultivation than other crops (Poole, 2004) through the creation of a relatively unstable agroecosystem (Weller *et al.*, 2010). For example, crop rotation may encourage the use of alternative herbicides to further control broadleaf weeds in the same field in successive years that would not otherwise be used if continuous soybean was grown (Gunsolus, 2012).

Planting high-quality, weed-free crop seed is another cultural practice that keeps weed infestations low and easier to manage. One of the most effective means of reducing weed competition is to establish a highly competitive crop. This is best accomplished by planting good quality seed into a well-prepared seedbed with good fertility and soil moisture. Higher seeding rates can help establish a competitive crop and for some weed species delaying planting will allow for destruction of early flushes of weeds via tillage or non-selective herbicide application.

### Integrated Weed Management

To reduce or mitigate against the selective pressures associated with the use of a single weed management practice, agronomists have recommended that growers adopt a diverse weed management strategy, also known as integrated weed management (IWM) (Norsworthy, 2012; HRAC, 2013). Effective IWM in crops usually involves a combination of cultural, mechanical, and chemical methods. Thus, IWM does not exclude any one management technique. IWM integrates practices such as crop rotation, cover crops, competitive crop cultivars, the judicious use of tillage, and targeted herbicide application to reduce weed populations and selection pressures toward the development of herbicide resistant weeds (Mortensen *et al.*, 2012).

A variety of strategies have been proposed to help farmers deal with glyphosate-resistant weeds (Boerboom, 1999; Beckie, 2006; Sammons *et al.*, 2007; Frisvold *et al.*, 2009). Resistance management begins with good agronomic practices, including the implementation of IWM to incorporate diverse weed control practices to reduce the frequency of herbicide applications and decrease selection pressure for herbicide resistant weed populations (Norsworthy, 2012). IWM programs that use herbicides from different groups, vary cropping systems, rotate crops, and use mechanical as well as chemical weed control methods will prevent the selection of herbicide-resistant weed populations (Powles, 2008; Green and Owen, 2011; Sellers *et al.*, 2011; Gunsolus, 2012; HRAC, 2013).

The Herbicide Resistance Action Committee, an industry-based group, has developed the following general principles of weed resistance management:

- Apply integrated weed management practices. Use multiple herbicide sites-of-action with overlapping weed spectrums in rotation, sequences, or mixtures;
- Use the full recommended herbicide rate and proper application timing for the hardest to control weed species present in the field;
- Scout fields after herbicide application to ensure control has been achieved. Avoid allowing weeds to reproduce by seed or to proliferate vegetatively; and
- Monitor site and clean equipment between sites.

For annual cropping situations, the following recommendations of the Herbicide Resistance Action Committee (HRAC, 2013) are provided:

- Start with a clean field and control weeds early by using a burndown treatment or tillage in combination with a pre-emergence residual herbicide as appropriate;
- Use cultural practices such as cultivation and crop rotation, where appropriate; and
- Use good agronomic principles that enhance crop competitiveness.

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# Appendix 4. Herbicide Use Trends and Predicted Use on Enlist™ Corn and Soybean

## Herbicide Use Trends and Predicted Use on Enlist™ Corn and Soybean

In recent years, herbicide use data has generally not been publicly available. For this analysis, third party proprietary data was obtained by Dow from GfK Kynetec's AgroTrak Agricultural Pesticide Usage Data and assumed to be "reported correctly". This source of pesticide usage data is the most comprehensive in the industry and is the same data source used by other government agencies that report on pesticide usage, namely the EPA and the US Geological Survey (US-EPA, 2012d; USGS, 2012). APHIS also relied on data from the EPA (Table 4-7) and USGS (Figure 4-8, Figure 4-9, Figure 4-10) however these data are also based on data derived from GfK Kynetec's AgroTrak Agricultural Pesticide Usage Data. APHIS used this information to identify the major herbicides, herbicide sites of action, and trends in their use on soybean and corn for the past twenty years. National usage is reported using the metric treatment acres and not pounds of active ingredient used per crop. Pounds of active ingredient per crop over emphasizes herbicides that are used at high application rates (such as glyphosate, 2,4-D, and chloroacetamides) and underestimates the use of herbicides used at low application rates (such as acetolactate synthase (ALS) and acetyl-CoA carboxylase (ACCase) inhibitors). The latter herbicides may be used at rates 100 times less than the former. Treatment acres refer to the acres of land treated with a particular herbicide summed for each time the land is sprayed. For example, if one acre of land is sprayed twice with a particular herbicide, it is counted as two treatment acres for that herbicide. This metric gives a better representation of grower reliance for a particular herbicide than does pounds of active ingredient.

### Corn Herbicide Use Trends

The ten most actively used herbicides used on corn, based on treatment acres and in order of use, nationwide and regionally in 2011 are shown in Table 4-1and Table 4-2, respectively. The top 10 herbicides accounts for greater than 95 percent of the herbicide use on corn (Rausch, 2013). Atrazine has historically been the most widely used herbicide on corn through as late as 2007 and is still widely used. In 2007, glyphosate became the most widely used herbicide on corn and its use has continued to increase through 2011. In addition, chloroacetamide herbicides are also still widely used including acetochlor and metolachlor-S. These two chloroacetamides have largely replaced alachlor and metolachlor, which were the predominant chloroacetamides used prior to 1997. Synthetic auxins such as 2,4-D and dicamba were also commonly used prior to the adoption of RR corn. As glyphosate use increased, synthetic auxin use decreased but both dicamba and 2,4-D are now finding increased use in corn as is a third synthetic auxin, clopyralid. Presumably the increased use of synthetic auxins is in response to the increasing prevalence of glyphosate tolerant and resistant weeds. In addition, the two HPPD type inhibitors, mesotrione and isoxaflutole, are finding increased use, as is the ALS inhibitor, flumetsulam.

Also shown in Table 4-1 are the WSSA group number, chemical family name, and site of action for the ten herbicides. These ten widely used corn herbicides represent six herbicide sites of action (Group 9: EPSPS inhibitors, Group 5: Photosystem II inhibitors, Group 15: very long chain fatty acid inhibitors, Group 27: 4-HPPD inhibitors, and Group 4: synthetic auxins). For the regional data in Table 4-2, just the active ingredient and group number are shown.

**Table 4-1. Top 10 Nationally Used Herbicides on Corn**

| Active Ingredient | WSSA Group | Chemical Family | Site of Action |
|---|---|---|---|
| glyphosate | 9 | Glycine | 5-enolpyruvylshikimate-3-phosphate synthase |
| atrazine | 5 | Triazine | Photosystem II |
| acetochlor | 15 | Chloroacetamide | Very Long Chain Fatty Acids |
| metolachlor-S | 15 | Chloroacetamide | Very Long Chain Fatty Acids |
| mesotrione | 27 | Callistemones | 4-Hydroxyphenyl-pyruvate dioxygenase |
| dicamba | 4 | Benzoic Acid | Synthetic Auxin |
| 2,4-D | 4 | Phenoxy-carboxylic acid | Synthetic Auxin |
| clopyralid | 4 | Pyridine carboxylic acid | Synthetic Auxin |
| flumetsulam | 2 | Triazolopyrimidine | Acetolactate synthase |
| isoxaflutole | 27 | Isoxazole | 4-Hydroxyphenyl-pyruvate dioxygenase |

Source: (DAS, 2013a)

**Table 4-2. Top 10 Regionally Used Herbicides on Corn**

| Heartland (6) | | N Crescent (6) | | N Great Plains (6) | | Prairie Gateway (7) | | Southeast (7) | |
|---|---|---|---|---|---|---|---|---|---|
| **AI** | **GN** | **AI** | **GN** | **AI** | **GN** | **AI** | **GN** | **AI** | **GN** |
| glyphosate | 9 | glyphosate | 9 | glyphosate | 9 | glyphosate | 9 | glyphosate | 9 |
| atrazine | 5 | atrazine | 5 | atrazine | 5 | atrazine | 5 | atrazine | 5 |
| acetochlor | 15 | metolachlor-S | 15 | acetochlor | 15 | dicamba | 4 | metolachlor-S | 15 |
| mesotrione | 27 | mesotrione | 27 | metolachlor-S | 15 | 2,4-D | 4 | mesotrione | 27 |
| metolachlor-S | 15 | acetochlor | 15 | mesotrione | 27 | metaolachlor-S | 15 | 2,4-D | 4 |
| flumetsulam | 2 | flumetsulam | 2 | isoxaflutole | 27 | acetochlor | 15 | dicamba | 4 |
| clopyralid | 4 | clopyralid | 4 | dicamba | 4 | mesotrione | 27 | rimsulfuron | 2 |
| isoxaflutole | 27 | dicamba | 4 | 2,4-D | 4 | isoxaflutole | 27 | simazine | 5 |
| 2,4-D | 4 | 2,4-D | 4 | clopyralid | 4 | difluflenzopyr | 19 | paraquat | 22 |
| thiencarbazone-methyl | 2 | rimsulfuron | 2 | flumetsulam | 2 | carfentrazone-ethyl | 14 | nicosulfuron | 2 |

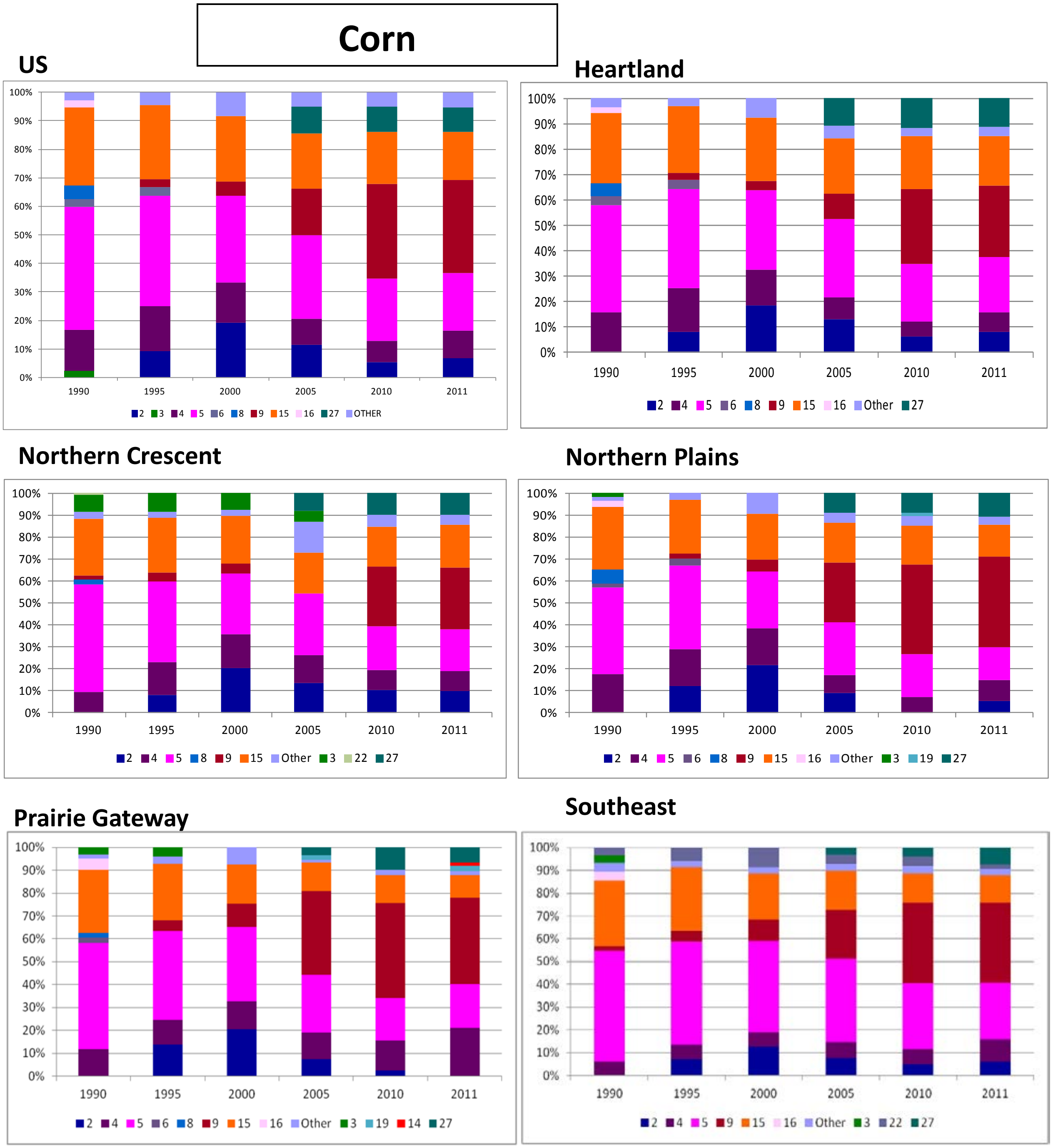
Source: (DAS, 2013a)

Heartland: MN, IA, MO, IL, IN, KY, OH
Northern Crescent: WI, MI, PA, NJ, NY, MA, RI, CT, VT, NH, ME
Northern Great Plains: MT, ND, SD, NE
Prairie Gateway: CO, KS, OK, TX
Southeast: AS, LA, MS, AL, GA, SC, NC, TN, VA, WV, MD, DE
Numbers next to the regions represent number of sites of action in the top ten most frequently used herbicides.
AI: active ingredient
GN: WSSA group number

Regional herbicide use on corn largely mirrors national use. The ten most widely used herbicides represent either 6 or 7 sites of action. In all regions glyphosate and atrazine are the two most frequently used herbicides. After atrazine, chloroacetamides and then HPPD inhibitors are in most frequent use in all regions except the Prairie Gateway. In this region, synthetic auxins, dicamba and 2,4-D are the most frequently used herbicides after atrazine. There are some differences in the type of ALS inhibitor used between regions. The Prairie Gateway and Northern Great Plains seldom rely on ALS inhibitors in corn. In the other areas, flumetsulam or rimsulfuron are the most commonly used ALS inhibitors. Both the Prairie Gateway and the Southeast use 7 modes of action compared to six in the other regions. In the Prairie Gateway, the seventh site of action is the PPO inhibitor, carfentrazone-ethyl, and in the South the 7$^{th}$ site of action is, paraquat, a PSI inhibitor which is commonly included in burndown applications.

**Trends in Herbicide Use on Corn by Site of Action (SOA)**

Although resistance may occur against one herbicide in a group and not another (for example, Enlist™ soybean is resistant to 2,4-D and sensitive to dicamba (Krieger, 2014) and Monsanto's Xtend™ soybean is much more resistant to dicamba than it is to 2,4-D (Feng and Brinker, 2010). ), there are examples where selection against one herbicide in the Group also cross selects resistance to other herbicides of that Group. For example, a biotype selected against the Group 2 herbicide imazethapyr was cross resistant to several other Group 2 herbicides including imazapic, chlorimuron, pyrithiobac, and flumetsulam (Heap, 2011). From the standpoint of managing weed resistance, it is better to rotate herbicide sites of action rather than herbicides within a site of action. Because selection of herbicide resistant weeds is a prominent issue in this FEIS, the analysis of herbicide use focuses on sites of action rather than individual herbicides. Figure 4-1 shows the trends in use of herbicide sites of action on corn nationally and by region in five year increments since 1990 and in 2011. Group 9 (glyphosate) use on corn has been increasing in all regions of the country while there appear to be decreases in the use of Group 15 (chloroacetamides), Group 2 (ALS inhibitors), and Group 5 (largely atrazine) herbicides. There have been increases in Group 4 (auxin) herbicide use regionally in the Southeast and Prairie Gateway.




| SOA | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| Chemical Family | ACCase | ALS | Mitosis Inhib | Auxins | PS II Inhib-A1 | PS II Inhib-B | PS II Inhib-A2 | FALB Inhib | EPSP Inhib |
| SOA | 10 | 13 | 14 | 15 | 16 | 19 | 22 | 27 | Other |
| Chemical Family | GS Inhib | DOXP Inhib | PPO Inhib | VLCFA Inhib | Unknown | ATI | PS I Inhib | HPPD Inhib | |

Source: (DAS, 2013d).
Classification of herbicides according to site of action.: http://www.hracglobal.com/Publications/ClassificationofHerbicideSiteofAction.aspx
Classification of Mechanism of Action http://wssa.net/weed/resistance/.

**Figure 4-1. Trends in Herbicide use on corn by SOA**

## Soybean Herbicide Use Trends

The trend in soybean herbicide use changed dramatically with the introduction of Roundup Ready® (RR) soybeans in 1996. The adoption of RR soybeans allowed post emergent application of a systemic herbicide (glyphosate) that controlled most grasses and broadleaves with one product that only required an average of 1.5 applications during the course of a season. This had the added benefits of using a single rate across soil types or pH and did not require either mechanical incorporation into the soil or rainfall for activation. This proved an attractive option for farmers that allowed a simpler solution and also gave a better weed control result in many cases and at less cost. The use of glyphosate post emergent on RR soybeans worked very well because soybeans are usually planted in narrow rows which provide rapid canopy closure thereby preventing most weeds from germinating. The benefit of total post emergent weed control also supported adoption of no till practices, saving time and money for the grower while reducing soil erosion.

In 1995 prior to the introduction of glyphosate-resistant soybean, the most commonly used herbicides in soybean were: imazethapyr (44 percent of soybean acres treated), pendimethalin (26 percent), trifluralin (20 percent), glyphosate (20 percent) (for pre-plant weed control)and metolachlor (10 percent) (USDA-NASS, 1995). By 2001, glyphosate had become the most commonly used herbicide in soybean, used on 73 percent of soybean acres, followed by pendimethalin (10 percent), imazethapyr (9 percent), fomesafen (7 percent), and trifluralin (7 percent) (USDA-NASS, 2002). Metolachlor no longer was included in the top 10 most commonly used herbicides on soybean.

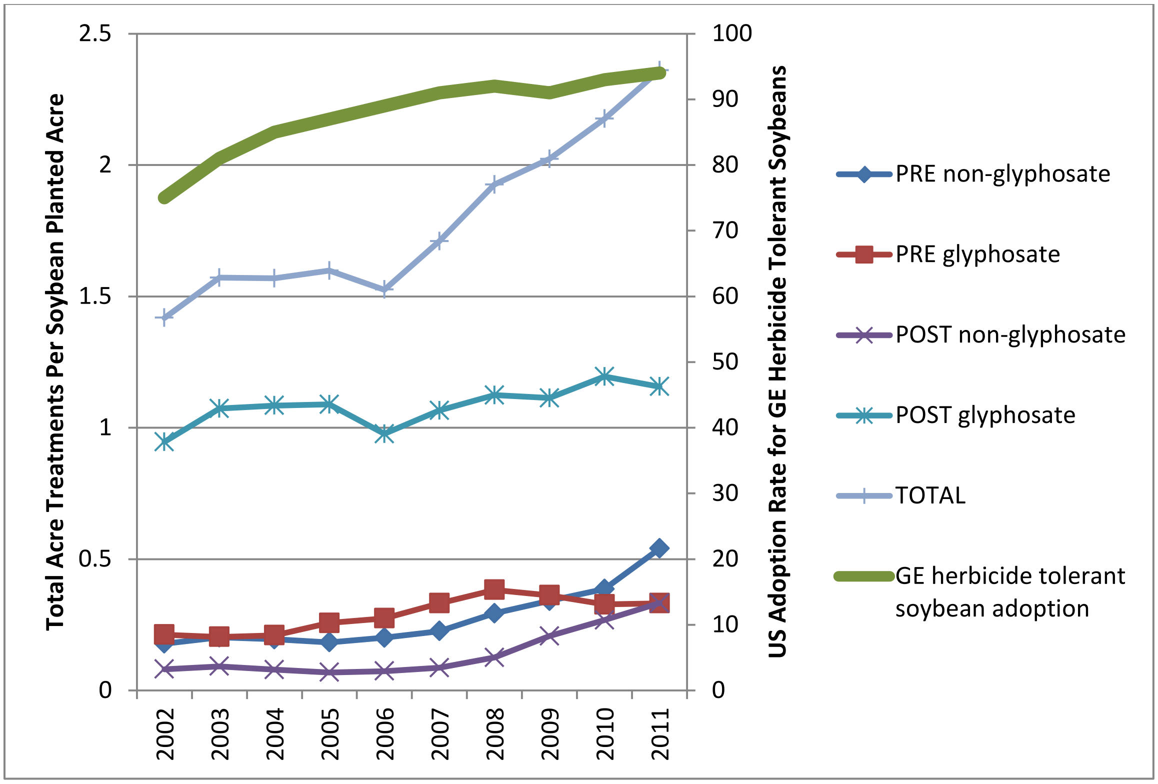
In 2006, glyphosate (all forms) continued to be the most commonly used herbicide on soybean; it was used on more than 96 percent of soybean acres and that use has largely continued to the present (Table 4-3). The next most commonly used herbicide on soybean was 2,4-D (all forms). Its use on soybean for pre-plant weed control has been steadily increasing since 2008 and in 2011 it was used on more than 12 percent of soybean acres.

**Table 4-3. Estimated 2,4-D, Glyphosate, and Glufosinate Use in Soybean, 2008-2011**

| Year | Total Soybean Acres | 2,4-D | | Glyphosate | | Glufosinate | |
|---|---|---|---|---|---|---|---|
| | | (percent acres treated) | (lbs/acre) | (percent acres treated) | (lbs/acre) | (percent acres treated) | (lbs/acre) |
| 2008 | 74,404,953 | 7 | 0.54 | 96 | 1.32 | | |
| 2009 | 77,584,979 | 10 | 0.48 | 94 | 1.30 | 0.3 | 0.46 |
| 2010 | 78,725,007 | 10 | 0.53 | 94 | 1.38 | 1.1 | 0.52 |
| 2011 | 74,835,007 | 12 | 0.55 | 96 | 1.40 | 1.3 | 0.53 |
| 2012 | 75,939,995 | NA | NA | NA | NA | 3.9 | 0.51 |

NA– Not Available
Source: (DAS, 2012c)

Although glyphosate use on soybean has remained fairly constant, since 2006, there has been a trend to use non glyphosate herbicides for both pre- and post-emergent applications, as depicted in Figure 4-3. As noted in Table 4-3, glufosinate use has also been increasing as more growers use soybean with the LibertyLink® trait. Between 2011 and 2012, glufosinate use increased 3 fold from 1.3 percent to 3.9 percent of acres treated.




Source: Total acre treatments from (Monsanto, 2012); soybean planted acres from (USDA-NASS, 2002; USDA-NASS, 2004; USDA-NASS, 2006; USDA-NASS, 2007; USDA-NASS, 2009; USDA-NASS, 2011)

**Figure 4-2. Total Acre Treatments per Soybean Planted Acre and Adoption of GE Herbicide Resistant Soybeans, 2002-2011**

Table 4-4 lists the 10 most frequently used herbicides on soybean in 2011 based on treatment acres in the order of their use. The top 10 herbicides account for greater than 95 percent of the herbicide use on soybean (Rausch, 2013). Glyphosate remains the most widely used herbicide though its dominance has been steadily declining since 2005. After glyphosate, the nine most frequently used herbicides comprise another five sites of action. These include in order of use, Group 14 PPO inhibitors (flumioxazin and fomesafen), Group 2 ALS inhibitors (chlorimuron, imazethapyr, thifensulfuron), Group 4 synthetic auxins (2,4-D), Group 15 chloroacetamides (metolachlor-S and acetochlor), and Group 1 ACCase inhibitor (clethodim) herbicides.

**Table 4-4. Top 10 Most Frequently Used Herbicides on Soybean in 2011 (Nationally)**

| Active Ingredient | WSSA Class | Chemical Family | Site of Action |
|---|---|---|---|
| glyphosate | 9 | glycine | EPSP synthase |
| chlorimuron | 2 | sulfonylurea | Acetolactate synthase |
| flumioxazin | 14 | N-phenylpthalimide | Protoporphyrinogen oxidase |
| 2,4-D | 4 | Phenoxy-carboxylic acid | Synthetic auxin |
| Fomesafen | 14 | Diphenylether | Protoporphyrinogen oxidase |
| Imazethyapyr | 2 | Imidazolinone | Acetolactate synthase |
| Metolachlor-S | 15 | Chloroacetamide | Very long chain fatty acids |
| Clethodim | 1 | Cyclohexandione | AcetylcoA carboxylase |
| Chloransulam-methyl | 2 | Triazolopyrimidine | Acetolactate synthase |
| Thifensulfuron-methyl | 2 | Sulfonylurea | Acetolactate synthase |

Source: (DAS, 2013a)

**<u>Regional Use of Herbicides in Soybean by U.S. Cropping Region</u>**

Most of U.S. soybean production occurs in the five regions indicated in Table 4-2. Herbicide use on soybeans was examined in these five regions and the top 10 herbicides used are listed in Table 4-5 based on treatment acres in the order of their use. The Heartland region is where most soybeans are grown in the U.S. and accounts for half of all soybean herbicide treatments (data not shown). Overall, the herbicides used to control weeds in soybean are similar across regions. Glyphosate provides the principal basis for weed control in each of the regions with other actives from Group 2, Group 4, and Group 14 being used to control weeds that are not controlled satisfactorily by glyphosate alone.

Some regional differences in herbicide use are as follows:

- In the Heartland, Northern Crescent, and Northern Great Plains, Group 15 herbicides are not widely used while the Group 1 grass herbicides are.
- The Northern Crescent is the one region where Group 5 Photosystem II inhibitors are widely used. The Northern Crescent is less reliant on synthetic auxins and uses a smaller variety of PPO inhibitors and a greater variety of ALS inhibitors.
- In the Northern Great Plains and the Prairie Gateway, Group 3 (mitosis inhibitors) herbicides are widely used.
- In the Southeast, Group 22 (Photosystem I) and Group 10 (Glufosinate) are widely used.
- Overall, the Heartland, uses the fewest sites of action in the top ten herbicides (5), the Southeast the most (7), while the other three regions use (6).

**Table 4-5. Top Ten Herbicides and WSSA Group Used on Soybean in the 5 Principal Growing Regions**

| Heartland (5) | | N Crescent (6) | | N Great Plains (6) | | Prairie Gateway (6) | | Southeast (7) | |
|---|---|---|---|---|---|---|---|---|---|
| **AI** | **GN** | **AI** | **GN** | **AI** | **GN** | **AI** | **GN** | **AI** | **GN** |
| glyphosate | 9 | glyphosate | 9 | glyphosate | 9 | glyphosate | 9 | glyphosate | 9 |
| chlorimuron | 2 | chlorimuron | 2 | imazethyapyr | 2 | chlorimuron | 2 | fomesafen | 14 |
| flumioxazin | 14 | imazethyapyr | 2 | saflufenacil | 14 | flumioxazin | 14 | flumioxazin | 14 |
| 2,4-D | 4 | flumioxazin | 14 | 2,4-D | 4 | 2,4-D | 4 | chlorimuron | 2 |
| clethodim | 1 | clethodim | 1 | clethodim | 1 | metolachlor-S | 15 | metolachlor-S | 15 |
| sulfentrazone | 14 | 2,4-D | 4 | flumioxazin | 14 | fomesafen | 14 | 2,4-D | 4 |
| chloransulam-methyl | 2 | metribuzin | 5 | chlorimuron | 2 | sulfentrazone | 14 | paraquat | 22 |
| imazethyapyr | 2 | thifensulfuron | 2 | pendimethalin | 3 | thifensulfuron | 2 | thifensulfuron | 2 |
| fomesafen | 14 | tribenuron methyl | 2 | chloransulam-methyl | 2 | lactofen | 14 | glufosinate | 10 |
| thifensulfuron | 2 | chloransulam-methyl | 2 | Fluthiacet-methyl | 14 | pendimethalin | 3 | dicamba | 4 |

Heartland: MN, IA, MO, IL, IN, KY, OH
Northern Crescent: WI, MI, PA, NJ, NY, MA, RI, CT, VT, NH, ME
Northern Great Plains: MT, ND, SD, NE
Prairie Gateway: CO, KS, OK, TX
Southeast: AS, LA, MS, AL, GA, SC, NC, TN, VA, WV, MD, DE
Numbers next to the regions represent number of sites of action in the top ten most frequently used herbicides.
AI: active ingredient
GN: WSSA group number
Source: (DAS, 2013a)

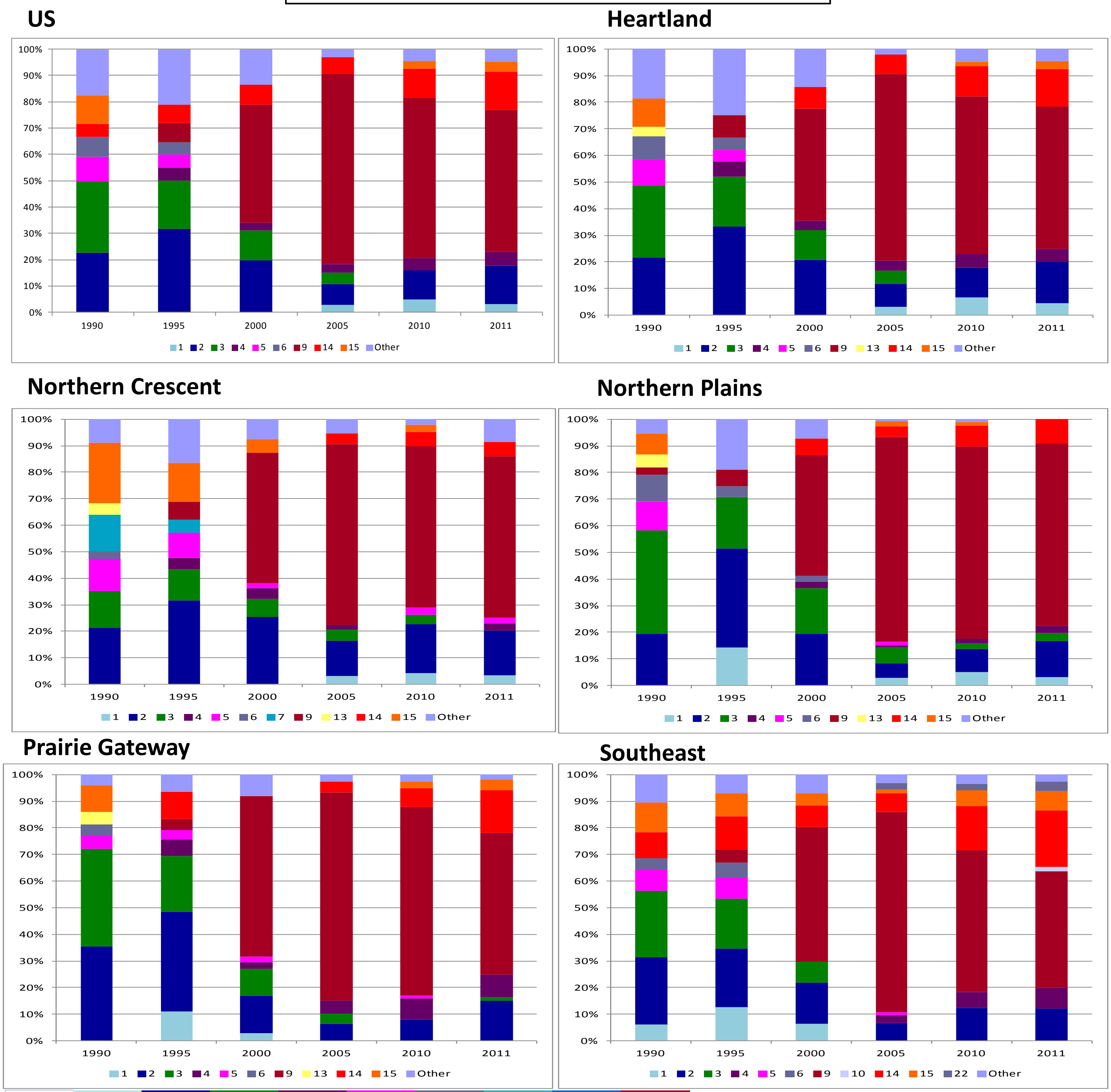
## Trends in Herbicide Use on Soybean by Site of Action (SOA)

Figure 4-3 shows trends in herbicides used on soybean from 1990-2010 in five year intervals and for 2011 alone, grouped according to Weed Science Society of America (WSSA) chemical classification for sites of action (WSSA, 2013). The analysis presents each herbicide site of action (SOA) as a percentage of the total treatment area of all actives used in that year. This approach allows a consistent comparison of herbicides used given the changes in crop area over time. The figure also breaks down usage by region. It illustrates the decreasing reliance of soybean growers on glyphosate and the utilization of additional sites of action including PPO inhibitors (Group 14), ALS inhibitors (Group 2), chloroacetamides (Group 15), and synthetic auxins (Group 4) (Figure 4-3).

In all regions there has been a similar increasing trend in the use of non-glyphosate herbicides as weed control has slipped in recent years with some weeds developing increased tolerance or resistance to glyphosate and Group 2 herbicides. In all the major soybean growing regions, the next most widely used herbicide is either a group 2 (chlorimuron and/or imazethapyr) or a Group 14 (flumioxazin, fomesan, or saflufenacil) herbicide. In all the regions 2,4-D is also widely used. There is increasing pre-emergent applications of residual herbicides such as metolachlor-S and pendimethalin in the Northern Great Plains, the Prairie Gateway, and the Southeast. These herbicides prevent weeds from germinating over a period of 4-6 weeks and help control glyphosate resistant weeds provided there is adequate rain for activation.

In the Southeast, where glyphosate resistant weeds are the most prevalent, there is a decreasing trend in glyphosate use and the greatest use of different sites of action among the various regions.

## Soybean




| SOA | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| Chemical Family | ACCase | ALS | Mitosis Inhib | Auxins | PS II Inhib-A1 | PS II Inhib-B | PS II Inhib-A2 | FALB Inhib | EPSP Inhib |
| SOA | 10 | 13 | 14 | 15 | 16 | 19 | 22 | 27 | Other |
| Chemical Family | GS Inhib | DOXP Inhib | PPO Inhib | VLCFA Inhib | Unknown | ATI | PS I Inhib | HPPD Inhib | |

Source: (DAS, 2013d)
Classification of herbicides according to site of action. http://www.hracglobal.com/Publications/ClassificationofHerbicideSiteofAction.aspx
Classification of Mechanism of Action http://wssa.net/weed/resistance/

**Figure 4-3. Trends in Herbicide Use on Soybean by SOA**

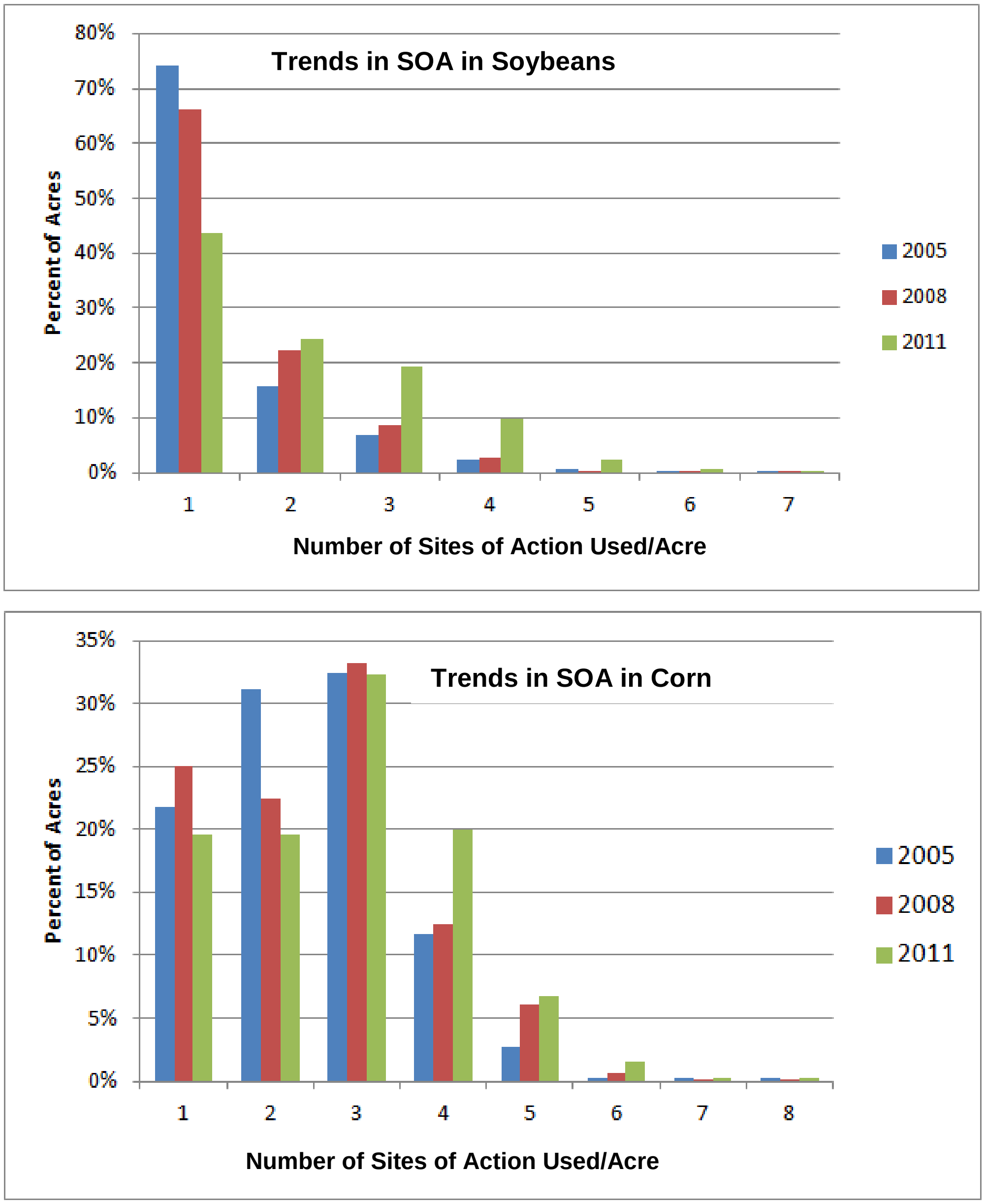
## Summary of Herbicide Trends in Soybean

Trends in herbicide use are evident in Figure 4-3. Since the mid-2000s, at the national level, the use of glyphosate and microtubule inhibitors has been declining. The use of four other sites of action has been increasing. These are the ALS inhibitor, chlorimuron, the PPO inhibitors flumioxazin and fomesafen, the auxin 2,4-D and the chloroacetamide, metolachlor-S. The greatest decline in glyphosate use has been in the southeast. In all 5 soybean regions, chlorimuron use on soybeans appears to be increasing. In the Prairie Gateway and Southeast, 2,4-D and flumioxazin use on soybean appears to be increasing. In the Southeast, fomesafen and metolachlor-S use also appear to be increasing.

## Comparison of Herbicide Use in Corn and Soybean

Herbicide use in corn differs substantially from that in soybean both in the types of herbicides used and the variety of herbicide sites of action. Corn yields are more negatively impacted by early season weed competition than soybeans. Corn is also planted in wider rows than soybeans and the resulting penetration of light allows weed germination over a longer period of time than in soybeans (Rausch, 2013). For these reasons, post emergent applications of glyphosate are not as beneficial in corn as they are in soybean. To obtain the best corn yields, growers need to manage weeds with pre-plant or pre-emergent herbicide applications. Historically they have used atrazine, and chloroacetamide herbicides such as acetochlor, metolachlor, and more recently metolachlor-S. They also relied on both dicamba and 2,4-D. Even after RR corn was widely adopted, most corn growers have continued to use residual herbicides followed by application of post emergent herbicides as needed to provide good weed control and maximize yield potential. Consequently, soybean growers have been much more reliant on glyphosate than have corn growers.

Figure 4-4 shows the number of herbicidal sites of action (SOA) corn and soybean growers used in 2005, 2008, and 2011. Whereas 3/4 of soybean growers relied exclusively on a single SOA for their weed control in 2005, less than ¼ of corn growers similarly relied on a single SOA. When only one SOA is used, in both cases the predominant herbicide is glyphosate (Figure 4-5). For soybean growers who used just one SOA, greater than 97 percent of the growers used exclusively glyphosate whereas in corn, this number was 75 percent in 2005 but increased to 90 percent in 2011. The alternative herbicides that are used as the only SOA on corn include atrazine, glufosinate, HPPD inhibitors, or chloroacetamides. However more commonly, several SOAs are used to raise corn. Over 30 percent of corn growers used at least three sites of action and this trend did not change over the period of 2005 to 2011 (Figure 4-4). In comparison, over the same period of time soybean growers using three sites of action changed from just over 5 percent to nearly 20 percent. Soybean growers using only glyphosate decreased to just over 65 percent in 2008 and further decreased to 44 percent of growers in 2011. As in soybean, the recent trend in corn has also been to use even more herbicide SOAs. For example from 2005 to 2011, the percentage of growers using 4 SOAs almost doubled from 10 percent to 20 percent. There has also been an upward trend in corn growers using herbicides representing 5 and 6 SOAs.




Source: (DAS, 2013c)

**Figure 4-4. Herbicide sites of action used in soybeans and corn since 2005 based on national data**

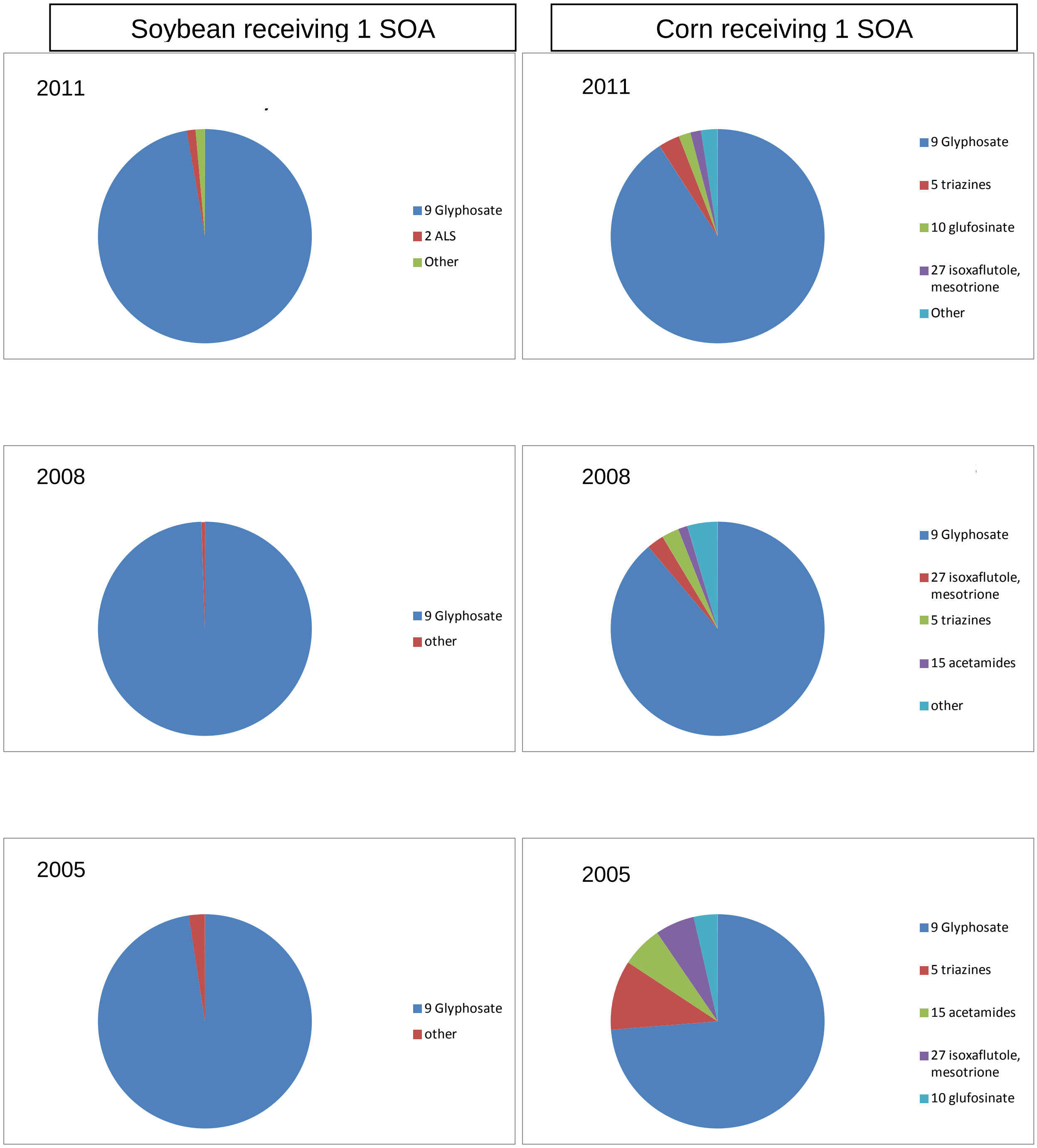



**Figure 4-5. Herbicides used in Corn and Soybean when a Single Herbicide is Applied** Source: (DAS, 2013d)

**Trends in Preplant/Pre-emergent vs Post-emergent Herbicide Use in Corn and Soy**

As described more fully in Appendix 3, pre-plant herbicide use refers to use of the herbicide prior to planting the crop, pre-emergent describes use of the herbicide prior to weed emergence, and postemergent describes use after the crop and weeds emerge. Figure 4-6 shows the most commonly used herbicides on corn and soybean and the percent each herbicide was used pre-plant/pre-emergent (pre) or post-emergent (post) in approximately five year increments since 1990 (DAS, 2013a). In some situations, such as the use of herbicide on perennial crops and fallow, this nomenclature is not applicable (NA) and notated accordingly. Herbicides that are primarily used in pre-emergent applications include acetachlor, metolachlor, metolachlor-S, atrazine, isoxaflutole, pendimethalin trifuralin, and paraquat. Herbicides that are used primarily post emergent include fomesafen, imazethapyr, thifensulfuron, glyphosate, and glufosinate. Some herbicides are widely used for both preplant/pre-emergent and post-emergent applications including 2,4-D, dicamba, flumetsulam, and mesotrione. One noteworthy trend is that for both 2,4-D and dicamba, pre-plant uses are increasing while post-emergent uses are declining. Presumably this use reflects increased use of these herbicides for pre-plant burndown to better manage glyphosate resistant weeds.

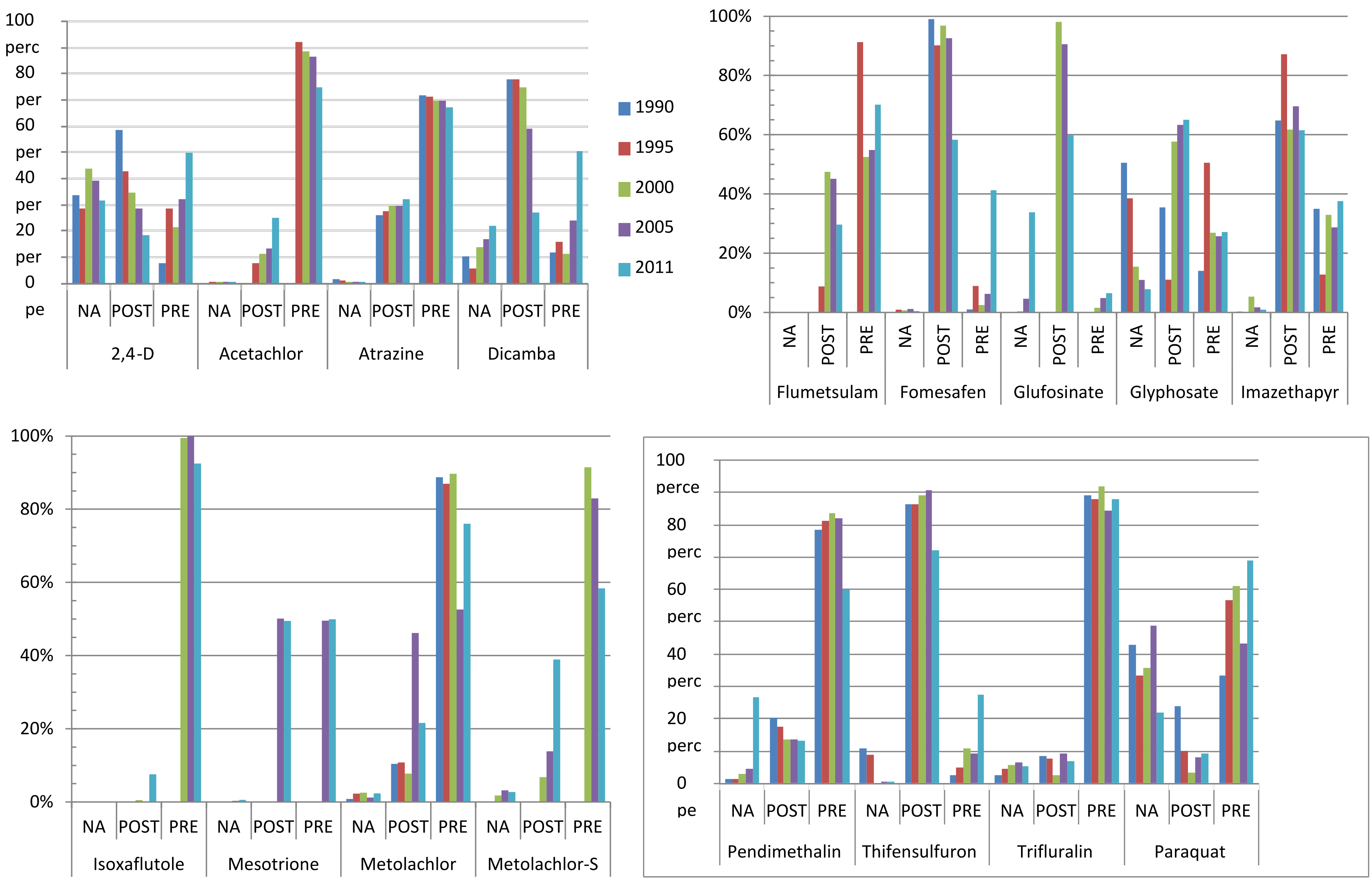



**Figure 4-6. Timing of Herbicide Use**

For each herbicide, the percentage of that herbicide used either post emergent, pre-emergent, or in situations where the timing is not applicable (NA) is noted for the years indicated.

Source: (DAS, 2013a)

## Common and Unique Herbicides Used in Corn and Soybean

One of the strategies to reduce the pressure of selecting herbicide resistant weeds is to diversify the herbicide sites of action that are used. As crops often are managed with different herbicides, crop rotation can facilitate the use of different herbicidal sites of action. To compare the extent to which herbicide sites of action would vary in a corn-soy rotation, the common and unique herbicides were identified from among the most widely used herbicides in the two crops. Sites of action corresponding to these herbicides were then compared. This information is presented in Table 4-6 for each of the five major corn and soybean regions. If an herbicide is used only on soybean in a particular region, the corresponding matrix square is colored blue. If the herbicide is only used on corn, the square is colored yellow. If the herbicide is used on both crops, the square is colored green. The stippled green squares represent the situation where a common SOA is used on both crops but the herbicides used differ. For the most part, Group 14 PPO inhibitors, Group 1 ACCase inhbitors, and Group 10 glufosinate herbicides are used on soy. Group 5 PSII inhibitors and Group 27 HPPD inhibitors are used on corn. The Group 15 chloroacetamides, which historically have been used primarily on corn, are now seeing increased use on soybean especially in the Prairie Gateway and the Southeast. Glyphosate and auxins, particularly 2,4-D are used on both corn and soybean. The auxins, dicamba and clopyralid, are still mostly used on corn.

**Table 4-6. Common and Unique Herbicides Used in Corn and Soy[1]**

| Regions | | Heartland | Northern Crescent | Northern Great Plains | Prairie Gateway | Southeast |
|---|---|---|---|---|---|---|
| **Sites of Action** | **WSSA** | | | | | |
| EPSPS | 9 | both | both | both | both | both |
| Auxin Action | 4 | both | both | both | both | both |
| PSI | 22 | N/A | N/A | N/A | N/A | both |
| ALS | 2 | | | | soy | |
| PPO | 14 | soy | soy | soy | | soy |
| ACCase | 1 | soy | soy | soy | N/A | N/A |
| Microtubule | 3 | N/A | N/A | soy | soy | N/A |
| GS | 10 | N/A | N/A | N/A | N/A | soy |
| PSII | 5 | corn | | corn | corn | corn |
| HPPD | 27 | corn | corn | corn | corn | corn |
| Chloroacetamide | 15 | corn | corn | corn | both | both |

[1]based on the 10 most widely used herbicides in a given region: Source: (DAS, 2013a).

**Key**

**Green (both)**: Herbicides with the same site of action used in both soybean and corn in a given region.

**Green Shaded**: Herbicides with the same site of action used in both soybean and corn but differing in individual herbicides.

**Blue** (**soy**): Herbicides with a site of action used only on soy in a given region.

**Yellow (corn)**: Herbicides with a site of action used only on corn in a given region.

**White** (N/A): Not applicable because herbicides with that site of action are not used in the region.

## Herbicide Use in the Different Market Segments

Only a few of the major herbicides used in corn and soybean have a major portion of their use in non-crop markets. These herbicides are glyphosate, pendimethalin and the synthetic auxins 2,4-D, clopyralid, and dicamba (Figure 4-7). In addition to use on agricultural crops, these herbicides are applied for use on range and pasture use and non-crop uses.

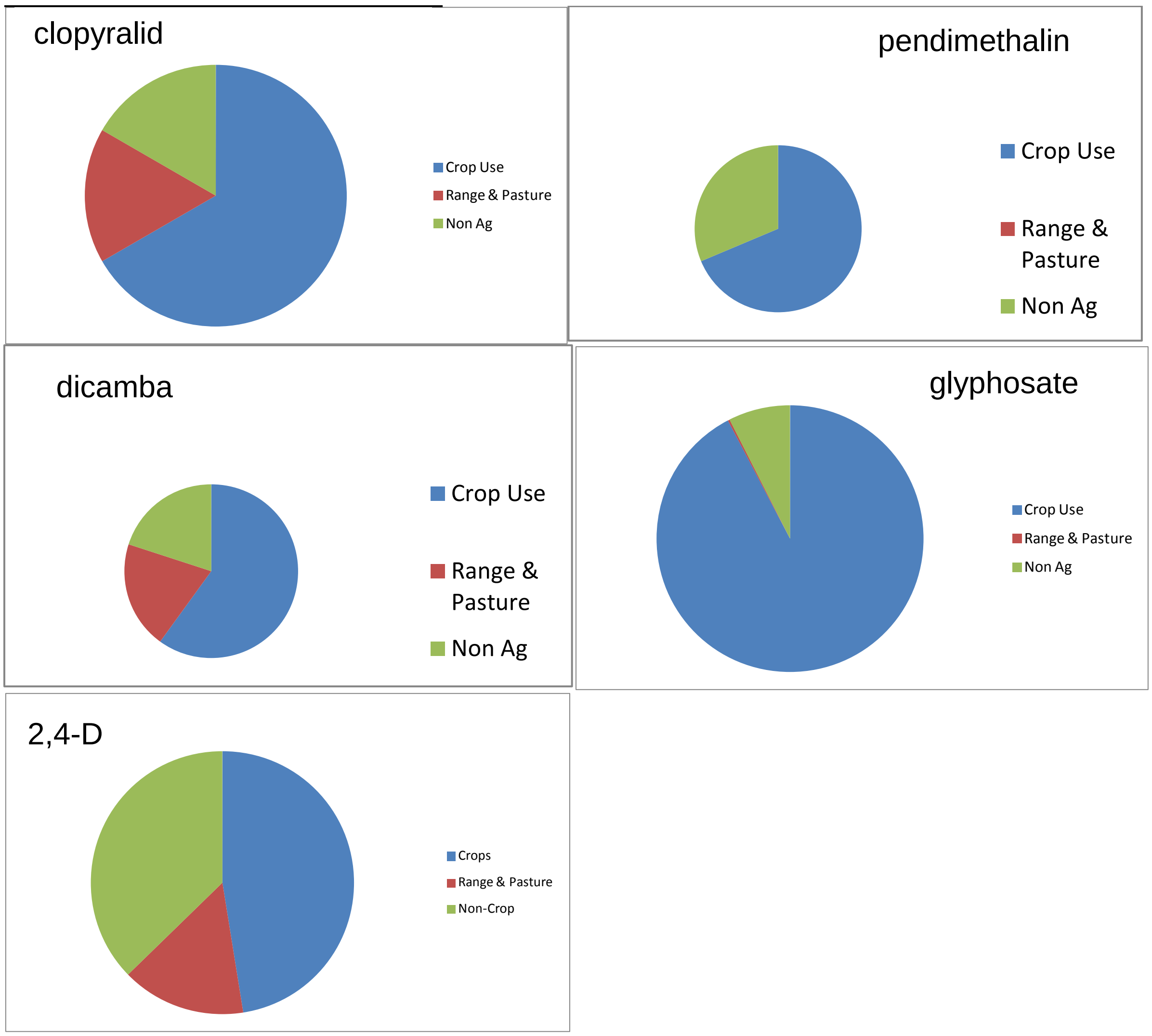
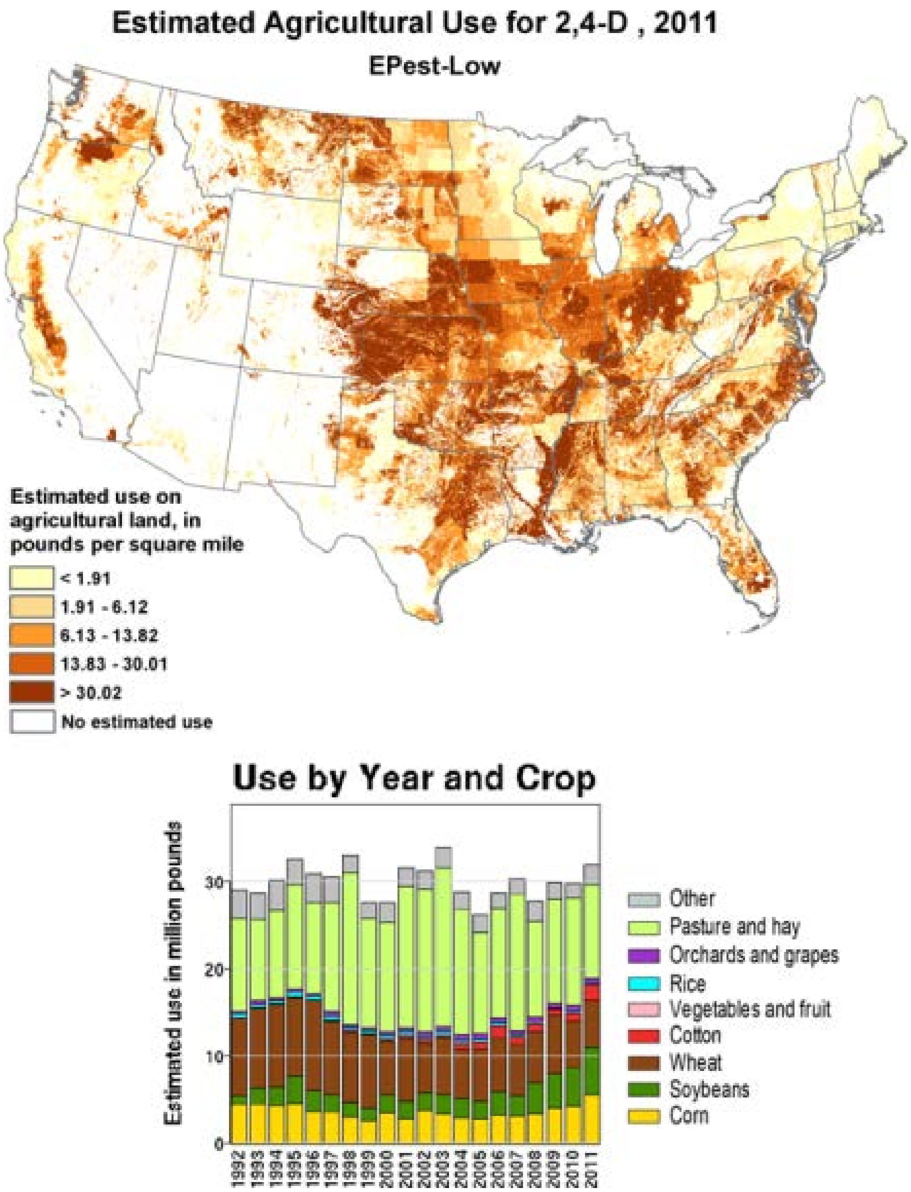



**Figure 4-7. Herbicide Use by Market Segment**
Source: (DAS, 2013a).

## Current 2,4-D Use

The herbicide 2,4-D is a phenoxy auxin herbicide, introduced more than 60 years ago and registered and used throughout the world for the treatment of broadleaf weeds. The mode of action of 2,4-D is described as an "auxin mimic," meaning that it kills the target weed by mimicking auxin plant growth hormones like indole acetic acid (IAA) (Tu *et al.*, 2001). Auxins and synthetic auxinic herbicides regulate virtually every aspect of plant growth and development; at low doses, auxinic herbicides possess similar hormonal properties to natural auxin (Kelley and

Riechers, 2007). However, as rates increase, they can cause various growth abnormalities in sensitive dicots (Tu *et al.*, 2001). Observable plant responses to 2,4-D can include epinasty, root growth inhibition, meristematic proliferation/callusing, leaf cupping/narrowing, stem cracking, adventitious root formation, senescence, and chlorosis. This uncontrolled and disorganized plant growth eventually leads to plant death when applied at effective doses (Tu *et al.*, 2001). The agricultural segment is made up of the crop use segment and the range and pasture segment. Within the crop segment these uses are very diverse ranging from burndown application prior to planting soybeans, to use underneath tree crops and use on wheat. The range and pasture segment consists of control of annual weeds as well as control of perennial weeds, woody and invasive species. Unlike the other herbicides, less than 50 percent of 2,4-D is used in the crop segment (Figure 4-7).




Source: (USGS, 2011a)
**Figure 4-8. Estimated Agricultural Use for 2,4-D, 2011**

As can be seen in Figure 4-8, 2,4-D is used predominantly in the Heartland, Prairie Gateway, the Southeast, and Northwestern U.S. 2,4-D controls many broadleaf weeds including carpetweed, dandelion, cocklebur, horseweed, morning glory, pigweed sp., lambsquarters, ragweed spp., shepherd's-purse, and velvetleaf. It has little to no effective activity on grasses, including wheat, corn, and rice (Industry Task Force II, 2005). The states with the highest use in both periods from 2001–2005 and 2006–2010 were Texas, Oklahoma, Kansas and Montana, while the sites with the highest use in terms of total pounds applied in these periods were pastureland, winter wheat, and corn. The three highest use states are those with some of the highest amounts of pastureland. The share of 2,4-D use on pastureland declined considerably between 2001–2005 and 2006–2010. The most non-agricultural usage in terms of pounds applied as reported in 2003 and 2005 was by consumers for lawn use, direct application, or as a fertilizer combination (US-EPA, 2012b).

2,4-D is an ingredient in approximately 660 agricultural and home use products as a sole active ingredient or in conjunction with other active ingredients. In 2002, 2,4-D was ranked as the third most used herbicide by active ingredient in the U.S. for all purposes (~46 million pounds), behind glyphosate (~102 million pounds) and atrazine (~77 million pounds) (Gianessi and Reigner, 2006). That same report found that the use of 2,4-D remained relatively steady from 1992 to 2002; Since that time, 2,4-D use has been increasing from about 46 million pounds in 2002 to 64 million pounds in 2011 (DAS, 2013b). In 2011, about 40 percent of 2,4-D was used on crops, 38 percent was used on turf and ornamentals, and 22 percent was used on range and pasture and for industrial vegetation management such as to control unwanted vegetative growth on utility corridors, rights-of-way, roadsides, railroads, cemeteries, non-crop areas, and managed forest. It is also used to control aquatic and nuisance weeds, e.g., purple loosestrife (Industry Task Force II, 2005). 2,4-D is very widely used for non-agricultural use.

A major use today of 2,4-D is in combination with other herbicides because it economically enhances the weed control spectrum of many other herbicides such as glyphosate, dicamba, mecoprop, and ALS herbicides (US-EPA, 2005). Agriculturally, it is used on a variety of grass crops including pasture/hay, small grains (spring wheat, winter wheat, rice, sorghum, barley, millet, oats), corn, and sugar cane and on nut and fruit tree crops (almonds, apples, apricots, cherries, citrus, hazelnuts, nectarines, peaches, pears, pecans, pistachios, plums, and walnuts). It is also used in the production of some crops which are very sensitive to 2,4-D such as soybean, cotton, grapes where the 2,4-D is used without applying it to the crop (see Table 4-7). Table 4-7 lists the crops where at least 10 percent of the crop is treated with 2,4-D and includes how many pounds of 2,4-D were applied based on EPAs screening level usage analysis conducted in 2012 (US-EPA, 2012b). Although 2,4-D is labeled for use in corn as a broad-leaf weed herbicide, its use is limited beyond early seedling stages because it can produce significant malformations of corn plants when applied at late seedling stages (Wright *et al.*, 2010). When used in soybean production, 2,4-D is applied as a pre-plant burndown treatment.

**Table 4-7. Agricultural Uses of 2,4-D**

| | | Amount Used | Percent Crop Treated | |
|---|---|---|---|---|
| | Crop | Pounds Active Ingredient (lbs a.i.) | Average | Maximum |
| 1 | Almonds | 200,000 | 15 | 20 |
| 2 | Apples | 80,000 | 20 | 25 |
| 3 | Apricots | 2,000 | 10 | 25 |
| 4 | Asparagus | 5,000 | 10 | 30 |
| 5 | Barley | 500,000 | 25 | 40 |
| 6 | Cherries | 30,000 | 15 | 25 |
| 7 | Corn | 3,200,000 | 5 | 10 |
| 8 | Cotton | 700,000 | 10 | 15 |
| 9 | Fallow | 2,300,000 | 25 | 30 |
| 10 | Grapefruit | 10,000 | 10 | 25 |
| 11 | Grapes | 50,000 | 5 | 15 |
| 12 | Hazelnuts (Filberts) | 20,000 | 25 | 35 |
| 13 | Nectarines | 5,000 | 15 | 35 |
| 14 | Oats | 300,000 | 15 | 20 |
| 15 | Oranges | 100,000 | 20 | 30 |
| 16 | Pasture | 10,600,000 | 10 | 15 |
| 17 | Peaches | 30,000 | 20 | 30 |
| 18 | Peanuts | 50,000 | 5 | 10 |
| 19 | Pears | 10,000 | 15 | 20 |
| 20 | Pecans | 40,000 | 10 | 15 |
| 21 | Pistachios | 9,000 | 5 | 20 |
| 22 | Plums | 5,000 | 15 | 30 |
| 23 | Prunes | 20,000 | 15 | 25 |
| 24 | Rice | 300,000 | 10 | 15 |
| 25 | Sorghum | 900,000 | 20 | 30 |
| 26 | Soybeans | 2,900,000 | 10 | 15 |
| 27 | Sugarcane | 400,000 | 40 | 65 |
| 28 | Sunflowers + | 60,000 | 5 | 10 |
| 29 | Sweet Corn | 7,000 | 5 | 10 |
| 30 | Tangelos | 1,000 | 30 | 45 |
| 31 | Tangerines | 2,000 | 10 | 20 |
| 32 | Walnuts | 40,000 | 10 | 15 |
| 33 | Wheat | 5,900,000 | 30 | 65 |

Source: (US-EPA, 2012a).

The current EPA-approved use directions for 2,4-D on corn allows a single pre-emergent (burn down) application of 0.5-1 lb acid equivalents/acre (ae/ac) of 2,4-D, a single post-emergent application of 0.5 lbs ae/ac, and a single preharvest application of up to 1.5 lbs ae/ac. Seasonal maximum use is 3 lbs ae/ac/season (DAS, 2010a).

The current EPA-approved use directions for 2,4-D on conventional soybean allows a single pre-plant (burn down) application of 0.35-1 lb acid equivalents/acre (ae/ac) of 2,4-D. There is a 7 to 30 day pre-plant restriction, depending on the application rate used during the pre-plant application (DAS, 2010b).

When 2,4-D is utilized in a burn down or pre-plant treatment (corn or soybean), it is almost always combined in a tank mix with glyphosate or other non-selective herbicide and, when tank-mixed, 2,4-D is generally recommended at the lower end of the rate range ~ 0.5 lbs ae/ac (Nice *et al.*, 2013)

In 2012, 97 million acres of corn were planted and 97.4 million acres were planted in 2013 (USDA-NASS, 2013). Based on third party proprietary data obtained by Dow, in 2011, 5.5 million pounds of 2,4-D were applied to 9.5 million acres (10 percent of the corn crop) for an average of 0.57 lbs ae/treated acre while in 2009, 4 million pounds were used on 7.3 million acres (8.4 percent of the corn crop) for an average of 0.55 lbs ae/treated acre (Table 4-8) (DAS, 2012d).

**Table 4-8. 2,4-D Applied to Corn**

| Year | Total Acres | Acres treated with 2,4-D | Treated Acres percent of Total | Total Pounds 2,4-D | Pounds 2,4-D/ Acre | Total Applications / Acre |
|---|---|---|---|---|---|---|
| **2009** | 86,382,000 | 7,300,000 | 8.4 | 4,000,000 | 0.55 | |
| **2011** | 91,936,000 | 9,500,000 | 10 | 5,500,000 | 0.57 | |

Source: (DAS, 2012d).

In 2012, 77 million acres of soybean were planted and 77.7 million acres were planted in 2013. 2,4-D use as a pre-plant burndown material has continued to increase between 2008 to 2011 where the percent of the crop treated has increased from 7 percent to 12 percent and total pounds used has increased from 2.7 million pounds to 4.9 million pounds (Table 4-9) (DAS, 2012c).

**Table 4-9. 2,4-D Applied to Soybean**

| Year | Total Acres | Acres treated with 2,4-D | Treated Acres percent of Total | Total Pounds 2,4-D | Pounds 2,4-D/ Acre | Total Applications /Acre |
|---|---|---|---|---|---|---|
| **2008** | 74,404,953 | 5,068,628 | 7 | 2,716,207 | 0.5 | 1.01 |
| **2009** | 77,584,979 | 7,637,880 | 10 | 3,680,330 | 0.4 | 1.01 |
| **2010** | 78,725,007 | 7,763,593 | 10 | 4,106,140 | 0.5 | 1.00 |
| **2011** | 74,835,007 | 8,832,324 | 12 | 4,893,146 | 0.5 | 1.00 |

Source: (DAS, 2012c).

**Current Quizalofop Use**

DAS-40278-9 corn is resistant to quizalofop-P-ethyl whereas conventional corn is sensitive. The "fop" herbicides (AOPP ACCase inhibitors) have been registered for crop use for more than 20 years (USDA-APHIS, 2010). The "fop" herbicides traditionally have not been used to control weed species in cornfields because, as a grass (Poaceae family) species, corn is damaged by AOPP ACCase inhibitor activity. The registration and use of "fop" herbicides has been primarily on broadleaf crops, such as soybean, to control grass weed species, although certain cereal plant varieties have a level of tolerance to some "fops" (see DuPont, 2010). According to the USDA National Agricultural Statistics Service (NASS) Agricultural Chemical Use Database, "fop" type herbicides were used for weed control on at least 23 food crop species between 1990 and 2006, totaling more than 16 million pounds of active ingredient (USDA-NASS, 2011).

The AOPP herbicides inhibit chloroplastic ACCase, which catalyzes the first committed step in fatty acid biosynthesis, causing plant death (Burton *et al.*, 1989). There are three families of ACCase inhibitors, the "fops", the "dims", and the "dens" where Quizalofpr-ethyl belongs to the "fops" family.The herbicidal activity of quizalofop-ethyl ester was first reported in 1983, and quizalofop-ethyl was first approved for use in a registered herbicide product in the U.S. in 1988 (DAS, 2010b; DuPont, 2010).[1] However, all end use product registrations were cancelled prior to 1996 and it was replaced by the more active quizalofop-P-ethyl (pure R-enantiomer of quizalofop racemic mixture), which first was approved for use in a registered product in 1990 (DuPont, 2010). Quizalofop-P-ethyl is a systemic herbicide that is absorbed from the leaf surface and translocated throughout the plant (DAS, 2010b).

Most non-graminaceous plants (dicots and sedges) are tolerant to quizalofop. Dicotyledonous plants contain a prokaryotic form of ACCase which is insensitive to "fop" herbicides. In contrast, monocotyledonous plants contain a sensitive eukaryotic form of ACCase in the plastid (DAS, 2010a). This is the primary reason that the "fop" herbicides are generally good graminicides, with little activity on dicot plants. In addition, some grass species, including some cereal crops and weeds (e.g., annual bluegrass and wild oats), are tolerant of some of these herbicides (i.e., clethodim, quizalofop, and others) due to their ability to metabolize the herbicides to inactive forms (Devine and Shukla, 2000; Powles and Preston, 2009).

Quizalofop-P-ethyl is used as a selective post-emergent herbicide for the control of annual and perennial grass weeds in 23 broadleaf food crop species. The currently registered uses of quizalofop-p-ethyl include canola, crambe, cotton, crops grown for seed, eucalyptus, dry beans (including Chickpea), dry and succulent peas, flaxseed, hybrid poplar plantings, lentils, mint (spearmint and peppermint), pineapple, ryegrass grown for seed, snap beans, soybeans, sugar beets, sunflowers, and noncrop areas. Current allowable rates for this herbicide vary from 0.0172 to 0.344 lb ai/acre, depending on crop and weed conditions (see EPA approved label for Assure II) (DAS, 2010b; DuPont, 2010).

[1] Reference to the DuPont Assure™ II label is for illustration only, and is not intended to infer any recommendation for the use of this product by APHIS or the USDA.

Although quizalofop-P-ethyl is registered for use on soybean, it is not among the 10 most frequently used herbicides on this crop. It is sometimes used to eliminate volunteer corn from soybean fields. The most frequently used ACCase inhibitor on soybean is clethodim, an herbicide in the "dim" family and the fifth most widely used herbicide in the Heartland, the Northern Crescent, and the Northern Great Plains. The "fop" herbicides traditionally have not been used to control weed species in cornfields because, like other grasses, corn is sensitive to ACCase inhibitors. DAS-40278-9 corn, however is resistant to quizalofop.

**Current Glufosinate Use**

Glufosinate is a nonselective herbicide that is used to control grasses, sedges and broadleaf weeds. Since it is a nonselective herbicide it injures or kills crop plants that it contacts. Several crop plants have been modified by inserting a gene that produces an enzyme which detoxifies glufosinate by converting the herbicide into a non-active form. Bayer Crop Science has registered glufosinate for use on glufosinate-resistant crops including corn and soybean. Ignite 280 SL Herbicide (EPA Reg. No. 264-829) is a commercially available glufosinate containing herbicide with directions for use on glufosinate-resistant crops (DAS, 2012a).

Glufosinate herbicides contain the active ingredient phosphinothricin and are in the phosphinic acid family of herbicides. The herbicide acts by blocking the plant enzyme glutamine synthetase, which is responsible for nitrogen metabolism and for detoxifying ammonia, a by-product of plant metabolism. The exposed plant dies by the over-accumulation of ammonia (US-EPA, 2008). First registered with EPA in 1993, initial glufosinate end-use products were designed for home owners; light industrial, non-food users; and farmstead, weed-control users (OSTP, 2001). Glufosinate, a water soluble herbicide, is approved for use on apples, berries, canola, corn, cotton, currants, grapes, grass grown for seed, potatoes, rice, soybeans, sugar beets, and tree nuts. Non-crop areas where glufosinate is registered for use on include residential lawns and industrial and public areas. Products include Rely™, Remove™, AEH™, Derringer™, and Finale™ (US-EPA, 2008). Ignite™/Liberty™ glufosinate products are registered exclusively for selective over-the-top use on GE LibertyLink™ corn, cotton, canola, rice, and soybean.

In 2002, it was estimated that glufosinate use in the U.S. for all purposes was 982,324 lb a.i. (Gianessi and Reigner, 2006). Estimates of annual applications of glufosinate in the U.S. indicate that approximately 1,000,000 lb a.i. were applied to agricultural land with the highest percentage (90 percent) used on corn (United States Geological Survey, No Date). Based on its proprietary data for the period from 2007–2011, EPA estimated that the highest annual agricultural uses of glufosinate are in corn (1.3 million lbs), almonds (200,000 lbs), cotton (200,000 lbs), grapes (200,000 lbs), canola (100,000 lbs) and soybeans (100,000 lbs)(US-EPA, 2012c). With the commercial availability of glufosinate-resistant LibertyLink™ soybean beginning in 2009, glufosinate use on soybeans has increased. Glufosinate-resistant soybean accounted for less than 1 percent of soybean acreage planted in the U.S. in 2009 with approximately 72,000 lb ai glufosinate applied. In 2012, the planted acreage of glufosinate-resistant soybeans increased to 3.9 percent, and glufosinate use rose to approximately 1,536,000 lb (DAS, 2012a) Table 4-3. The map in Figure 4-9 shows the use of glufosinate from 2009 prior to the use on soybean. (A more recent version is/is not available). At that time, most use of glufosinate was concentrated in the Midwest.

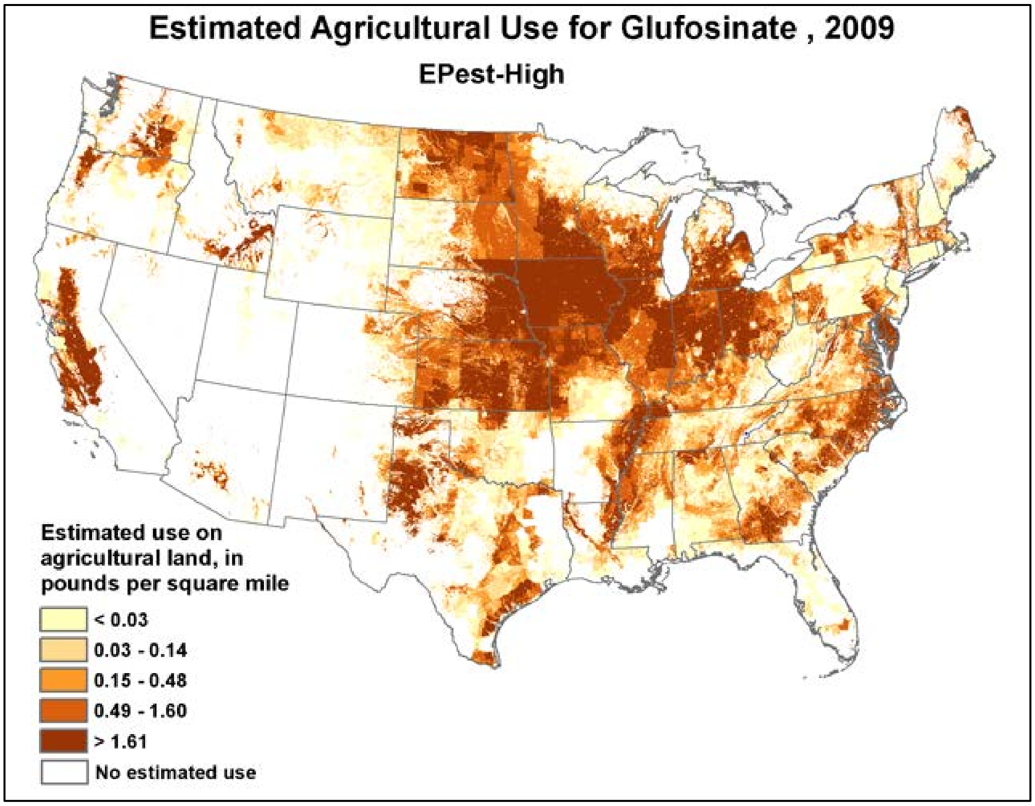



**Figure 4-9. Estimated Annual Agricultural Use of Glufosinate in the U.S.**
Source: (USGS, 2009)

Due to its nonselective activity, glufosinate has a weed management spectrum similar to glyphosate and its use has grown, particularly in areas with glyphosate-resistant weeds (Southeast Farm Press, 2012). In the southeast in 2011, glufosinate was the ninth most frequently used herbicide on soybean. Glufosinate resistance in Enlist™ soybean enables use of glufosinate as an herbicide on commercially grown soybeans but also provides use as a selection agent in breeding programs and seed amplification (DAS, 2010b).

Glufosinate-resistant soybeans are a more recent introduction than glyphosate-resistant soybeans. The number of acres planted to glufosinate-resistant soybeans has grown steadily but is still a very small fraction of total soybean acres. Average seasonal use rate is about a half pound per acre with just over 1 application per acre made. Glufosinate can also be used as a pre-plant (burn down) treatment on conventional and glufosinate-resistant soybean, however volume estimates for this use have a high degree of uncertainty (DAS, 2012a). For the years 2009-2011only a total of 46,000 lbs were used in a pre-plant treatment and 75 percent of those pounds were used in 2011.

Although glufosinate provides an additional means of weed control, it is not as versatile as glyphosate. For example, glufosinate needs to be applied to smaller weeds with finer droplet sizes and larger carrier volumes to achieve adequate control. This is in part because, unlike glyphosate which translocates readily throughout the plant, glufosinate has limited mobility and thus requires better coverage for control (hence the larger carrier volumes and smaller droplet sizes).

Application rates of glufosinate range significantly by use pattern, with the highest rate allowed for broadcast (ground) spray applications, at 1.5 lbs a.i./A, on orchard nuts and fruits, grapes, grasses grown for seed, and golf course turf. On the low end of application rates, labeled uses of glufosinate on turf and patio are at 0.03 lbs a.i./A. Multiple applications are allowed by most labels, although the interval is not generally specified (US-EPA, 2008). The EPA-registered use of glufosinate on LibertyLink™ (i.e., glufosinate-resistant) soybean includes an initial application of glufosinate no higher than 0.66 lb a.i./A (36 fl oz/A) with a minimum of 0.40 lb a.i./A (22 fl oz/A). A single second application of glufosinate up to 0.53 lb a.i./A (29 fl oz/A) is approved on LibertyLink™ soybeans, with a seasonal maximum rate of 1.2 lb a.i./A (65 fl oz/A) permitted. Glufosinate applications on LibertyLink™ soybean should be made from emergence up to but not including the bloom growth stage and within 70 days of harvesting soybean (Bayer CropScience, 2011).

## Current Glyphosate Use

Current glyphosate use directions approved by EPA for use on glyphosate-resistant corn allow a maximum pre-emergence application amount of 3.7 lbs glyphosate ae/ac, and two post-emergent applications each at 1.125 lbs glyphosate ae/ac (total 2.25 lbs ae/ac). An additional pre-harvest application of 0.77 lbs ae/ac can be made. Total seasonal use rate is 6 lbs glyphosate ae/ac . Application of glyphosate to soybean is similar with the exception that post-emergent applications from 0.75 to 1.5 lbs glyphosate ae/ac (total 2.25 lbs ae/ac/season) can be made.

Third party proprietary market research data indicate that the percentage of glyphosate-resistant corn acres has grown over the last four years (Table 4-10). Total pounds of glyphosate applied to corn have also increased during this time where the percentage of the crop has increased from 77 percent treated in 2008 to 90 percent treated in 2011. In contrast, acres of soybean treated have remained fairly constant at 94-96 percent of the crop (Table 4-11). The application rate and the total applications/acre have remained fairly uniform for both crops despite the increase in glyphosate resistant weeds.

**Table 4-10. Glyphosate Use on Glyphosate-Resistant (GR) Corn**

| Year | Total Acres | GR Corn Acres | GR as percent of Total | Total Pounds Glyphosate | Pounds Glyphosate/ Acre | Total Applications/ Acre |
|---|---|---|---|---|---|---|
| **2008** | 86,705,017 | 66,854,236 | 77 | 67,760,400 | 1.06 | 1.29 |
| **2009** | 86,409,977 | 71,071,345 | 82 | 68,621,113 | 1.05 | 1.28 |
| **2010** | 87,230,005 | 75,958,684 | 87 | 75,582,434 | 1.11 | 1.31 |
| **2011** | 91,620,001 | 82,163,813 | 90 | 85,671,957 | 1.17 | 1.33 |

Source:(DAS, 2012d)

**Table 4-11. Glyphosate Use on Glyphosate-Resistant Soybean**

| Year | Total Acres | GR Soybean Acres | GR as percent of Total | Total Pounds Glyphosate | Pounds Glyphosate/ Acre | Total Applications/ Acre |
|---|---|---|---|---|---|---|
| **2008** | 74,404,953 | 71,592,624 | 96 | 95,398,687 | 1.32 | 1.58 |
| **2009** | 77,584,979 | 73,219,835 | 94 | 96,415,627 | 1.30 | 1.55 |
| **2010** | 78,725,007 | 74,059,182 | 94 | 102,162,527 | 1.38 | 1.58 |
| **2011** | 74,835,007 | 71,734,538 | 96 | 100,121,452 | 1.40 | 1.54 |

Source: (DAS, 2012c)

Glyphosate use is concentrated heavily in the Midwest, along the Mississippi River, the Southeast seaboard, and the Central Valley of California as depicted in Figure 4-10.

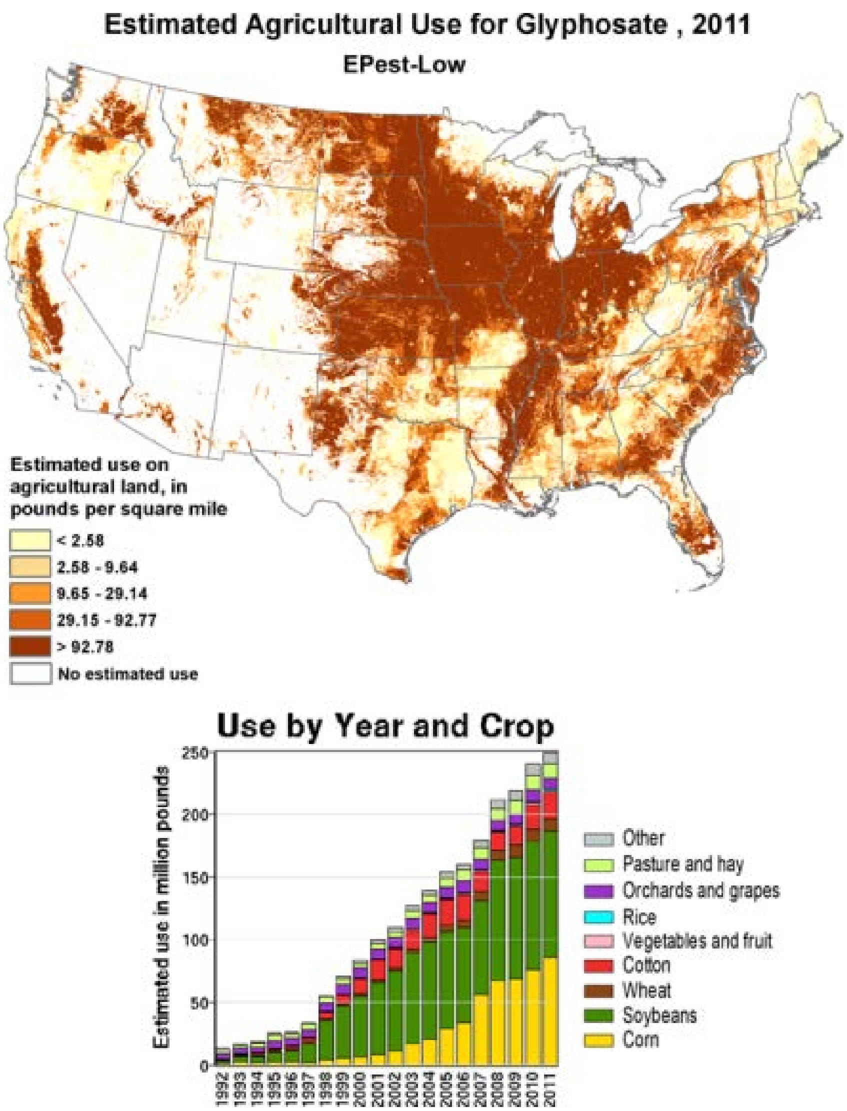



**Figure 4-10. Estimated Annual Agricultural Use of Glyphosate in the U.S.**
Notes: Map represents average annual pesticide use intensity expressed as average weight (in pounds) of a pesticide applied to each square mile of agricultural land and typical use patterns over the 5-year period of 1999 through 2004. Source: (USGS, 2011b)

## Changes in 2,4-D and Glyphosate Use for Enlist Duo™ Herbicide

Proposed new use rates of 2,4-D and glyphosate, the active ingredients in the new Dow Enlist Duo™ herbicide formulation, on Enlist™ corn and soybeans are detailed in Appendix 8.

**Projected 2,4-D Use in Corn and Soybean under the No Action and Action Alternatives**

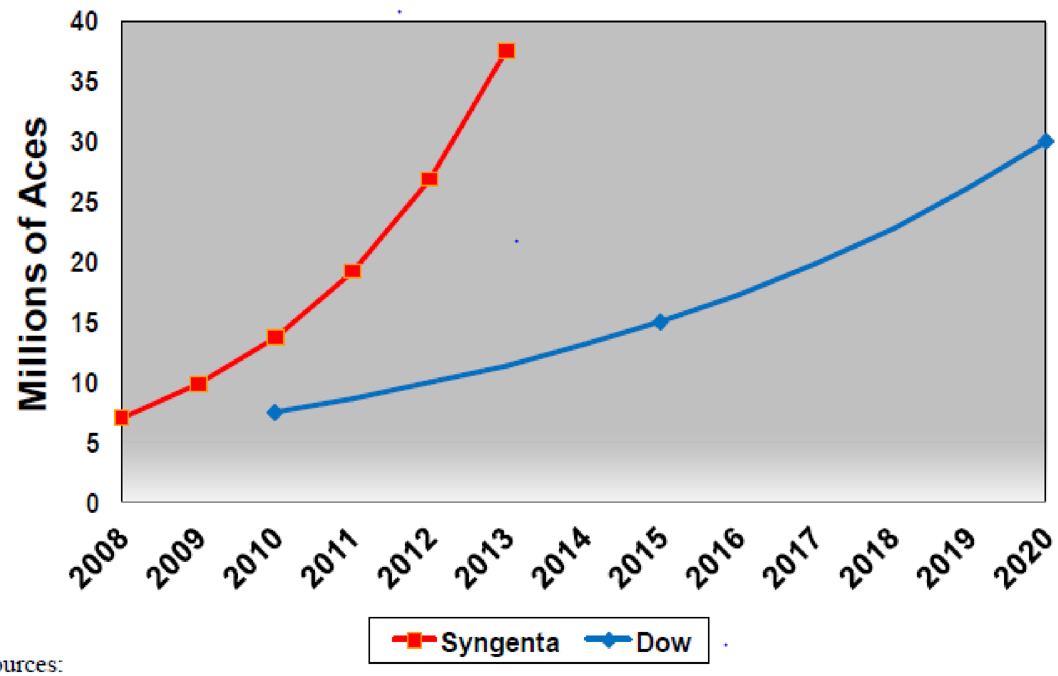
**<u>No Action Alternative</u>**

In the past 3 years, there has been a 38 percent increase in the amount of 2,4-D applied to corn (Table 4-8) and an 80 percent increase in the amount applied to soybean over the past 5 years (Table 4-9) (DAS, 2012d; DAS, 2012c). These increases are due to the increased fraction of the crops treated and the increase in acreage of both crops. Although the acreage of corn is expected to decrease and the acreage of soybean is not expected to increase substantially beyond current levels, the percentage of the crop treated is expected to continue to increase as glyphosate resistant weeds become more widespread. Thus, under the No Action Alternative, an increase in baseline use of 2,4-D on corn and soybean is expected. Historically, the highest recorded use of 2,4-D is its application to 14 percent of the U.S. corn acres in 1994 (USDA-NASS, 2011) which would result in a further 4 percent increase in 2,4-D use in corn. However, APHIS sees no reason that this share is an upper limit and 2,4-D use in either crop as a pre-plant burndown could reasonably be expected to follow the distribution of glyphosate-resistant weeds in the corn and soybean crop.

Third-party proprietary market research demonstrates that over 96 percent of glyphosate-resistant soybean acres receive at least one glyphosate application (burn down and/or post emergent). A small population of farmers (~4 percent) that purchase glyphosate-resistant soybeans elect not to make a post-emergent glyphosate application. The market research also indicates that 22 percent of planted soybean acres currently receive a burn-down (pre-plant or pre- emergence) herbicide application. For corn, ~10 percent of farmers that purchase glyphosate-resistant corn elect not to make a post-emergent glyphosate application. The market research also indicates that 22 percent of planted corn acres currently receive a burn-down (pre-plant or pre-emergence) herbicide application.

Using third party market data, Dow has estimated that 5 percent of U.S. corn or soybean acreage had glyphosate-resistant weeds in 2010, and that the percentage would grow to 10 percent of soybean/corn acreage by 2015 and to 30 percent by 2020 (Figure 4-11). This is consistent with but less aggressive than predictions made by other others, (Foresman, 2009; Farm Industry News, 2013).

Assuming that by 2020, 30 percent of corn and soybean fields will be infested with glyphosate resistant weeds, it is reasonable to assume that up to 30 percent of corn and soy growers will use 2,4-D on their crops for burndown applications. Currently 12 percent of the soy crop is treated with 2,4-D (Table 4-9). If that percentage increases to 30 percent, 2,4-D use on soy would be expected to increase from 5.4 to 13.5 million pounds ( a factor of 30/12=2.5). Likewise, 10 percent of the corn crop is treated with 2,4-D (Table 4-8). If 30 percent were treated, the amount of 2,4-D applied would increase from 5.4 million pounds to 16.2 million pounds. Assuming 2,4-D use does not increase in other crop or non-crop applications, the total applied to crops is predicted to increase from 25.6 million pounds to 44.5 million pounds resulting in a 74 percent increase in crop use of 2,4-D and a 29 percent increase in total 2,4-D use (Table 4-12) under the No Action Alternative.




Sources:

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**Figure 4-11. Projected corn and soybean acres infested with glyphosate resistant weeds.**
Source: (DAS, 2011a).

## Action Alternatives

There is considerable uncertainty regarding the projected use of 2,4-D on DAS-40278-9 corn, DAS-68416-4 soybean, and DAS 44406-6 soybean should all be granted non-regulated status. The adoption rate would depend on the availability of the traits in high performing varieties, the extent to which weeds are difficult to control with existing herbicides, cost of the new product relative to existing varieties, to name a few.

EPA has approved 2,4-D for use on other major agricultural crops at rates greater than those proposed for DAS-68416-4 soybean, DAS 44406-6 soybean or DAS-40278-9 corn. The proposed maximum 2,4-D application rate for soybean is the same as that currently approved for use on field corn and popcorn (US-EPA, 2005), which are typically grown in the same areas as soybeans and often in the same fields in rotation with soybean. Utilizing the historically consistent data from the current and broad use of glyphosate on DAS-40278-9 corn (Table 4-10), Dow has estimated that farmers who grow Enlist™ corn will use an average of 0.875 lbs 2,4-D ae/ac/application with an average of 1.33 applications per season. Similarly, utilizing the historically consistent data from the current and broad use of glyphosate on soybean (Table 4-11) plus field trial data on weed control with various herbicide application rates, Dow has estimated that farmers who grow Enlist™ soybean will use an average of 0.875 lbs 2,4-D ae/ac/application with an average of 1.54 applications per season (includes burn down and post emergent applications). The application rate of 0.875 lbs 2,4-D ae/ac is the midpoint between the medium and high rates allowed on the Enlist Duo™ label and is consistent with the glyphosate rate needed for weed control. As Enlist Duo™ contains an ~1:1 ratio of 2,4-D and glyphosate, nearly identical rates of 2,4-D and glyphosate will be applied.

Dow provided to APHIS three projections of 2,4-D use in corn and soybean:

***Scenario* 1** assumes growers will only apply Enlist Duo™ to DAS-40278-9 corn, DAS-68416-4 soybean, or DAS 44406-6 soybean where growers are facing or actively trying to prevent the establishment of glyphosate-resistant weeds. Additionally this scenario also assumes that all farmers with corn or soybean acres that have glyphosate resistant weeds will plant DAS-40278-9 corn or DAS-68416-4/ DAS 44406-6 soybeans and will use Enlist Duo™ herbicide. This is an overestimate of the use of 2,4-D given the fact that other weed control options are available. Assuming that minimal additional acreage would be treated to prevent glyphosate resistant weeds from becoming established, and using the assumptions set forth above regarding total corn or soybean acres, application rates and applications per season, the following formula was used to calculate total lbs of 2,4-D ae that might be used on DAS 40278-9 corn, DAS-68416-4 soybean, or DAS 44406-6 soybean:

**Corn**

92MM acres x 30 percent resistant weeds (in 2020) x .875 lbs ae/ac/application x 1.33 applications/season = 32MM lbs 2,4-D ae per year (Table 4-12). This represents an approximate six-fold increase in 2,4-D use on corn in 2020 compared to the volume of 2,4-D currently used on corn in 2011 and a 100 percent increase compared to the volume predicted to be used under the No Action Alternative for 2020.

**Soybean**

76MM acres x 30 percent resistant weeds (in 2020) x .875 lbs ae/ac/application x 1.54 applications/season = 31MM lbs 2,4-D ae per year (Table 4-12). This represents an approximate six- fold increase in 2,4-D use in 2020 compared to the volume of 2,4-D currently used on soybean in 2011 and a 130 percent increase compared to the volume predicted under the No Action Alternative for 2020.

***Scenario Two.*** The second scenario assumes that all acres of DAS 40278-9 corn, DAS-68416-4 soybean, or DAS 44406-6 soybean would receive applications of Enlist Duo™, regardless of weed control need, and thus relies on estimates of what the projected market share of these two crops will be:

Dow sells corn and soybean seed through its subsidiary seed companies, i.e., Mycogen Seeds, Renze Seeds, Dairyland Seed, Pfister Seeds, Brodbeck Seeds, Triumph Seed, Prairie Brand Seed and Hyland Seeds. Through these subsidiaries, Dow currently has <5 percent of the market share for field corn and silage corn and <3 percent of the market share for soybean. At this time, Dow is not planning to breed DAS-40278-9 corn into all of its corn hybrids, so DAS-40278-9 corn would occupy considerably less than Dow's current $\leq$5 percent of the market. Similarly, Dow is not planning to breed DAS-68416-4 soybean into all of its soybean varieties, so Enlist™ soybean would occupy less than Dow's current $\leq$3 percent of the market. However, for purposes of this estimate, 5 percent and 3 percent will be used as a minimum potential for DAS-40278-9 corn and Enlist™ soybean acreage, respectively.

Dow is interested in and is pursuing licensing agreements with additional corn and soybean seed companies to breed DAS-40278-9 corn and DAS-68416-4 or DAS-44406-6 soybean into a licensee's corn and soybean germplasm, respectively. To date, two licensing agreements have been made representing ~35 percent of the soybean market but no agreements have been made for corn. Through natural growth and these licensing arrangements it is reasonably possible that, at maturity, approximately 45 percent of the corn and soybean germplasm could have the Enlist™ trait and these corn and soybean varieties could be planted on up to 45 percent of the total corn and soybean acreage. Due to the technical aspects of corn and soybean seed breeding, rapid improvement of germplasm and stacking with other traits, this level of adoption of DAS-40278-9 corn, DAS-68416-4 soybean, or DAS-44406-6 soybean is estimated to take 5-10 years to reach maturity (maturity in 2018-2023).

**Corn**:

Assuming application rates of 2,4-D are as described above: an average of 0.875 lbs ae/ac/application with 1.33 applications per year and 90 percent of acres estimated (based on current glyphosate application information from proprietary third party data that only 90 percent of glyphosate resistant corn is sprayed with glyphosate) :

At present market share of 5 percent, 2,4-D use on corn is expected to double compared to 2011:

92MM acres x 5 percent market share x 90 percent DAS-40278-9 corn acres treated x 0.875 lbs ae/ac/application x 1.33 applications per DAS-40278-9 corn acre = 4,709,250 additional lbs 2,4-D ae per year compared to 5.4 million pounds in 2011.

At a market share of 45 percent, 2,4-D use on corn might increase 8 fold compared to 2011 levels.

92MM acres x 45 percent market share x 90 percent DAS-40278-9 corn acres treated x 0.875 lbs ae/ac/application x 1.33 estimated applications per DAS-4078-9 corn acre = 43,361,325 lbs 2,4-D ae per year.

**Soybean**:

Assuming application rates of 2,4-D are as described above: an average of 0.875 lbs ae/ac/application with 1.54 applications per year and 100 percent of acres are treated:

At a market share of 45 percent, 2,4-D use on soybean is expected to increase approximately nine-fold compared to 2011 levels.

76MM acres x 45 percent market share x 100 percent DAS-68416-4 soybean acres treated x 0.875 lbs ae/ac/application x 1.54 estimated applications per Enlist™ soybean acre = 46,084,500 lbs 2,4-D ae per year.

***Scenario Three*:** The third scenario assumes that all current glyphosate-resistant corn and soybean acres would be planted to hybrids that also contain the DAS-40278-9 corn, DAS-68416-4 soybean, or DAS44406-6 soybean traits. This is an unrealistically high estimation but provides an upper confidence level on 2,4-D volume. It is unrealistic to assume that all glyphosate resistant corn and soybean will be replaced by the Enlist™ products. First, not all growers will be faced with glyphosate resistant weeds and such growers may have little economic incentive to adopt Enlist™ corn or soybean. Second, other herbicide resistant soybean varieties are on or expected to appear on the market, such as glufosinate, dicamba, isoxaflutole, and mesotrione resistant varieties so competition is expected to reduce market share. Third, corn is already resistant to 2,4-D and dicamba for at least part of its growth cycle, and thus some growers may not value this trait in corn. Even with this extreme assumption, the estimated 2,4-D volume is only a 17-fold increase in 2,4-D use on corn and a fourteen fold increase on soybean compared to the current use of 2,4-D on existing varieties, calculated as follows:

From Table 4-10, 82MM acres of the 92 MM total corn acres are planted to glyphosate-resistant corn. Using the same application information and other assumptions used in the previous two scenarios, the 2,4-D volume can be estimated as follows:

82MM glyphosate-resistant acres x 90 percent DAS-40278-9 corn acres treated x 0.875 lbs ae/ac/application x 1.33 estimated applications per DAS-4078-9 corn acre = 85,884,750 lbs 2,4-D per year.

For soybean, at least 32 percent of the market (24MM acres) will not contain the DAS-68416-4 or DAS-44406-6 soybean traits, due to one developing technology that will be a direct competitor to the Enlist™ Weed Control System. Correcting for this market share, the maximum acreage that might be planted to DAS-68416-4 or DAS 44406-6 soybean traits is 52MM acres (76MM-24MM). Using the previously applied assumptions for soybean, 2,4-D volume is estimated as follows:

52MM glyphosate-resistant acres x 100 percent DAS-68416-4/DAS 44406-6 soybean acres treated x 0.875 lbs ae/ac/application x 1.54 estimated applications per DAS-68416-4/DAS-44406-6 soybean acre = 70,070,000 lbs 2,4-D per year**.**

Other Estimates of 2,4-D Use on Enlist™ Corn and Soybean.

Benbrook (Benbrook, 2012) projected much higher 2,4-D use rates on DAS-40278-9 corn (30 fold) than any of the scenarios noted above. One major discrepancy is his assumption that 2,4-D use on corn may increase to 55 percent of planted corn acres by 2019. This is a much larger estimate than Dow made (30-45 percent) based on its potential for licensing of its technology to corn seed breeders. He also assumes a much higher use rate. Both Benbrook and Dow estimate a comparable application rate of 0.84 and 0.875 lbs/acre, respectively. However Benbrook projects that the frequency of applications will increase to 2.3 applications/year, while Dow estimates the average number of applications to be 1.33 per year. Historically, corn growers have used 3-4 different herbicide chemistries even after the introduction of Roundup Ready corn. If growers continue to use other modes of action, it is unlikely that 2,4-D applications will rise to 2.3 applications/year. Therefore, USDA considers the Benbrook projection to be an overestimate.

Summary of Projected 2,4-D Use

The information from the calculations described above is summarized in Table 4-12. Under the No Action Alternative, 2,4-D use is expected to increase to 82.8 million pounds for all uses of 2,4-D where 44.5 million pounds are applied to crops. The predicted 2020 crop usage constitutes an increase of nearly 75 percent compared to the volume of 2,4-D used on crops in 2011 (44.5 million pounds vs 25.6 million pounds).

Under the Action Alternatives, three scenarios were considered (I, II, and III). Under Scenario I, up to a six fold increase in 2,4-D use is estimated for both corn and soybean compared to current levels. Under Scenario II, an 8 fold increase is estimated for corn and a 9 fold increase is estimated for soybean. Under Scenario III, a 17 fold increase is estimated for corn and a 14 fold increase is estimated for soybean. These calculations are summarized in Table 4-12. Total crop 2,4-D use is predicted to range from 98.6 million pounds to 214.5 million pounds, depending on the scenario and Alternative.

Compared to levels of 2,4-D used in 2011, the predicted increase in crop 2,4-D use under the Preferred Alternative would be approximately 204 percent to 588 percent. However compared to the No Action Alternative estimation for 2020, the increase on crop use is estimated to range from 75 percent- 296 percent.

Under Alternative 3 where only corn would be deregulated, the increase of crop 2,4-D use predicted under the three scenarios ranges from an increase of 136 percent to 370 percent compared to the current situation. Relative to the No Action Alternative estimation for 2020, the increase ranges from 36 percent to 169 percent.

Under Alternative 4, where only soy would be granted non-regulated status, the increase of crop 2,4-D use predicted under the three scenarios ranges from an increase of 201 percent to 316 percent compared to the current situation. Relative to the No Action Alternative estimation for 2020, the increase ranges from 39 percent to 139 percent.

Note that even under Scenario I which predicts the smallest fold increase in 2,4-D use, USDA considers the estimate to be high because it assumes an unrealistically high market share. Thus while 2,4-D use is expected to increase under the Action Alternatives, the difference from the predicted No Action is expected to be less than the 75 percent increase noted in Table 4-12.

Currently, 2,4-D is the third most frequently used herbicide in the U.S (an estimated 64 million pounds were used in 2011) after glyphosate (an estimated 250 million pounds were used in 2011) and atrazine (an estimated 77 million pounds were used in 2011) (Table 4-13). Levels of atrazine use have stayed fairly constant over the past decade but use of glyphosate and 2,4-D have continued to increase. Based on the assumptions made, it is estimated that 2,4-D use will surpass atrazine use by 2020 under both the No Action and Action Alternatives.

**Table 4-12. Projected 2,4-D Use Under Four Alternatives**

| Alternative 2 (Enlist™ corn + soybean) | | | | | |
|---|---|---|---|---|---|
| | actual 2,4-D (millions of pounds) | projected 2,4-D use in 2020 under No Action (NA) Alternative | Projected 2,4-D use based on DOW estimates for 2,4-D use on 2,4-D corn and soybean (millions of pounds) | | |
| | 2011 | increased burndown[1] | Scenario I[2] | Scenario II[3] | Scenario III[4] |
| **crops** | 25.6 | 44.5 | 77.8 | 104.1 | 176.2 |
| **turf and ornamental** | 24.3 | 24.3 | 24.3 | 24.3 | 24.3 |
| **range/pasture/industrial management** | 14.0 | 14.0 | 14.0 | 14.0 | 14.0 |
| **corn** | 5.4 | 16.2 | 32.0 | 43.3 | 85.9 |
| **soybean** | 5.4 | 13.5 | 31.0 | 46.0 | 70.1 |
| **total 2,4-D** | 64.0 | 82.8 | 116.1 | 142.4 | 214.5 |
| **percent increase in crop 2,4-D relative to No Action 2020** | | | 75 percent | 134 percent | 296 percent |
| **percent increase in total 2,4-D relative to No Action 2020** | | | 40 percent | 72 percent | 159 percent |

| Alternative 3 (Enlist™ corn only) | | | | | |
|---|---|---|---|---|---|
| | 2011 | increased burndown[1] | Scenario I[2] | Scenario II[3] | Scenario III[4] |
| **crops** | 25.6 | 44.5 | 60.3 | 71.6 | 119.6 |
| **Turf and ornamental** | 24.3 | 24.3 | 24.3 | 24.3 | 24.3 |
| **range/pasture/industrial management** | 14.0 | 14.0 | 14.0 | 14.0 | 14.0 |
| **corn** | 5.4 | 16.2 | 32.0 | 43.3 | 85.9 |
| **soybean** | 5.4 | 13.5 | 13.5 | 13.5 | 13.5 |
| **total 2,4-D** | 64.0 | 82.8 | 98.6 | 109.9 | 157.9 |
| **percent increase in crop 2,4-D relative to NA 2020** | | | 36 percent | 61 percent | 169 percent |
| **percent increase in total 2,4-D relative to NA 2020.** | | | 19 percent | 33 percent | 91 percent |

| Alternative 4 Enlist™ (soybean only) | | | | | |
|---|---|---|---|---|---|
| | **2011** | **increased burndown[1]** | **Scenario I[2]** | **Scenario II[3]** | **Scenario III[4]** |
| **crops** | 25.6 | 44.5 | 62.0 | 77.0 | 106.5 |
| **Turf and ornamental** | 24.3 | 24.3 | 24.3 | 24.3 | 24.3 |
| **range/pasture/industrial management** | 14.0 | 14.0 | 14.0 | 14.0 | 14.0 |
| **corn** | 5.4 | 16.2 | 16.2 | 16.2 | 16.2 |
| **soybean** | 5.4 | 13.5 | 31.0 | 46.0 | 70.1 |
| **total 2,4-D** | 64.0 | 82.8 | 100.3 | 115.3 | 144.8 |
| **percent increase in crop 2,4-D relative to NA 2020** | | | 39 percent | 73 percent | 139 percent |
| **percent increase in total 2,4-D relative to NA 2020.** | | | 21 percent | 39 percent | 75 percent |

[1]Assumes 2,4-D applied to 30 percent of corn and soybean crop as preplant burndown.
[2]I estimate (30 percent glyphosate resistant weeds)= up to 6X current soy and corn use.
[3]II estimate (Dow 45 percent market share corn and soy)= 9x current soy and 8X current corn
[4]III estimate (all corn and soy less competitor market share)=14X current soy and 17X current corn
Source: (DAS, 2013d).

**Table 4-13. Top Three Herbicides-Total Crop Use in 2002, 2011 and Estimated Use Under Alternatives (millions of lbs)**

| | **2002** | **2011** | **2020 (No Action)** | **2020 (Preferred)** | **2020 (Alt 3)** | **2020 (Alt 4)** |
|---|---|---|---|---|---|---|
| glyphosate | 102 | 250 | 250 | 250 | 250 | 250 |
| atrazine | 77 | 77 | 77 | 77 | 77 | 77 |
| 2,4-D | 40 | 64 | 83 | 116-215 | 99-160 | 100-145 |

Source: (DAS, 2013d).

### Projected use of Quizalofop on DAS 40278-9 Corn

### Changes in Quizalofop Use Directions with Enlist™ Weed Control System

Quizalofop is currently registered for use on soybean and no changes in the use of quizalofop on soybean are projected.

Quizalofop is not yet registered for use on corn. It's use as a post-emergent herbicide on corn is a proposed new use[2] (DAS, 2010b). The petitioner has indicated that "fop" herbicides could be

[2]As required under FIFRA, metabolism and residue data, along with proposed labeling changes, has been submitted to the EPA for the use of "fop"-type herbicides (specifically quizalofop) in DAS-40278-9 Cornfields (page 18 of the Petition). Under FIFRA, it is unlawful to use an herbicide "in a manner inconsistent with its labeling" without an experimental use permit issued (7 U.S.C. 136j). On July 14, 2014 EPA issued a Proposed Interim Registration

used to maintain seed purity in DAS-40278-9 corn breeding nurseries, hybrid production fields, and generally for the control of grass weeds in corn. Table 4-16 provides a summary of the current labeled uses of quizalofop in comparison with proposed application rates and directions for use on DAS-40278-9 corn.

In current registered uses of quizalofop, the EPA has approved single application rates ranging from 0.034 to 0.082 lbs ai/acre (38 g ai/ha to 92 g ai/ha), depending on the weed species, with the highest maximum seasonal application rate being 0.206 pounds ai/acre (231 g ai/ha) for weed control in mint (DAS, 2011b). Upon EPA approval of the herbicide registration amendment, a quizalofop herbicide (e.g., Assure II) would be available for use on DAS-40278-9 corn. Whether used as a selection agent or as an herbicide, the proposed use directions would essentially be the same. The proposed directions for use of quizalofop on DAS-40278-9 corn would allow up to two post emergent applications from the V2 to V6 growth stage (Figure 4-12). Application rates are 0.034-0.082 lbs ai/ac. The total amount that could be applied in a season is 0.082 lbs ai/ac (DAS, 2011b). The maximum seasonal rate for quizalofop on DAS-40278-9 corn would be less than or equal to the maximum seasonal rate on the label for all other crops. DAS-40278-9 corn has proven tolerant to quizalofop post-emergent application rates of up to 184 g ai/ha (0.164 lbs ai/acre) in field trials (DAS, 2011c). The proposed maximum application rate is also the seasonal maximum application rate (DAS, 2011c). This maximum application rate is less than that currently approved for use of quizalofop for control of grassy weeds in soybeans and cotton, where a seasonal maximum application rate of 139 g ai/ha (0.124 lb ai/acre) is approved (DAS, 2011c).

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Review Decision for quizalofop (US-EPA, 2014). The Agency's final registration review decision for quizalofop will be issued once an ESA Section 7 consultation with the Fish and Wildlife Services has taken place and an Endocrine Disruptor Screening Program FFDCA section 408(p) determination has been made (US-EPA, 2014).

**Table 4-14. Comparison of Current and Proposed Application Rates for Quizalofop**

| Crop Stage | Current Use Pattern for Quizalofop on Soybeans and Cotton | | Proposed New Use on DAS-40278-9 Corn | |
|---|---|---|---|---|
| | **Maximum Application Rate (lb/acre)[1,2]** | **Directions and Timing** | **Maximum Application Rate (lb/acre)[1,2]** | **Directions and Timing** |
| Post-emergence | 0.082 | Apply 0.034 to 0.082 lb/acre per application. Do not exceed a total of 0.124 lb/acre per season. | 0.034 to 0.082 | Apply 0.034 to 0.082 lb/acre per application from V2 – V6 Growth stages.<br>Do not make more than 2 applications.<br>Do not exceed a total of 0.082 lb/acre per season.<br>Do not apply later than V6 growth stage. |
| **Total Annual Maximum Application** | 0.124 | --- | 0.082 | --- |

Source: (DAS, 2010a).

Notes:
1. Active ingredient.
2. 1 lb/acre is the equivalent of 1,120 g/hectare.

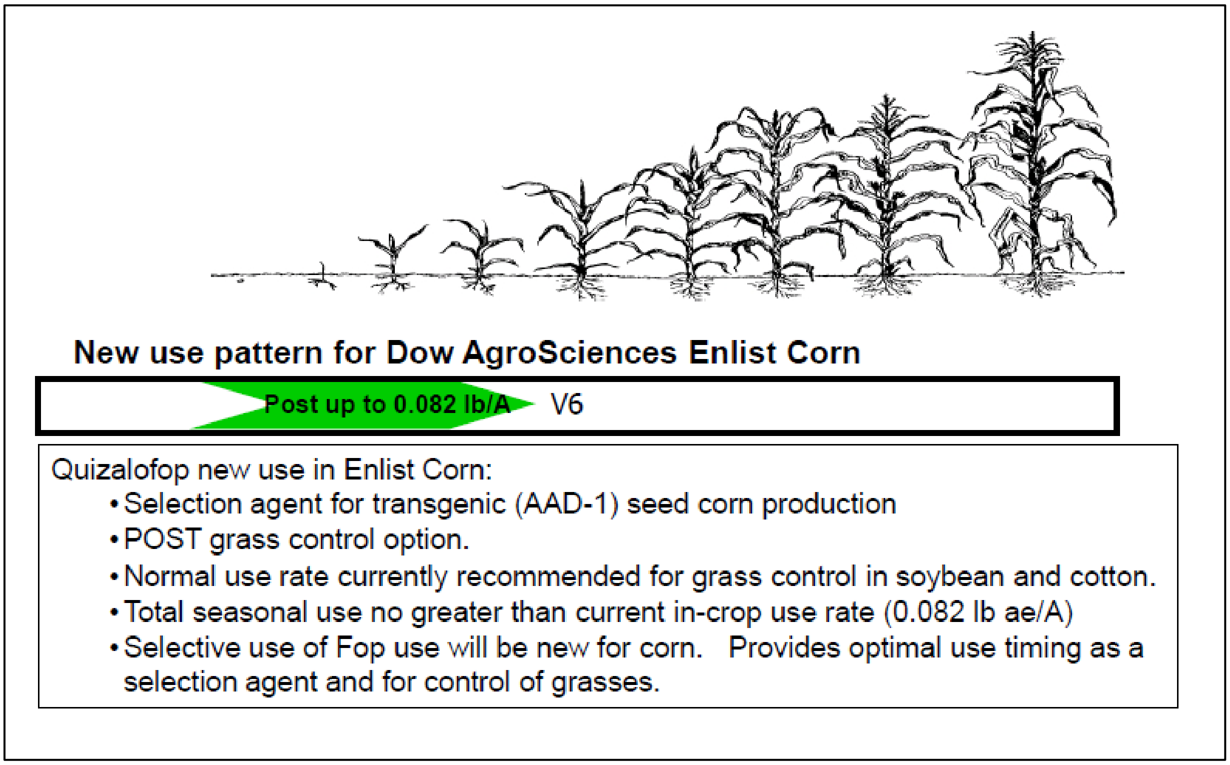


**Figure 4-12. Proposed Use Pattern of Quizalofop on DAS 40278-9 Corn**
Source: (DAS, 2012b).

Under the No Action Alternative and Alternative 4, Enlist™ corn would not be deregulated and quizalofop could not be used on currently available corn varieties due to its inherent sensitivity. No changes are anticipated in the use of quizalofop on soybean.

Under the Preferred Alternative and Alternative 3, DAS-40278-9 corn would be deregulated. Because, unlike all other corn, DAS-40278-9 corn is resistant to quizalofop, new uses for quizalofop may arise including the control of glyphosate resistant grasses in corn. A determination of nonregulated status of DAS-40278-9 corn, with EPA-approved use of quizalofop on corn, has the potential to result in an increase in the annual amount of quizalofop use. Although six grass species have developed resistance to glyphosate in the US (jungle rice, goosegrass, Italian ryegrass, rigid ryegrass, annual bluegrass and Johnsongrass), glyphosate remains an effective grass herbicide because the acreage of the affected area is still small. Hence, in the near future it is not expected that quizalofop will be used to control grass weeds in corn. One of the major uses of quizalofop is to control volunteer corn in soybean. It is expected that this use of quizalofop to control volunteer corn will decrease on farms that have adopted DAS-40278-9 corn, under the Preferred Alternative and Alternative 3.

Dow anticipates that the primary use of quizalofop will be to enhance the purity of lines bred with the DAS 40278-9 trait. The expected primary use is as a selection agent, to remove (kill) any corn plants in the seed propagation nursery that do not contain the DAS 40278-9 trait. It could find more widespread use to control grassy weeds in corn if other herbicide control options prove to be unsatisfactory. E.I. DuPont Company (DuPont) has submitted a label amendment (Assure II, EPA Reg. No.352-541, active ingredient quizalofop) to provide new directions for quizalofop use as a selection agent in growing seed corn and as a grass herbicide for use in corn.

There are two applications considered in predicting the use of quizalofop on DAS 40278-9 corn: Use as a selection agent in producing hybrid seed corn, and use as an herbicide to control glyphosate-resistant grasses. In the foreseeable future, the latter is not considered likely given the effectiveness of glyphosate in controlling grass weeds. Hence projections are only considered for the use of quizalofop in seed corn production.

*Seed Corn Production*: The production of hybrid seed corn requires approximately 1 acre of nursery to produce sufficient hybrid seed to plant 125 acres the following season. Two scenarios are presented to bound the range. The first scenario, the lower bound, uses Dow's current 5 percent market share for field and silage corn. The second, upper bound, assumes Dow's market share will expand to 45 percent.

***Scenario 1***: 5 percent market share for field and silage corn.

92MM acres /125 acres nursery/acre of field corn x 5 percent market share x 0.082 lbs ai/ac/application x 1 application = 3018 lbs quizalofop.

***Scenario two***: 45 percent market share for field and silage corn.

92MM acres /125 acres nursery/acre of field corn x 45 percent market share x 0.082 lbs ai/ac/application x 1 application = 27,158 lbs quizalofop.

Note that if just one percent of the adopters had previously used quizalofop to manage volunteer corn in soybean, either increase will be offset by a corresponding decrease in quizalofop that will no longer be used to manage corn volunteers. For example if 1 percent of the soybean growers no longer use quizalofop to control volunteer corn and assuming a 5 percent market share of DAS-40278-9 corn is grown in rotation with soybean, the decrease in quizalofop is calculated as follows:

76MM acres soybean x 5 percent market share of DAS-40278-9 corn adopters x 1 percent no longer using quizalofop for volunteer control x 0.082 lbs ai/ac/application x 1 application=3116 pounds.

If Enlist™ corn reaches 45 percent market share and is grown in rotation with soybean and 1 percent of the soybean users no longer use quizalofop to control corn volunteers, the decrease in quizalofop is calculated as follows:

76MM acres soybean x 45 percent market share of DAS-40278-9 corn adopters x 1 percent no longer using quizalofop for volunteer control x 0.082 lbs ai/ac/application x 1 application=28044 pounds.

Thus the small increase in quizalofop use that is expected for corn seed production under the Preferred Alternative 2 and 3 is likely to be offset by a corresponding or larger decrease in quizalofop use by soybean growers who had previously used quizalofop to manage corn volunteers. Accordingly, it is expected that quizalofop use will decrease overall under the Preferred Alternative and Alternative 3.

**Glufosinate Proposed Use on DAS-68416-4 Soybean**

Under the No Action Alternative, glufosinate resistant lines of corn and soybean will still be available (Liberty Link™). As noted earlier, the planting of glufosinate resistant soybean increased three fold between 2011-2012 and further increases can be anticipated under the No Action Alternative. The Action Alternatives will not impact the availability of glufosinate resistant corn and soybean varieties. In all likelihood, glufosinate and glyphosate resistance traits will be stacked with resistance to 2,4-D and growers will have the flexibility to use glufosinate, glyphosate, and 2,4-D as appropriate. Most likely, the use of glufosinate would not increase under the Action Alternatives relative to the No Action Alternative. Possibly, glufosinate use will decrease relative to the No Action Alternative if 2,4-D is considered a more favorable option for glyphosate resistant weed control compared to glufosinate.

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# Appendix 5. Common Weeds in Corn and Soybean

## Common Weeds in Corn and Soybean

Weeds are simply plants growing in areas where their presence is undesired by humans (Baucom and Holt, 2009). Plants that colonize frequently disturbed environments have evolved with characteristics or mechanisms that allow them to survive conditions in agricultural environments. Weedy plants typically exhibit early germination and rapid growth from seedling to sexual maturity, have the ability to reproduce sexually and asexually, and therefore are well adapted to agricultural fields (Baucom and Holt, 2009).

The presence of weeds in corn and soybean fields is a primary detriment to productivity. Weeds are the most important pest complex in agriculture, impacting yields by competing with crops for light, nutrients, and moisture. In addition to taking valuable resources from crops, weeds can introduce weed seed or plant material to a crop, thereby reducing the market grade of the crop.

Additionally, weeds can harbor insects and diseases; weeds also can interfere with harvest, clogging and causing extra wear on harvest equipment (Loux *et al.*, 2008). For example, some winter annuals have been found to serve as alternative hosts for the soybean cyst nematode, a pest that affects soybean yields in the U.S.

Effective weed management involves an understanding of weed biology and of weed management strategies. This section provides an overview of weed types, the weed seed bank, and the timing and occurrence of weeds. Also described are the types of weeds that occur in corn and soybean. Weed management is discussed in Appendix 3.

## Weed Classification

Weeds are classified according to their life cycle, as annuals, biennials or perennials. Weeds are also classified as broadleaf (dicots) or grass (monocots). Weeds can reproduce by seed, rhizome (underground creeping stems), or other underground part (e.g., buds, bulbs).

An annual is a plant that completes its lifecycle in one year or season and reproduces only by seed. Annuals can be further differentiated into summer or winter annuals. Summer annuals appear in the spring or early summer and die prior to or by the first frost, producing seeds within the same growing season. These weeds grow rapidly, strongly competing with crops for resources, and can outgrow and shade slower-growing crops. These weeds tend to be the most problematic weeds in corn and soybeans, as they share a similar life cycle.

Summer annuals can be further categorized into three groups: small-seeded summer annual broadleaf weeds, large-seeded summer annual broadleaf weeds, and summer annual grass weeds (Schonbeck, 2010). Some small-seeded summer annual broadleaf weeds include pigweeds, common lambsquarters, common purslane, galinsoga, and smartweeds. Commonly found large-seeded summer annual broadleaf weeds include velvetleaf, common cocklebur, and morning glory. Summer annual grass weeds have small to medium sized seeds and include foxtail, crabgrass, and goosegrass.

Winter annuals typically emerge in late summer or early fall, but can also germinate as late as early spring. Usually these weeds over-winter as small seedlings and set seed in the spring.

These weeds have little effect on warm season crops. Common winter annuals include purple deadnettle, henbit, field pennycress, shepherd's-purse, and chickweed (Schonbeck, 2010; Mock *et al.*, 2011).

Biennials have a life cycle of two years or seasons. After persisting as low-growing vegetation during their first season, biennial weeds overwinter, then flower and produce seeds in their second growing season. Examples of biennial weeds are burdock, bull thistle, poison hemlock, and wild carrot.

Perennials are plants that live for more than two years and are typically categorized as simple or creeping or invasive perennials. These weed species have root systems that store large amounts of food reserves, making them difficult to control. Winter perennials are particularly competitive and difficult to control because these weeds re-grow every year from rhizomes or root systems (DAS, 2010). Canada thistle, bermudagrass, common milkweed, common pokeweed, dandelion, johnsongrass are examples of perennial weeds (Penn State University, 2009; Mock *et al.*, 2011).

Generally, annual grass and broadleaf weeds are considered the most common weed problems in corn and soybean (Krausz *et al.*, 2001; DAS, 2010).

**Weed Seed Bank**

An important concept in weed control is the seed bank which is the reservoir of seeds that are on the soil surface and scattered at different depths in the soil. The soil weed seedbank determines the size and species composition of the weed community within a growing season (Norsworthy, 2012). Under favorable conditions, these seeds have the potential to germinate and emerge, creating weed pressure (i.e., competition) in crops. The weed seed bank contains recently dropped seeds, older seeds mixed into the soil, tubers, bulbs, rhizomes, and other vegetative structures. Climate, soil characteristics, shifts in agricultural management practices, such as tillage, crop selection, and weed management practices, affect the density and species composition of the seed bank within a given field (Davis *et al.*, 2005; May and Wilson, 2006; Buhler *et al.*, 2008).

The majority of seeds in the weed seed bank come from the weeds that have grown and set seed in the field. Wind, water, animals, and birds can carry seeds, adding to the weed seeds already present. Also, manure or other material (e.g., mulch, feed, soil) transported by humans or farm equipment from other locations can be indirect sources of weed seed (Renner, 2000).

Agricultural soils can contain thousands of weed seeds and a dozen or more vegetative weed propagules per square foot (Menalled and Schonbeck, 2013). Estimates of weed seeds in Corn Belt soils range from 56 to 14,864 seeds per square foot (Renner, 2000). Annual weeds produce large numbers of seeds. For example, a pigweed plant can shed at least 100,000 mature seeds and one lambsquarters plant can produce more than 50,000 seeds (Renner, 2000). If left untended and without crop competition, giant ragweed can produce approximately 10,000 seeds, common waterhemp 70,000 seeds, and waterhemp 100,000 seeds, or more, per plant. Larger-seeded broadleaf weeds are not as prolific in comparison to small-seeded summer broadleaf weeds, but seed production is still high, with a few hundred to a few thousand per plant (Schonbeck, 2010). It has been observed that weeds in agricultural fields produce less seeds as a result of competition from the crop, damage from herbicides, and other factors, although these weed still produce high numbers of seeds that can affect production (Buhler *et al.*, 1997).

Although seedbanks are made up of numerous weed species, generally only a few species will comprise 70 to 90 percent of the total seed bank (Wilson, 1988; Buhler *et al.*, 1997; Renner, 2000). For example, common lambsquarters (Chenopodium album) is the dominant weed seed in many field soils in the north central region of the U.S. (Michigan) (Renner, 2000). A second smaller group of weed species may represent 10 to 20 percent of the seed bank (Buhler *et al.*, 1997).

Additionally, only a fraction of the seeds in a weed seed bank germinate and grow each year. Birds, rodents, insects, and other animals typically will consume available weed seeds found on the soil surface. Some seeds may decay or become unviable in the soil; other seeds may germinate but will die. Some seeds can remain dormant in the soil for long periods of time. When changes in the cropping system occur, creating conditions that are suitable for germination and development of a particular weed species, that species can respond rapidly, becoming non-dormant and establish itself in the cropping system (Renner, 2000; Durgan and Gunsolus, 2003; May and Wilson, 2006; Steckel *et al.*, 2007). It is estimated that less than 10% of the weed seeds in the soil are non-dormant and able to germinate within a season. The remaining dormant seeds thereby serve to extend the longevity of the seed bank (Renner, 2000; PhysicalWeeding, 2009). For example, summer annuals can remain viable for years, even if buried deeper in the soil, while the larger broadleaf seeds can remain viable for decades (Schonbeck, 2010).

The majority of weeds grow from seeds in the top two inches of soil with the most significant numbers emerging from only the top one inch of soil (PhysicalWeeding, 2009). In general, most small-seeded weeds (e.g., foxtail, pigweed) germinate and emerge within the upper half inch of the soil surface. The large-seeded summer annual broadleaf weeds are usually found in soils below the surface layer (about 0.5 to 2 inches below the surface) and can germinate from soil depths of 1.5 inches or more. Summer annual grass weeds germinate predominantly from the top inch of soil. Generally, tillage brings these seeds to the surface, where they rapidly grow in response to light. The effects of different forms of tillage on the prevalence of weed species are discussed further, below.

Weed populations change in response to agricultural management decisions. Collectively, management decisions will impart selection pressures[1] on the present weed community, resulting in weed shifts on a local level (i.e., field level). These weed shifts occur regardless of what the selection pressure may be and may result in changes in weed density or weed diversity (Reddy and Norsworthy, 2010; Weller *et al.*, 2010). Weed shifts are generally most dramatic when a single or small group of weeds increases in abundance at the expense of other weed populations, potentially dictating the primary management efforts of the grower.

[1] Selection pressure may be defined as any event or activity that reduces the reproductive likelihood of an individual in proportion to the rest of the population of that one individual. In agriculture, selection pressure may be imparted by any facet of management in the production of a crop, including the type of crop cultivated, strategy of pest management, or when and how a crop is planted or harvested.

The vertical distribution of weed seeds in the soil is primarily influenced by the tillage system used.[2] These resulting changes in the distribution of the weed seeds in the weed seedbank will impact weed emergence and the resulting weed population in farm fields (Renner, 2000). As shown in Figure 5-1, the practice of no-till results in a majority of the weed seeds remaining at or near the soil surface where they have been deposited (Renner, 2000; Shrestha *et al.*, 2006; Menalled and Schonbeck, 2013). In no-till fields with more seeds at the surface, a greater diversity of annual and perennial weeds species may occur (Baucom and Holt, 2009). Winter annuals thrive in soil that is undisturbed from late summer or fall through early summer the following year which is best provided by no-till systems. Similarly, biennial weeds are prevalent in fields that have been in no-till for several years, as they need undisturbed soil for two consecutive growing seasons.

Under reduced tillage systems (such as chisel plowing), approximately 80 to 90 percent of the weed seeds are distributed in the top four inches, with the majority found at depths ranging from two to four inches. Summer annual grass weeds germinate predominantly from the top inch of soil with prevalence in shallow and reduced tilled fields (Curran *et al.*, 2009). With recent increased rates of conservation tillage, there has been an observed decrease in large-seeded broadleaf weeds and an increase in perennial, biennial, and shallow-emerging annual grasses, small-seeded broadleaves, and winter annual weed species in those fields (Green and Martin, 1996; Durgan and Gunsolus, 2003; Norsworthy, 2012). The growth and spread of some perennial species that reproduce by spread of underground structures (e.g., rhizomes) may be encouraged by no-till or conservation tillage system which allows these structures to remain undisturbed (Buhler *et al.*, 2008; Baucom and Holt, 2009; Curran *et al.*, 2009).

[2]Tillage represents a mechanical means of weed control and is generally characterized by the amount of remaining in-field residue and may be classified as conservation ($\geq$30 percent), reduced (15-30 percent), or intensive (0-15 percent) (CTIC, 2008)

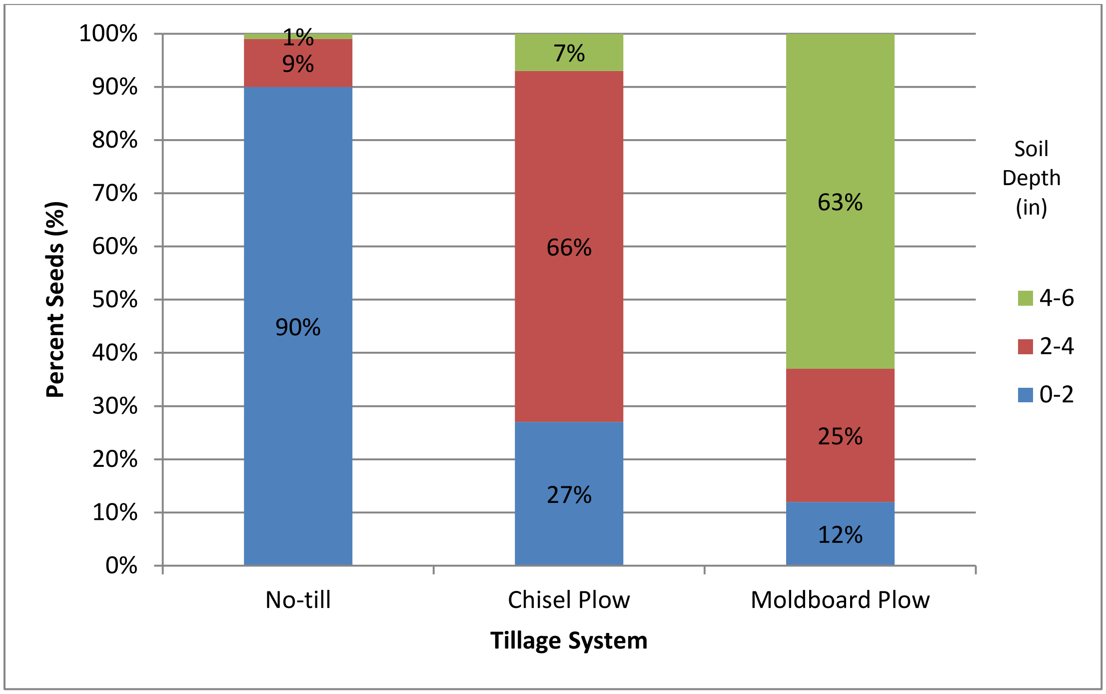


**Figure 5-1. Vertical Distribution of Weed Seeds in the Soil Profile at Depths of 0 to 2 inches, 2 to 4 inches, and 4 to 6 inches Affected by Different Tillage Regimes**
Source: (Shrestha *et al.*, 2006)

Weed seeds become buried approximately four to six inches below the surface as a result of increasing tillage (Menalled and Schonbeck, 2013). As fewer weeds can germinate when buried, weed diversity tends to decline and annual large-seeded broadleaves are more prominent (Norsworthy, 2012).

These shifts in weed species necessitate changes in weed management strategies. Tillage practices must be regularly changed, in a manner similar to that of other agricultural production practices, to prevent buildup of any particular species or group of weeds in the soil seedbank.

## Weed Emergence/Timing

In addition to weed density, the timing of weed emergence affects how they compete with the corn or soybean crop and influences the level of crop yield loss. The critical period of weed control (CPWC) is the time during which weeds must be controlled to prevent yields losses. The key components defining CPWC are 1) knowing when weeds need to be removed and 2) when the crop becomes dominant (Boerboom, 2000b). Weeds emerging before the CPWC may not impact crop yields if those weeds are controlled by the start of the CPWC. Weed competition occurring after the end of the CPWC will not affect yield (Boerboom, 2000b; Knezevic, 2007). In particular, early in the growing season, the critical period of weed competition is most affected by: 1) how competitive the different weed species are, 2) the density of weeds, and 3) the relative time of weed emergence (Boerboom, 2000b).

Corn is more vulnerable to early competition by weeds than soybean, especially when weed density is high, when corn is under stress from environmental conditions (e.g., drought, extreme wet conditions, cold soils), or when the crop is slow to establish (Monsanto, 2012). Weed control is most critical during the first three to five weeks after emergence of corn seedlings (Sikkema and Hamill, 2005; ANR, 2009). Weed costs in corn begin almost as soon as the corn emerges. Weeds that are about 3 to 4 inches tall when corn is at the V-3 to V-4 growth stage[3] are going to present the most competition. If the weeds are taller than corn, they will shade the crop. Control should be begin four to five days (one to two leaves) prior to the beginning of the CPWC (Knezevic, 2007). If weeds are controlled early, after several weeks when the corn canopy closes, corn can compete with later emerging weeds by shading them out. Narrow row spacing and adequate plant populations promote early corn canopy closure (Rosenberg, 2013).

Although weeds do not impact corn yield nearly as much later in the corn growing season, those weeds can harbor destructive insect pests, such as thrips, which can carry Fusarium ear rot, and armyworms, which can defoliate corn. Additionally, weeds in corn can also reduce silage and feed quality, slow harvesters by causing wheel slippage or clogging, raise grain moisture content, and reduce future corn harvests by adding to the seed bank (ANR, 2009).

In soybean, the later that weeds emerge, the less impact they will have on yield, although weeds emerging later can have a negative influence on seed quality and harvest efficiency (Prostko, 2013). Soybean plants withstand early season weed competition longer than corn because the soybean canopy closes earlier (Boerboom, 2000a). The extent of canopy closure restricts the light available for weeds and other plants growing below the soybean. In addition, canopy closure occurs more quickly when soybean is drilled or planted in narrow rows (Boerboom, 2000b; Bradley, 2006); however, in some studies it has also been observed that, depending on factors such as weed species, environmental conditions (i.e., rainfall amounts) and soybean cultivar, soybeans are able to compete with weeds with no resulting yield reduction (Krausz *et al.*, 2001). Place et al. have determined that larger soybean seeds produce a larger canopy more quickly and are, therefore, more successful at outcompeting weeds (Place *et al.*, 2011). Full-season soybean planting is preferable during the drier late spring conditions; however, summer annual weed emergence often occurs at this same time, resulting in a high level of weed interference with soybean emergence and establishment (DeVore *et al.*, 2013).

## Common Weeds in Corn and Soybean

To assist growers in managing weeds, individual states, typically through their state agricultural extension service, list the prevalent weeds in crops in their area and the most effective means for their control (see, e.g., IPM, 2004; IPM, 2007; University of California, 2009). Some of the key weed species found in corn and soybean fields are described in the following sections.

Weed species emerge in a particular order throughout the year with each species having one or more periods of high emergence. The initial emergence date can vary from year to year, but the order stays relatively constant. Figure 5-2 shows the relative emergence of common weed species found in summer annual crops such as corn and soybean. Weed emergence timing can dictate which weeds will be the most problematic for or be more easily controlled by a specific

[3] Corn at the V3 is approximately 2 weeks after emergence and is ~8 inches tall and at the V4 growth stage is near or at 12 inches tall.

crop production or weed management practice (Buhler *et al.*, 2008). Weed management is discussed in Appendix 3.

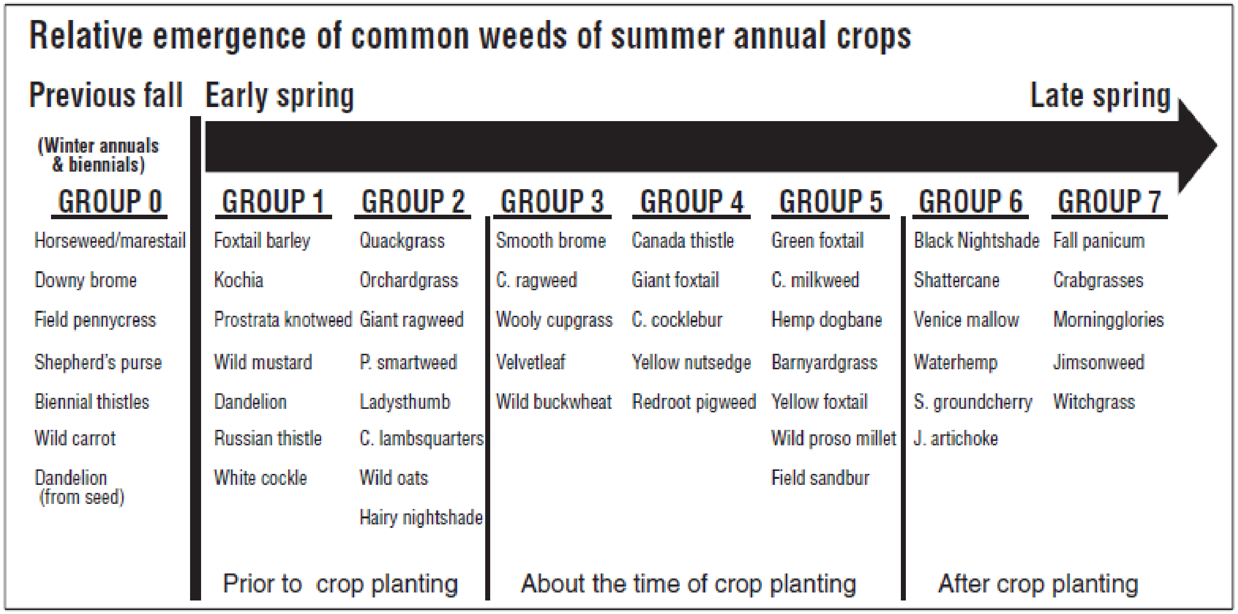


**Figure 5-2. Relative Emergence of Common Weeds of Summer Annual Crops**

Source: (Buhler *et al.*, 2008).

## <u>Problem Weeds in Corn and Soybean</u>

Based on a survey of growers in 2011, Table 5-1 lists the 10 broadleaf or grass weeds found in corn and soybean that growers indicated they most often had to manage in their fields (DAS, 2013). The first column lists those weeds on a national basis and the remaining columns list the weeds that are most problematic in each region. Regions that produce very little corn or soybean were not included. The Southeast region produces very little corn, but significant amounts of soybean; so information for the region was included for soybean but not for corn. Likewise the Prairie Gateway produces considerable corn but little soybean and was included in the section for corn but not soybean. Many of the problem weeds are present in multiple regions.

**Table 5-1. National and Regional List of Top Ten Troublesome Broadleaf and Grass Weeds in Corn and Soybean in 2011**

| US Corn | Heartland | Northern Crescent | Northern Great Plains | Prairie Gateway |
|---|---|---|---|---|
| **Broadleaf Weeds most treated for** | | | | |
| VELVETLEAF | VELVETLEAF | LAMBSQUARTERS | VELVETLEAF | PIGWEED, REDROOT |
| PIGWEED, REDROOT | WATERHEMP, COMMON | PIGWEED, REDROOT | PIGWEED, REDROOT | KOCHIA |
| LAMBSQUARTERS | LAMBSQUARTERS | VELVETLEAF | WATERHEMP, COMMON | THISTLE |
| WATERHEMP, COMMON | RAGWEED, GIANT | RAGWEED | SUNFLOWER | VELVETLEAF |
| COCKLEBUR | COCKLEBUR | RAGWEED, GIANT | COCKLEBUR | MORNINGGLORY |
| RAGWEED, GIANT | PIGWEED, REDROOT | DANDELION | KOCHIA | THISTLE, RUSSIAN |
| KOCHIA | RAGWEED | THISTLE, CANADA | LAMBSQUARTERS | BINDWEED, FIELD |
| MARESTAIL | MARESTAIL | MORNINGGLORY | MARESTAIL | COCKLEBUR |
| RAGWEED | MORNINGGLORY | COCKLEBUR | THISTLE, CANADA | THISTLE, MUSK |
| MORNINGGLORY | HORSEWEED | THISTLE | SUNFLOWER | SUNFLOWER |
| **Grass weeds most treated for** | | | | |
| FOXTAIL | FOXTAIL | FOXTAIL | FOXTAIL, YELLOW | JOHNSONGRASS |
| FOXTAIL, GIANT | FOXTAIL, GIANT | QUACKGRASS | FOXTAIL | SANDBUR |
| FOXTAIL, YELLOW | FOXTAIL, YELLOW | FOXTAIL, GIANT | FOXTAIL, GREEN | WHEAT, VOLUNTEER |
| FOXTAIL, GREEN | FOXTAIL, GREEN | FOXTAIL, YELLOW | FOXTAIL, GIANT | PANICUM, TEXAS |
| JOHNSONGRASS | JOHNSONGRASS | CRABGRASS | SANDBUR | BARNYARDGRASS |
| CRABGRASS | PANICUM, FALL | FOXTAIL, GREEN | WHEAT, VOLUNTEER | SICKLEGRASS |
| WHEAT, VOLUNTEER | CUPGRASS, WOOLLY | PANICUM, FALL | OAT, WILD | |
| QUACKGRASS | BARNYARDGRASS | GRASSES, ALL | BARNYARDGRASS | |
| PANICUM, FALL | QUACKGRASS | MILLET, WILD-PROSO | CHEAT | |
| BARNYARDGRASS | CRABGRASS | CUPGRASS, WOOLLY | CRABGRASS | |

| US Soybeans | Heartland | Northern Crescent | Northern Great Plains | SouthEast |
|---|---|---|---|---|
| Broadleaf Weeds most treated for | | | | |
| REDROOT PIGWEED | WATERHEMP, COMMON | LAMBSQUARTERS | VELVETLEAF | PIGWEED, REDROOT |
| COMMON WATERHEMP | VELVETLEAF | VELVETLEAF | WATERHEMP, COMMON | MORNINGGLORY |
| VELVETLEAF | RAGWEED, GIANT | PIGWEED, REDROOT | COCKLEBUR | MARESTAIL |
| COCKLEBUR | LAMBSQUARTERS | RAGWEED | MARESTAIL | COCKLEBUR |
| MARESTAIL | COCKLEBUR | RAGWEED, GIANT | PIGWEED, REDROOT | AMARANTH, PALMER'S |
| LAMBSQUARTERS | PIGWEED, REDROOT | DANDELION | MUSTARD, WILD | SICKLEPOD |
| GIANT RAGWEED | MARESTAIL | NIGHTSHADE, BLACK | BUCKWHEAT, WILD | SIDA, PRICKLY |
| MORNINGGLORY | RAGWEED | CHICKWEED, MOUSEEAR | LAMBSQUARTERS | LAMBSQUARTERS |
| RAGWEED | MORNINGGLORY | MORNINGGLORY | SUNFLOWER | SESBANIA, HEMP |
| SUNFLOWER | WATERHEMP, TALL | WATERHEMP, COMMON | KOCHIA | HENBIT |
| Grass weeds most treated for | | | | |
| FOXTAIL | FOXTAIL | FOXTAIL | FOXTAIL | JOHNSONGRASS |
| FOXTAIL, GIANT | FOXTAIL, GIANT | QUACKGRASS | FOXTAIL, YELLOW | BARNYARDGRASS |
| JOHNSONGRASS | FOXTAIL, YELLOW | FOXTAIL, GIANT | OAT, WILD | CRABGRASS |
| FOXTAIL, YELLOW | JOHNSONGRASS | FOXTAIL, YELLOW | FOXTAIL, GIANT | SIGNALGRASS, BROADLEAF |
| BARNYARDGRASS | CORN, VOLUNTEER | CORN, VOLUNTEER | FOXTAIL, GREEN | RYEGRASS |
| FOXTAIL, GREEN | FOXTAIL, GREEN | CRABGRASS | BROME, DOWNY | WATERGRASS |
| CRABGRASS | QUACKGRASS | FOXTAIL, GREEN | BROME, JAPANESE | BLUEGRASS, ANNUAL |

Source: (DAS, 2013)

Based on the information in Table 5-1, a list of the unique problem weeds in corn and soybean are presented in Table 5-2. In some cases the same weed species are listed under two different common names in Table 5-1. In Table 5-2, common waterhemp and tall waterhemp are listed as waterhemp. Marestail and horseweed are listed as horseweed. Moringglory and field bindweed are listed as field bindweed. Thistle is listed as Canada, Russian, or Musk thistle. Foxtail is listed as giant, yellow, or green foxtail.

In summary, there are 25 broadleaf and 22 grass weed species noted from the top ten lists, respectively, that required control measures in the major growing regions of soybean and corn. Some species such as redroot pigweed were problematic in all regions in both corn and soybean fields (marked in green in Table 5-2). Other species such as sicklepod, prickly sida, and wild buckwheat were more regional problems. Combining the lists of corn and soybean, there are a total of thirteen broadleaf and nine grass weeds, respectively, that are a problem in both corn and soybean, four broadleaf and seven grass weeds that are mostly problematic in corn (marked in yellow in Table 5-2), and eight broadleaf and six grass weeds that are mostly problematic in soybean (marked in blue in Table 5-2).

**Table 5-2. Summary of Problem Weeds Affecting Corn and Soybean**

| Broadleaf Weeds | | | Grass Weeds | | |
|---|---|---|---|---|---|
| **Corn + Soybean** | **Corn** | **Soybean** | **Corn + Soybean** | **Corn** | **Soybean** |
| redroot pigweed | henbit | wild mustard | giant foxtail | woolly cupgrass | downy brome |
| lambsquarters | Pennsylvania smartweed | black nightshade | yellow foxtail | wild-proso millet | Japanese brome |
| waterhemp | Russian thistle | mousear chickweed | green foxtail | sandbur | broadleaf signalgrass |
| cocklebur | musk thistle | hemp sesbania | johnsongrass | fall panicum | ryegrass |
| giant ragweed | | palmer's amaranth | crabgrass | cheat | watergrass |
| kochia | | sicklepod | wheat, volunteer | Texas panicum | annual bluegrass |
| horseweed | | prickly sida | quackgrass | sicklegrass | |
| common ragweed | | wild buckwheat | barnyardgrass | | |
| field bindweed | | | wild oat | | |
| sunflower | | | | | |
| Canada thistle | | | | | |
| velvetleaf | | | | | |
| dandelion | | | | | |

Based on the data in Table 3-1 (DAS, 2013) .
Notes:
Green: Weeds managed in both corn and soybean
Yellow: Weeds primarily managed in corn
Blue: Weeds primarily managed in soybean

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# Appendix 6. Herbicide Resistance

## Herbicide Resistance

Not unlike other agronomic practices, herbicide use may impart selection pressures on weed communities, resulting in shifts in the weed community that favor those weeds that do not respond to the herbicide used (Owen, 2008). Herbicide resistance is described by the Weed Science Society of America as the "inherited ability of a plant to survive and reproduce following exposure to a dose of herbicide normally lethal to the wild type" (WSSA, 2011b). The shift to herbicide resistance in plants is largely a function of the natural selection of herbicide-resistant traits and is strongly related to the repeated use of one or a limited number of herbicides (Durgan and Gunsolus, 2003; Duke, 2005).

Individual plants within a species can exhibit different responses to the same herbicide rate. Initially, herbicide rates are set to work effectively on the majority of the weed population under normal growing conditions. Genetic variability, including herbicide resistance, is exhibited naturally in normal weed populations, although at very low frequencies. When only one herbicide is used year after year as the primary means of weed control, the number of weeds resistant to that herbicide compared to those susceptible to the herbicide may change as the surviving resistant weeds reproduce. With no change in weed control strategies, in time, the weed population may be composed of more and more resistant weeds.

Both the increased selection pressure from the extensive use of glyphosate associated with glyphosate-tolerant crops along with the subsequent reduction in the use of other herbicides and changes in weed management practices (i.e., conservation tillage or no-till) have resulted in weed population shifts and increasing glyphosate resistance among some weed populations (Owen, 2008; Duke and Powles, 2009). Glyphosate-resistant crops themselves do not influence weeds any more than non-transgenic crops. It is the weed control tactics chosen by growers that create selection pressure that ultimately over time changes these weed communities and may result in the selection of herbicide-resistant weeds (Owen, 2008).

## History of Weed Resistance to Herbicides and its Development

One of the earliest selective chemical herbicides to be used in agriculture was 2,4-D, a synthetic auxin, whose commercial use began in 1945 (Burnisde, 1996). Use of 2,4-D in corn was successful in controlling broadleaf weeds such that in the mid-1950s 2,4-D was applied to nearly one-half of all U.S. corn acres (Knake, 1996). Within 12 years, the first herbicide resistance to 2,4-D was reported in spreading dayflower in a Hawaiian sugarcane field (*Commelina diffusa*) in 1957 (see report in (Sellers et al., 2011; Isaac et al., 2013)) and then in field bindweed (*Convolvulus arvensis*) in Kansas cropland in 1964 (Heap, 2013a).

Simazine was the first triazine to be used commercially in 1956. In 1958, the herbicide atrazine was first registered for weed control in corn in the U.S. Similar to what had occurred with 2,4-D, triazines were used extensively in the 1960s and common groundsel resistant to triazine herbicides was discovered in Washington in 1970 (Buhler, unknown). Regardless of the occurrence of resistant weeds, atrazine was, and still is, an extremely effective herbicide due to its broad spectrum, low cost, and flexible timing of applications (International, 2012).

ALS inhibitors or Group 2 herbicides were introduced in the mid-1980s and became extensively used in both corn and soybeans. With its broad-spectrum weed control, residual activity, and flexibility in application timing, the Group 2 herbicides became popular in the late 1980s and early 1990s. For example, by the early-1990s, Pursuit™, containing the ALS herbicide imazethapyr, was used on more than 75 percent of the soybeans in Iowa (Tranel and Wright, 2002). The widespread use of Group 2 herbicides resulted in the rapid selection of ALS-resistant waterhemp. By the mid-1990s, Group 2 resistant waterhemp was so widespread that the industry essentially stopped recommending Group 2 herbicides for this weed (Hartzler, 2013).

Sales of glyphosate began in 1974 and it became one of the most commercially successful and dominant herbicides in the U.S. (Duke and Powles, 2008). There are several reasons for the success of glyphosate in the market and the corresponding market sector penetration of glyphosate-tolerant crops since their introduction in the mid-late 1990s. Glyphosate: 1) works non-selectively on a wide range of plant species; 2) is a relatively low-cost herbicide; 3) enhances no-till farming practices; and 4) has minimal animal toxicological and environmental impact (Duke and Powles, 2008; Owen, 2008; Duke and Powles, 2009).

The widespread adoption of glyphosate-tolerant soybean, in combination with an increased reliance on glyphosate, has been related to the adoption of no-till cultivation which depends on controlling weeds without tillage. Glyphosate tolerant soybean also led to a simplification in weed control compared to past practices, reduced input and labor costs associated with the cultivar and glyphosate use, and increased flexibility in herbicide application timing (Lorenz et al., 2006).

Most instructive are the events leading to the development of glyphosate resistance in weeds in the U.S. The previous history of glyphosate use for 20 years did not result I the selection of herbicide resistant weeds. As a result, industry promoted the view that widespread glyphosate use was unlikely to result in the selection of glyphosate resistant weeds (Bradshaw et al., 1997), despite the fact that resistance to other herbicides, such as 2,4-D were being reported (see history in (Mithila et al., 2011). The first case reported, glyphosate resistant rigid ryegrass, was documented and confirmed in Australia in 1996 (Powles et al., 1998), over twenty years after glyphosate first began to be used in agriculture.

Herbicide-resistant crops were introduced in 1996 with glyphosate-resistant soybean rapidly adopted by growers. As glyphosate went off patent in 2000, increased usage of glyphosate-resistant crops was facilitated by the low price of the herbicide. Tank mixes for separate activity against grasses and broad-leaf weeds were not needed when glyphosate could be used for weed control. In the mid-1990s, 51 percent of growers were using three, four or more herbicides for soybean weed control (cited in Gianessi et al. (2008)) or about three overall in 1995 (USDA-ERS, 1997). With the availability of glyphosate and glyphosate-resistant crops, herbicide applications could be reduced in many situations.

The efficacy of post-applications of glyphosate became clear, with weed control often not requiring a pre-application for good control (Reddy, 2001). If a grower needed additional weed control for effectiveness or flexibility, a pre-application of glyphosate and a post-glyphosate application were as effective and cost less than a pre-application with a non-glyphosate residual herbicide followed by post-application of glyphosate (Reddy, 2001). Increasing glyphosate applications resulted in a decline of the sales and use of most other herbicides. The earliest U.S. glyphosate resistance in a GE crop was found in horseweed, *Conyza canadensis*, in Delaware soybean in 2000 (Heap, 2013a). Increasing exposure of weeds to glyphosate in other herbicide resistant crops such as corn and cotton soon began to expand the numbers and populations of resistant weeds in the U.S.

The intense use of glyphosate compared to sparing use of other herbicides on field crops is apparent in overall herbicide use trends over the last decade, and surveys of grower usage, such as that of Prince et al. (2012), provide specific details (see also Figures 4-1, 4-3. 4-4, and 4-5). These surveys give evidence of the prevalent practices employed by growers in which glyphosate was nearly the only herbicide used with the subsequent overexposure of crops and weeds to glyphosate. In 2005, surveyed growers in multiple states rotating soybean and corn indicated they chose glyphosate 22 percent of the time for spring burndown, versus 9 percent for other herbicides (Table 6-1). For continuous soybean, growers chose glyphosate 46 percent of the time and 22 percent another herbicide (Table 6-1) (Prince et al., 2012). Overall, 74 percent of the continuous soybean growers used glyphosate two or more times during a growing season (Table 6-2), and growers rotating between corn and soybean, used glyphosate two or more times 50 percent of the time on soybean. When growers used non-glyphosate herbicides, continuous soybean growers used these herbicides in post-emergence applications 67 percent of the time, and corn/soybean growers applied the herbicides on soybean post-emergence 35 percent of the time (Table 6-2). Growers were choosing glyphosate frequently for pre-plant burndown, but also post-planting with high frequency, so that repeated exposure of weeds to glyphosate during crop production was common within the same season, and because the most common rotation crop for corn is soybean, exposure of weeds to selecting doses of glyphosate occurs in consecutive seasons. Prince et al. (2012) document that in 2005, glyphosate tolerant corn/glyphosate tolerant soybean rotations, only 9 percent of soybean acreage received non-glyphosate herbicides, although 45 percent of corn acreage received non-glyphosate treatment.

**Table 6-1. Frequency of Spring Pre-plant Application of Glyphosate among Surveyed Growers (2005)**

| | Herbicide Application | |
|---|---|---|
| **Crop** | **Glyphosate** | **Non-glyphosate** |
| Continuous soybean | 46% | 22% |
| Soybean in soybean/corn rotation | 22% | 9% |

Source: (Prince *et al.*, 2012)

**Table 6-2. Frequency of Glyphosate Application to Crop by Surveyed Growers (2005).**

| | Herbicide Application | | | | | |
|---|---|---|---|---|---|---|
| **Crop** | **Glyphosate** | | | **Non-glyphosate** | | |
| **Frequency** | 1X | 2X | 3X | 1X | 2X | 3X |
| Continuous soybean | 23 | 62 | 12 | 27 | 7 | 67 |
| Soybean in soybean/corn rotation | 48 | 47 | 3 | 53 | 12 | 35 |

Source: (Prince *et al.*, 2012)

It is clear that when herbicides are applied, selection for those weeds with adaptive mechanisms to escape elimination will survive. If the herbicide is repetitively used in crop production, the surviving weeds will be further selected, and dominant genes as well as multi-component resistance mechanisms will be selected. While many practices can be used to manage weeds, the recent history of glyphosate use shows that when the collective knowledge of resistance development is either neglected or practices not sufficiently integrated with mechanical and cultural controls, or with more robust herbicidal strategies, resistant weeds will arise. As noted earlier, it is not so much herbicide resistant crops that are a cause of herbicide resistant weeds, but from the failure to apply best management practices in the production of herbicide resistant crops.

## Mechanisms of Herbicide Resistance in Weeds and Relationship to Selective Pressure

Two types of weed resistance may arise following inadvertent weed selection and both confer complex management concerns for growers. The first is target site specific resistance (TSR), and the second, non-target site specific (NTSR). The first results in an alteration of the target site of the herbicide so the target is no longer inhibited. The second type of resistance is more general and may confer resistance to a wide range of chemistries. For example, NTSR resistance may provide protection by reduced penetration of the herbicide, altered translocation, overproduction of targets, target mutation, or neutralization of cytoplasmic toxins (Délye et al., 2013). TSR confers resistance usually to a single herbicide, and NTSR may confer resistance to as many as nine different modes of action (e.g., *Lolium rigidum*) and 16 herbicides (Burnet et al., 1994). In the case of NTSR, the use of herbicides on weeds with unknown NTSRs may provide a substantial risk for development of weed resistance (Délye et al., 2013).

The target site alterations leading to TSR are often produced by dominant or semidominant nuclear mutations and can be found in herbicide Groups 1, 2, 3, 23, 14, and 9, while triazine herbicides (Group 5) result from dominant cytoplasmic mutations (Délye et al., 2013). This resistance arises following a single mutation, which because of its beneficial nature promotes immediate survival and is positively and rapidly selected within the agricultural environment. Glyphosate resistance that is TSR is a consequence of one amino acid change at position 106 of the chloroplast EPSPS protein. Worldwide, 14 of these populations have been identified (Beckie, 2011).

### Natural Tolerance

Natural tolerance to certain herbicides may be apparent when weeds are first exposed to a herbicide, or with selection, existing genes may be selected and then accumulated to produce varying levels of tolerance (likely by NTSR). Field morning glory (*Convolvulus arvensis* L.) has such tolerance to glyphosate and has been assessed in detail (Westwood and Weller 1997). Glyphosate tolerance in *Convolvulus* was also found in historical populations which predated glyphosate resistant crop introductions (Baucon and Mauricio, 2010). The pre exposure NTSR to glyphosate was at about the same level as that which is currently observed. Morning glory can also be shown to have pre-existing  resistance (that is, by TSR) but which is not as high as that expressed by plants now collected (Baucon and Mauricio, 2010). Both types of resistance can exist in the species, but independently, with resource allocation costs apparent for the plant’s tolerance mechanisms for the herbicide (Baucon and Mauricio, 2008) . At least some populations of 16 species have been alleged as not controllable by recommended field rates of glyphosate, presumably by natural tolerance mechanisms (Duke and Powles, 2008).

## Weeds Resistant to Multiple Herbicides

Direct resistance of a weed species to an herbicide is an unwelcome consequence of weed selection, but cross resistance to other herbicides in the same class or to other classes of herbicides provides an even greater consequence to those who manage weeds, since a grower's choice of herbicide site of action (SOA) will be restricted in the present season's crop and potentially also in the rotation crop. When resistance is based on non-target site mechanisms, which may include increased metabolism and reduced translocation to target sites, the weed may be capable of resistance to multiple herbicide modes of action (Beckie and Tardif, 2012). NTSR appears to arise from a weed's accretion of variants of several genes which may originally have been subsets of stress-tolerance genes (see review in Délye (2013). Délye (2013) attributes much of the recently discovered weed resistance to this mechanism, and it is particularly important in Groups 9 (glyphosate) and 1 (acetyl-CoA carboxylase inhibitors), as well as grasses and probably broadleaf weeds (Group 2: acetohydroxyacid synthase inhibitors). In the case of glyphosate, Beckie (2011) lists 15 instances worldwide of glyphosate NTSR.

## Weed Selection for Resistance to Herbicides by Overuse

The intense use of glyphosate on field crops compared to decreased use of other herbicides is a trend within the last decade, but how growers use glyphosate in field situations makes the situation clearer in grower surveys such as that of Prince (2012). These surveys give evidence of the prevalent practices employed by growers in which glyphosate is sometimes the only herbicide used, allowing the overexposure of crops and weeds to glyphosate. Growers were choosing glyphosate frequently for pre-plant burndown, but also post-planting with high frequency, so that repeated exposure of weeds to glyphosate during crop production was common within the same season. Because the most common rotation crop for corn is soybean, exposure of weeds to selecting doses of glyphosate occurs in consecutive seasons as well.

Because conservation tillage systems are inherently more dependent upon weed management using herbicides, selective pressure on weeds is greater than that on fields using conventional tillage with its greater options for pre-plant primary tillage and post plant secondary tillage (Vencill *et al.*, 2012). In a survey conducted in 2007, growers that planted 87 percent of their crops to glyphosate resistant corn, soy or cotton varied the SOA used on their crops 'always' or 'mostly' just 39 percent of the time, with the remaining 61 percent affirming they did so 'seldom' or 'never' (Frisvold *et al.*, 2009). Thus, when conservation tillage and HR crops define the production system, growers are likely to use the same herbicide (i.e., glyphosate) frequently. Some other options also may be foreclosed by conservation tillage (especially no-till), such as soil incorporation of residual herbicides, although some residuals can also be soil applied (Penn State Extention, 2013).

Considering the recommendations for success in reducing resistant weed development (Vencill *et al.*, 2012), unsuccessful herbicide strategies that have encouraged resistant weeds can include:

1. Herbicide use of mostly one or a few modes of action (Norsworthy, 2012) and infrequent use of herbicide tank mixes, sequences and diversity across seasons (WSSA, 2011a),
2. Incorrect timing of herbicide application (Norsworthy, 2012),
3. Failure to consider the likelihood that a weed already has non-target site resistance mechanisms (Délye *et al.*, 2013) against specific herbicides (including metabolic potential, ability to prevent translocation, or ability to sequester the herbicide).
4. Applying low doses of herbicide thereby allowing weeds to be exposed to low rates herbicide which encourages sequential escapes and accumulating resistance genes (WSSA, 2011b);
5. Not establishing fields devoid of active weeds at planting or good weed control at canopy closure (for soybean) because not all available tools and herbicides were used (Monsanto, 2013); resulting in poorer crop establishment and more weed initiation.

**Weed Resistance from Undervaluing a Balance of Residual and Contact Herbicides**

The decrease in use of soil applied residual herbicides and a focus instead on mainly foliar-applied contact herbicides may be another basic and strategic misapplication of technology by field crop producers and these resulted in resistant weed development. In the era before introduction of HR soybean and corn, and afterwards, production changes by growers were noted in the use of herbicides in the transition to greater HR crop acreage. For soybeans, in 1996, 70 percent of growers used pre-emergent herbicides, but by 2002 they did so less than 20 percent of the time (Livingston and Osteen, 2012). A decline in corn pre-emergent herbicide use also occurred, from nearly 80 percent to around 60 percent. Post-emergent herbicides were applied to about 80 percent of soybean in 1996, then steadily increased to nearly 100 percent in 2010; in corn, post emergent herbicide use increased from 60 percent to 75 percent. These reflect increased use of glyphosate with its utility as an over the top and POST herbicide on soybean, but also a decline in reliance on pre-emergent non glyphosate herbicides. Likewise, Prince (2012) concluded that soybean growers were less likely than corn or cotton growers to use a residual herbicide (often pre-emergent) in their multistate survey of herbicide use in 2005 and 2010. Growers thus lost value from an herbicide by not deploying a residual (soil applied residual in no-till production) herbicide that has a different SOA than glyphosate, and relying on post-emergence control using glyphosate or another foliar active herbicide. Perhaps as a consequence of awareness of weed herbicide resistance or in an effort to combat glyphosate resistant crops, use of residual herbicides has increased modestly between 2005 and 2009 from 15 percent to 27 percent of soybean acreage (Owen *et al.*, 2011).

Related to the issue of reductions in residual pesticide use is that of reductions in numbers of herbicides used in soybean and corn. An USDA Agricultural Resources and Environmental Indicators (AREI) survey showed that soybean growers reached a high point of rotating pesticides to slow resistance evolution in1998, but this declined steadily to low single digits in 2010 (USDA-ERS, 2010). Corn growers chose to rotate pesticides to avoid resistance development from a high of 45 percent in 1998 to about 30 percent in 2010. Total applications of all herbicides have also declined from nearly 3 per year in soybean in 1996 to about 2 in 2006 (USDA-ERS, 2010). Although this survey does not tabulate different sites of action applied in these years, it is clear that fewer SOAs were likely employed since overall application rates indicate limited actual use of non-glyphosate herbicides on soybean.

**Weeds Resistant to the Herbicides Commonly Used on Corn and Soybean**

As of March 21, 2013, internationally, there were 397 cases of herbicide resistant weeds in 217 species (Heap, 2013a). The first herbicide-resistant biotypes were described in the 1950s, but the number of weeds resistant to herbicides increased dramatically in the 1980s and 1990s, and resistance to 21 of the 25 known herbicide sites of action has been identified throughout the world (Heap, 2013a). Of the 25 known herbicide sites of action, 11 of these sites of action are commonly used on corn and soy (See Appendix 4, Table 6-3). These sites of action and the particular herbicides commonly used to manage weeds in corn and soybean are listed on the top and bottom, respectively of Table 6-3. While there are hundreds of cases of herbicide resistant weeds, most of these weeds are not actively managed in corn and soybean. The analysis below focuses on weeds that are actively managed in corn and soybean fields and addresses which of these have developed herbicide resistance to the major herbicides used in corn and soybean.

Table 6-3, below, lists the problem weeds of corn and soybean, derived from survey data noted in Tables 5-1 and 5-2 in Appendix 5, and indicates whether validated herbicide resistance has been reported for these species as noted in the International Survey of Herbicide Resistant Weeds (Heap, 2013a). Each column represents a different site of action and the WSSA number associated with that site of action is also listed on the top of each column. The major herbicides used on corn and soybean are listed below the table and color coded green if used on both corn and soybean, blue if used only on soybean, and yellow if only used on corn. If a particular weed has been reported to be resistant to any of the herbicides listed below the chart, the herbicide is so indicated for that combination and colored as just described. In cases where herbicide resistance has been noted only outside the U.S., the herbicide is marked with an asterisk. Quizalofop-p-ethyl is not among the top ten herbicides used in corn or soybean, but nevertheless is indicated where corn/soybean weeds are resistant. Cells are marked NR, for “not reported,” in cases where resistant weeds against the listed herbicides are not reported on International Survey of Herbicide Resistant Weeds site (Heap, 2013a).The last column lists those cases where weeds have been selected for resistance against more than one herbicide site of action corresponding to the listed herbicides. In those cases, the WSSA Herbicide Group # for the site of action is listed. For example, two types of multiply resistant kochia biotypes have been noted. One is multiply resistant to both ALS (#2) and PSII inhibitors (#5), the other is multiply resistant to ALS inhibitors (#2) and glyphosate (#9).

## Table 6-3. Herbicide Resistant Biotypes of Problem Weeds in Corn and Soybean

| WSSA herbicide # | 2 | 5 | 1 | 4 | 22 | 9 | 3 | 14 | 15 | 27 | 10 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| major weeds in corn and soybean | ALS | PSII | ACCase | Auxin | Bipyridiliums | EPSPS | Dintro-anilines | PPO | Chloroacetamides | 4-HPPD | GS | multiple |
| **BROADLEAF** | | | | | | | | | | | | |
| PIGWEED,REDROOT | imazethapyr<br>Chlorimuron-ethyl<br>chloransulam-methyl<br>thifensulfuron-methyl<br>tribenuron methyl [1]<br>nicosulfuron[1] | metribuzin[1]<br>atrazine<br>simzine[1] | N/A | NR | NR | NR | NR | NR | NR | NR | NR | 2+5<br>2+7 |
| LAMBSQUARTERS | thifensulfuron-methyl<br>tribenuron methyl [1] | metribuzin<br>atrazine<br>simzine | N/A | dicamba[1] | NR | NR | NR | NR | NR | NR | NR | NR |
| WATERHEMP | Chlorimuron-ethyl<br>imazethypyr<br>chloransulam-methyl<br>thifensulfuron-methyl<br>flumetsulam<br>nicosulfuron<br>rimsulfuron | atrazine | N/A | 2,4-D | NR | Glyphosate | NR | fomesafen<br>lactofen | NR | mesotrione<br>isoxaflutole | NR | 2+5<br>2+[1]4<br>2+9<br>2+27<br>2+5+9<br>2+5+[1]4<br>2+9+[1]4<br>2+5+27<br>2+9+27<br>2+5+[1]4+27<br>2+5+9+[1]4<br>2+5+9+27<br>2+5+9+[1]4+27 |

| WSSA herbicide # | 2 | 5 | 1 | 4 | 22 | 9 | 3 | 14 | 15 | 27 | 10 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| major weeds in corn and soybean | ALS | PSII | ACCase | Auxin | Bipyridiliums | EPSPS | Dintro-anilines | PPO | Chloroacetamides | 4-HPPD | GS | multiple |
| COCKLEBUR | imazethypyr<br>Chlorimuron-ethyl<br>chloransulam-methyl | NR | N/A | NR | NR | NR | NR | NR | NR | NR | NR | NR |
| RAGWEED, GIANT | chloransulam-methyl<br>imazethypyr<br>Chlorimuron-ethyl | NR | N/A | NR | NR | Glyphosate | NR | NR | NR | NR | NR | 2+9 |
| KOCHIA | imazethypyr<br>thifensulfuron-methyl<br>tribenuron methyl<br>rimsulfuron<br>nicosulfuron | atrazine | N/A | dicamba | NR | Glyphosate | NR | NR | NR | NR | NR | 2+5<br>2+9 |
| Horseweed | Chlorimuron-ethyl<br>chloransulam-methyl<br>thifensulfuron-methyl<br>tribenuron methyl | atrazine<br>simzine | N/A | NR | paraquat | Glyphosate | NR | NR | NR | NR | NR | 2+9<br>9+22<br>5+7[1]<br>2+5[1] |
| RAGWEED | Chlorimuron-ethyl<br>chloransulam-methyl<br>imazethypyr | atrazine<br>simzine | N/A | NR | NR | Glyphosate | NR | flumioxazin<br>fomesafen<br>lactofen | NR | NR | NR | 2+[1]4<br>2+9 |
| Field Bindweed | NR | NR | N/A | 2,4-D | NR | NR | NR | NR | NR | NR | NR | NR |
| SUNFLOWER | Chlorimuron-ethyl<br>imazethypyr<br>chloransulam-methyl<br>flumetsulam | NR | N/A | NR | NR | NR | NR | NR | NR | NR | NR | NR |

| WSSA herbicide # | 2 | 5 | 1 | 4 | 22 | 9 | 3 | 14 | 15 | 27 | 10 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **major weeds in corn and soybean** | **ALS** | **PSII** | **ACCase** | **Auxin** | **Bipyridiliums** | **EPSPS** | **Dintro-anilines** | **PPO** | **Chloroacetamides** | **4-HPPD** | **GS** | **multiple** |
| THISTLE, CANADA | NR | NR | N/A | 2,4-D[1] | NR | NR | NR | NR | NR | NR | NR | NR |
| velvetleaf | NR | atrazine | N/A | NR | NR | NR | NR | NR | NR | NR | NR | NR |
| dandelion | NR | NR | N/A | NR | NR | NR | NR | NR | NR | NR | NR | NR |
| HENBIT | NR | NR | N/A | N/A | NR | NR | NR | NR | NR | NR | NR | NR |
| Pennsylvania SMARTWEED | NR | atrazine | N/A | NR | NR | NR | NR | NR | NR | NR | NR | NR |
| Russian thistle | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR |
| Musk thistle | | | | 2,4-D | | | | | | | | |
| wild mustard | chloransulam-methyl<br>imazethypyr<br>thifensulfuron-methyl<br>tribenuron methyl[1] | atrazine[1]<br>metribuzin[1] | N/A | dicamba[1]<br>2,4-D[1] | NR | NR | NR | NR | NR | NR | NR | NR |
| black nightshade | NR | atrazine<br>simazine | NR | | paraquat | NR | NR | NR | NR | NR | NR | NR |
| mousear chickweed | NR | NR | N/A | NR | NR | NR | NR | NR | NR | NR | NR | NR |
| hemp sesbania | NR | NR | N/A | NR | NR | NR | NR | NR | NR | NR | NR | NR |
| palmer's amaranth | imazethypyr<br>Chlorimuron-ethyl<br>thifensulfuron-methyl | atrazine | | | | Glyphosate | | | | mesotrione | | 2+9<br>2+5+27 |
| sicklepod | NR | NR | N/A | NR | NR | NR | NR | NR | NR | NR | NR | NR |
| prickly sida | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR |
| wild buckwheat | thifensulfuron-methyl<br>tribenuron methyl[1] | NR | N/A | NR | NR | NR | NR | NR | NR | NR | NR | NR |
| **Grasses** | | | | | | | | | | | | |
| foxtail, giant | imazethypyr<br>nicosulfuron<br>rimsulfuron | atrazine | clethodim<br>quizalofop-p-ethyl[2] | N/A | NR | NR | NR | NR | NR | NR | NR | NR |

| WSSA herbicide # | 2 | 5 | 1 | 4 | 22 | 9 | 3 | 14 | 15 | 27 | 10 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| major weeds in corn and soybean | ALS | PSII | ACCase | Auxin | Bipyridiliums | EPSPS | Dintro-anilines | PPO | Chloroacetamides | 4-HPPD | GS | multiple |
| foxtail, yellow | imazethypyr | atrazine simzine | NR | N/A | NR | NR | NR | NR | NR | NR | NR | NR |
| foxtail, green | imazethypyr[1] | atrazine[1] | NR | N/A | NR | NR | NR | NR | NR | NR | NR | NR |
| johnsongrass | nicosulfuron | NR | quizalofop-p-ethyl[2] | N/A | NR | Glyphosate | NR | NR | NR | NR | NR | NR |
| | rimsulfuron[1] imazethypyr | | clethodim | | | | | | | | | |
| crabgrass | imazethypyr[1] nicosulfuron[1] | atrazine[1] | clethodim[1] quizalofop-p-ethyl[1]([2]) | N/A | NR | NR | NR | NR | NR | NR | NR | NR |
| wheat, volunteer[3] | NR | NR | N/A | N/A | NR | NR | NR | NR | NR | NR | NR | NR |
| quackgrass | NR | NR | N/A | N/A | NR | NR | NR | NR | NR | NR | NR | NR |
| barnyardgrass | imazethypyr[1] nicosulfuron[1] | atrazine simzine | quizalofop-pethyl[1]([2]) | | | | | | | | | |
| oat, wild | rimsulfuron[1] | NR | clethodim[1] quizalofop-p-ethyl[2] | N/A | NR | NR | NR | NR | NR | NR | NR | NR |
| cupgrass, woolly | NR | NR | N/A | N/A | NR | NR | NR | NR | NR | NR | NR | NR |
| millet, wild-proso | NR | NR | N/A | N/A | NR | NR | NR | NR | NR | NR | NR | NR |
| sandbur | NR | NR | N/A | N/A | NR | NR | NR | NR | NR | NR | NR | NR |
| panicum, fall | NR | atrazine[1] | NR | N/A | NR | NR | NR | NR | NR | NR | NR | NR |
| cheat[4] | NR | NR | N/A | N/A | NR | NR | NR | NR | NR | NR | NR | NR |
| panicum, texas | NR | NR | N/A | N/A | NR | NR | NR | NR | NR | NR | NR | NR |
| sicklegrass | NR | NR | N/A | N/A | NR | NR | NR | NR | NR | NR | NR | NR |
| brome, downy | NR | atrazine[1] simzine[1] | clethodim quizalofop-p-ethyl[2] | N/A | NR | NR | NR | NR | NR | NR | NR | NR |
| brome, japanese[4] | NR | NR | N/A | N/A | NR | NR | NR | NR | NR | NR | NR | NR |
| signalgrass, broadleaf | NR | NR | N/A | N/A | NR | NR | NR | NR | NR | NR | NR | NR |
| Italian ryegrass | NR | NR | clethodim[1] quizalofop-p-ethyl[2] | N/A | NR | Glyphosate | NR | NR | NR | NR | glufosinate | 9+10 |

| WSSA herbicide # | 2 | 5 | 1 | 4 | 22 | 9 | 3 | 14 | 15 | 27 | 10 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| major weeds in corn and soybean | ALS | PSII | ACCase | Auxin | Bipyridiliums | EPSPS | Dintro-anilines | PPO | Chloroacetamides | 4-HPPD | GS | multiple |
| watergrass[4] | NR | NR | N/A | N/A | NR | NR | NR | NR | NR | NR | NR | NR |
| bluegrass, annual | NR | simzine atrazine | NR | N/A | NR | Glyphosate | NR | NR | NR | NR | NR | NR |

Key: Commonly used herbicides on corn and soybean

| 2 | 5 | 1 | 4 | 22 | 9 | 3 | 14 | 15 | 27 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| ALS | PSII | ACCase | Auxin | Bipyridiliums | EPSPS | Dintroanilines | PPO | Chloroacetamides | 4-HPPD | GS |
| Chlorimuron | metribuzin | clethodim | 2,4-D | paraquat | Glyphosate | pendimethalin | flumioxazin | metolachlor-S | mesotrione | glufosinate |
| imazethypyr | atrazine | quizalofop-p-ethyl[2] | dicamba | | | | fomesafen | acetochlor | isoxaflutole | |
| chloransulam-methyl | simzine | | clopyralid | | | | sulfentrazone | | | |
| thifensulfuron-methyl | | | | | | | saflufenacil | | | |
| tribenuron methyl | | | | | | | flutiacet-methyl | | | |
| flumetsulam | | | | | | | lactofen | | | |
| thiencarbazone-methyl | | | | | | | | | | |
| rimsulfuron | | | | | | | | | | |
| nicosulfuron | | | | | | | | | | |

[1]outside US only

[2]not a top 10 herbicide in either soy or corn

[3]ALS resistant varieties through conventional breeding; glyphosate resistant variety identified as volunteers in a single Oregon field though never deregulated.

[4]Not resistant to herbicides commonly used on corn and soybean.

Source: (DAS, 2013; Heap, 2013b); (Avila-Garcia and Mallory-Smith, 2011)

The most widespread resistance is observed for the ALS inhibitors. Five different ALS inhibitors are commonly used on soybean and four are used on corn but none of these herbicides are commonly used on both crops. For this site of action, 12 of the 25 problem broadleaf weeds and 7 of the 22 grasses include ALS resistant biotypes. We are not aware if these biotypes exhibit cross reactivity to other ALS herbicides listed or otherwise. From limited survey data, it has been inferred that ALS resistant weeds are present in all soybean fields in the Heartland (Tranel et al., 2011).

Also widespread are biotypes resistant to PSII inhibitors which include 11 of the problem broadleaf weed species and eight of the grasses. Most of these cases involve biotypes that have been selected against atrazine in corn or metribuzin in soybean.

ACCase inhibitors are grass specific herbicides and so have not been used on corn. They have been used on soybean and other crops. Clethodim is one of the more commonly used herbicides on soybean. Quizalofop-p-ethyl, is not commonly used on soybean but is considered here because Enlist™ corn would also be resistant to that herbicide. Seven of the problem grasses have developed resistance to quizalofop-p-ethyl and a subset of six biotypes are also reported to be resistant to clethodim, though for two of these cases, crabgrass, and barnyard grass, resistant biotypes have only been reported outside the U.S.

Glyphosate, 2,4-D, and dicamba are the three herbicides that are commonly used on both soybean and corn. Of the three, only glyphosate is effective on most grass weeds. Relatively few grass weeds have resistant biotypes so glyphosate remains a very effective herbicide to control grasses. Of the problem weeds in corn and soybean, three: johnsongrass, Italian ryegrass, and annual bluegrass have been selected for glyphosate resistance. Glyphosate resistant broadleaf weeds have been more problematic. In this case, resistant biotypes have been selected in five broadleaf species and these resistant biotypes are more widely disseminated especially in the Southeast. The prevalence of such weeds is increasing and becoming more problematic in the Northern Crescent, Heartland, and Great Plains. Corn/soybean weeds that now have glyphosate resistance include waterhemp, giant ragweed, kochia, horseweed, and common ragweed.

Resistance to glufosinate offers an alternative mode of action to glyphosate for the broad-spectrum control of weeds in soybean. To date, only Italian Ryegrass has been reported as resistant to glufosinate in the U.S. and this biotype is located in Oregon. However, this population of Italian Ryegrass also appears tolerant to glyphosate. Three problem corn/soybean weeds, lambsquarters, kochia, and wild mustard have dicamba resistant biotypes (though wild mustard is not reported to be resistant in the U.S.). Four problem corn/soybean weeds, waterhemp, field bindweed, canada thistle, and wild mustard, are reported to be resistant to 2,4-D (though the Canada thistle and wild mustard biotypes are not reported to be resistant in the U.S.). Resistance to clopyralid, the other auxin commonly used in corn, has not been reported.

For the other commonly used herbicides on corn and soybean, resistant biotypes have generally not been selected in the problem weeds. The exceptions include horseweed and black nightshade resistant to paraquat, waterhemp and ragweed resistant to PPO inhibitors, Italian ryegrass resistant to glufosinate, and waterhemp and Palmer's amaranth resistant to the 4-HPPD inhibitors mesotrione and isoxaflutole. There are two sites of action for which we are not aware of any resistant biotypes in the problem weeds. These include the dinitroanilines, such as pendamethalin, and the chloroacetamides such as metolachlor-S and acetochlor.

A number of the problem weeds have biotypes that are resistant to herbicides corresponding to more than one site of action. The most problematic is waterhemp which is resistant to six of the eleven sites of action commonly used in corn and soybean. Biotypes multiply resistant to 13 combinations of these sites of action have been reported including one biotype that is resistant to five sites of action (Owen, 2012). Ragweed, kochia, and horseweed are each reported to have biotypes resistant to four sites of action including biotypes that are multiply resistant to two herbicides. Horseweed has four such biotypes, kochia and ragweed each have two. Multiply resistant biotypes have also been selected in redroot pigweed and giant ragweed. In total, 7 of the 47 problem weeds include biotypes resistant to more than one herbicide.

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# Appendix 7. Off-Target Pesticide Movement

## Off-Target Pesticide Movement

Once applied, pesticides (which include herbicides) that are not taken up by targeted plants that have been harvested will persist, degrade, or move in the environment. The potential environmental fate of an herbicide is shown in Figure 7-1. Degradation occurs by hydrolysis, photolysis, or microbial dissipation resulting in the herbicide being broken down and losing its herbicidal activity. Herbicides can be transported from their original application site by spray drift, runoff, leaching, volatility, wind erosion, or crop removal. Off-site movement of herbicides have the potential to impact non-target plant and animal communities living in proximity to fields in which herbicides are used, as well as human populations.

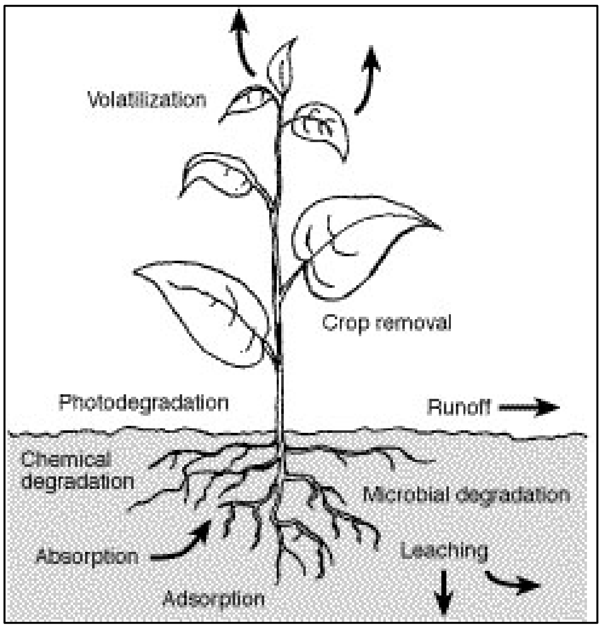


**Figure 7-1. Environmental fate of herbicides in the environment**

Pesticide use has the potential to affect soil quality due to the impact to the soil microbial community. The length of persistence of herbicides in the environment depends on the concentration and rate of degradation by biotic and abiotic processes (Carpenter *et al.*, 2002). Persistence is measured by the half-life or dissipation time ($DT_{50}$), which equates to the length of time needed for the herbicide to degrade to half of its original concentration.

Use of herbicides for field crop production may introduce these chemicals to water through spray drift, cleaning of pesticide application equipment, soil erosion, or filtration through soil to groundwater. Irrigation and rainfall occurring the first few days after herbicide application can influence herbicide loss through leaching and runoff. However, it has been estimated that even after heavy rains, herbicide losses to runoff generally do not exceed 5 to 10 percent of the total applied (USDA-NRCS, 2000; Tu *et al.*, 2001). Planted vegetation, such as grass buffer strips, or crop residues can effectively reduce runoff (Fishel, 1997; USDA-NRCS, 2000).

Pesticides applied to crops may volatilize, thereby introducing chemicals to the air. Volatilization typically occurs during application, but herbicide deposited on plants or soil can also volatilize. Volatilization occurs when pesticide surface residues change from a solid or liquid to a gas or vapor after application. Volatilization refers to the transformation of a liquid or solid pesticide into a gas. The extent of volatilization is dependent on properties of the chemical and herbicide formulation, and environmental factors such as air temperature, wind speed, and relative humidity. Volatilized pesticides can be carried by air currents potentially leading to off-target exposure. Once airborne, volatilized pesticides may be carried long distances from the treatment location by air currents. The higher the vapor pressure of a chemical, the more volatility it exhibits. In addition, other physical and chemical pesticide properties, agricultural practices, meteorological conditions, persistence of a pesticide on plant surfaces, and soil properties influence the extent of volatilization (University of Missouri, 1997; US-EPA, 2012c). Most of the herbicides considered highly volatile are no longer used (Tu *et al.*, 2001).

Drift is the physical movement of spray droplets moving off-site as a chemical application is made. Under certain conditions, the potential for physical drift from an application site to adjacent non-target environments is possible for all types of pesticide spray applications. This is an application- related phenomenon independent of the chemical pesticide, which may be influenced by the formulation ingredients and spray mix additives. Spray drift is a concern for non-target susceptible plants growing adjacent to fields when herbicides are used in the production of any crop. This potential impact relates to exposure of non-target susceptible plants to the off-target herbicide drift (Jordan *et al.*, 2009). Damage from spray drift typically occurs at field edges or at shelterbelts (i.e., windbreaks), but highly volatile herbicides may drift further into a field. The risk of off-target herbicide drift is recognized by EPA, which has incorporated both equipment and management restrictions to address drift on EPA-approved herbicide labels. These EPA label restrictions include requirements that the grower manage droplet size, control spray boom height above the crop canopy, restrict applications under certain wind speeds and environmental conditions, and use drift control agents (Jordan *et al.*, 2009).

The amount of drift varies widely and is influenced by a range of factors, including weather conditions, topography, the crop or area being sprayed, application equipment and methods, and practices followed by the applicator (US-EPA, 2000). EPA's Office of Pesticide Programs (OPP), which regulates the use of pesticides and herbicides in the U.S., encourages pesticide applicators to use all feasible means available to minimize off-target drift. EPA-OPP has introduced several initiatives to help address and prevent the problems associated with drift. Currently, EPA-OPP is evaluating new regulations for pesticide drift labeling and the identification of BMPs to control such drift (US-EPA, 2009), as well as identifying scientific issues surrounding field volatility of conventional pesticides (US-EPA, 2010). Additionally, EPA-OPP and its Office of Research and Development are developing a new voluntary program, the Drift Reduction Technology (DRT) Program, which encourages the development, marketing, and use of application technologies verified to significantly reduce spray drift (US-EPA, 2009).

EPA's core pesticide risk assessment and regulatory processes ensure that protections are in place for populations of non-target species potentially exposed to pesticides, including humans. These assessments provide EPA with information needed to develop label use restrictions for the pesticide. Growers are required to use pesticides, such as 2,4-D and quizalofop, consistent with the application instructions provided on the EPA-approved pesticide label. Labels can include restrictions related to minimizing drift or exclusion distances from bodies of water when necessary. These label restrictions carry the weight of law and are enforced by EPA and the states (FIFRA 7 USC 136j (a)(2)(G) Unlawful Acts).

In the comments to the EA on 2,4-D resistant corn and soybean, the issue was raised whether the increase in 2,4-D use expected from the adoption of Enlist™ corn and soybean would result in greater off-target effects to neighboring crops and thereby increase adverse socioeconomic impacts to these farmers. A group, Save Our Crops Coalition (SOCC), comprised of fruit and vegetable growers in the Heartland, petitioned the USDA to conduct an EIS regarding the deregulation of Enlist™ corn and soybean, because of their concern that off target movement of 2,4-D would damage their crops. In this appendix, we consider the EPA's regulation of off-target pesticide movement, the recorded cases of 2,4-D damages to neighboring farms, and the changes requested by Dow for the registration of Enlist™ products aimed at mitigating off-target pesticide movement.

## **2,4-D and off-target movement**

Since it was introduced in 1948, there have been reports of 2,4-D adversely affecting non-target broadleaf food and feed crops, such as cotton, grapes and tomatoes, growing in the vicinity of target crops (Schultz *et al.*, 1956). Such incidents have been linked to drift of spray droplets (especially through aerial spraying) or drift of vapors formed by volatilization of the 2,4-D itself (Dexter, 1993).

Increased control of drift and volatilization across pesticides has been achieved with proper equipment setup and attention paid to climatic conditions at the time of application. University extension agencies have been especially prominent in developing and disseminating "Good Application Practices" to minimize drift. Additionally, pesticide label restrictions, state pesticide regulations, nozzle technology and manufacturer stewardship programs have helped to develop and establish application practices that minimize the potential for off-target exposure.

The herbicide 2,4-D is currently available in several formulations, including 2,4-D acid, 2,4-D sodium salt, 2,4-D diethyl amine, 2,4-D dimethylamine salt, 2,4-D isopropyl acid, 2,4-D triisopropyl acid, 2,4-D butoxyethyl ester), 2,4-D ethylhexyl ester, and 2,4-D isopropyl ester (US-EPA, 2005c). In 2011, EPA approved the first new use of the 2,4-D choline salt formulation on crops, including corn and soybean (US-EPA, 2011). The 2,4-D mode of action as a synthetic auxin is not changed by these formulations, but the chemical and physical properties of each formulation influence the selection of equipment, mitigation measures adopted in the field to minimize off-target impacts, and formulation-specific safety measures. 2,4-D is formulated primarily as an amine salt in an aqueous solution or as an ester in an emulsifiable concentrate (US-EPA, 2005c). For a majority of uses, 2,4-D is combined with other herbicides because it economically enhances the weed control spectrum of many other herbicides such as glyphosate, dicamba, mecoprop, and acetolactate synthase (ALS)-inhibitor herbicides (US-EPA, 2005c).

Attributions of volatility to 2,4-D have largely been associated with the esters, particularly short chain esters. Early forms of 2,4-D included short chain esters that were favored due to rapid herbicidal activity, but these were relatively volatile (Nice *et al.*, 2004). A desire to reduce risk of off-target injury to sensitive crops, such as cotton, tomatoes or grapes, led to the development of longer chain esters that were notably less volatile, and to development of various amine salts that EPA considers to be essentially non- volatile. The volatility of the salt forms approaches two orders of magnitude reduction compared to the short chain esters (US-EPA, 2013). In the last two decades, longer chain esters have replaced the shorter chain esters and reduced volatility issues. In addition, the new 2,4-D choline salt further reduces the potential for volatility.

**Federal and State Regulation of Off-target Pesticide Movement (DAS, 2013)**

EPA is the federal agency vested with the authority and responsibility for regulating the sale, distribution and use of pesticides, including herbicides such as 2,4-D. EPA registers or approves a pesticide for one or more uses only after determining that the product will not cause unreasonable adverse effects on the environment – the statutory test for registration under FIFRA. When EPA approves the registration of a pesticide, it approves a particular product for a particular use or uses under specified conditions (including composition, application methods, usage rates, and protective measures) and specifies the language that must appear on the label of the pesticide product that sets forth those conditions and limitations. If a pesticide product is used in a manner that is inconsistent with its labeling, the user is subject to federal and state enforcement action. When making its registration decision, EPA specifies the data and information it needs to support that registration. Among the data EPA requires are those relating to off-target pesticide movement including, e.g., spray drift and volatilization (40 CFR part 158, Subparts L and N).

Federal law requires EPA to periodically review existing pesticide registrations to ensure that they meet the FIFRA standard for registration (the "no unreasonable adverse effects" criteria of FIFRA) under current scientific standards. EPA specifically addressed issues regarding off-site pesticide movement of 2,4-D in EPA's 2005 Reregistration Eligibility Decision (RED) for 2,4-D (US-EPA, 2005c), which incorporated major label revisions to products containing 2,4-D. These revisions included:

- lower limits for spray droplet size;
- prohibitions on spraying at wind speeds greater than 15 mph,
- spraying with a wind direction that is not favorable to on-target deposition, or spraying with sensitive non-target crops within 250 feet downwind;
- a prohibition on spraying at wind speeds of less than 3 mph if there are temperature inversion conditions, or stable atmospheric conditions at or below nozzle height;
- a prohibition on spraying where sensitive crops might otherwise be susceptible to drift;
- restrictions on boom length and spray release height for aerial applications, and nozzle height for ground boom applications;
- lower limits on application rates and total applications per year for specific crops
- compliance with any state and local laws that are more stringent (e.g., California, areas of which have seasonal limitations on use of 2,4-D) (US-EPA, 2005c)

EPA determined the use of the then-existing formulations of 2,4-D to be eligible for reregistration with those label restrictions. States also regulate the use of pesticides, including herbicides. A number of states have passed laws to specifically address spray drift (Feitshans, 1999). These laws may include penalties and/or restrict application methods, require prior notification, impose buffer zones, etc., as each state has deemed appropriate.

In addition to registering individual pesticides, EPA also regularly assesses the safety of pesticide use more broadly, and has repeatedly addressed issues associated with off-target pesticide movement. As stated on their web site (http://www.epa.gov/pesticides/factsheets/spraydrift.htm.) some of these efforts include:

- In 2009, EPA developed and issued for public comment a draft guidance document (PR Notice) on Pesticide Drift Labeling to provide guidance to pesticide manufacturers on labeling statements concerning pesticide drift, and to inform the public of EPA's policies with regard to pesticide drift. EPA continues to work with stakeholders to finalize this guidance.

- For many years EPA has contributed funding to support education and training programs on drift management. EPA provides annual funds to states to support pesticide applicator training programs, many of which include educational material on drift management, and EPA has contributed to other educational programs, such as the National Coalition on Drift Minimization educational video and CD-Rom, the National Pesticide Applicator Certification Core Manual, and the National Agricultural Aviation Association's Professional Aerial Applicator Support System (PAASS) to support their training and education programs to reduce drift incidents.

- EPA encourages pesticide applicators to use all feasible means available to them to minimize off-target drift. To support this goal, EPA has stated its intent to work with applicators, agricultural extension agents, registrants, environmental groups, and other interested stakeholders to collect and develop information on best management practices (BMPs) to reduce off-target drift for specific application methods and crop sector combinations. These guidance documents will be consolidated by EPA and made available online.

- OPP and the EPA's Office of Research and Development are developing a new voluntary program, the Drift Reduction Technology (DRT) Program, which encourages the development, marketing, and use of application technologies, verified to significantly reduce spray drift (US-EPA, 2012a).

- EPA has also taken action to address issues around pesticide volatility. In December 2009, EPA convened the FIFRA Scientific Advisory Panel (SAP) to examine scientific issues associated with field volatilization of conventional pesticides, focusing on methodologies by which bystander inhalation could be measured.

**Existing precautions against off-target exposure (DAS, 2013)**

Despite federal and state controls and the best efforts of applicators, off-target pesticide movement occasionally damages neighboring crops. Crops may be exposed to pesticide volatility or drift from a variety of sources, including public right of way uses for road maintenance and utilities, and agricultural uses. Crops that have the potential for damage due to exposure to a particular pesticide are considered sensitive crops. Sensitive crops to 2,4-D include cotton, grapes, and many fruits and vegetables.

Growers use a number of approaches to protect their crops from off-target exposure. Location of where the crop is grown is a key consideration; sensitive crop growers may choose to plant in fields that are sheltered or protected from potential exposure, and are not immediately adjacent to conventional crops(Mohr). Buffer zones and vegetative barriers are often used as a no spray zone between a sensitive area and a crop being sprayed. A buffer zone may be a vegetative barrier consisting of groves, hedge rows, wind breaks, pastures, or even the grower's own conventional crops. Vegetation planted in strategic lines can reduce the extent of spray drift of agricultural chemicals by filtering out spray droplets in air passing through their foliage (Department of Primary Industries). In some cases, growers are able to select a sensitive crop variety that is less sensitive to pesticides that are commonly applied to neighboring areas. Modified cultural practices, including timing of operations, are another approach that can be used to protect against off-target exposure (Maynard *et al.*, 2012).

Sensitive crop growers may help to avoid exposure in right of way areas by posting signs and making arrangements with government road crews or utility companies to do their own maintenance of easements and road ways near their sensitive crops. Similarly, neighboring farms can be notified of the presence of sensitive crops that require protection from herbicide spray drift and volatility. Since applications of herbicides are increasingly being made by custom applicators, signage placed near field entrances alerting operators to the presence of sensitive crops and that no sprays are allowed, are also used. Alternatively, sensitive crop growers may notify the local coops and applicators directly.

Some states have a pesticide sensitive crop registry and locator. Driftwatch (Driftwatch) is a national online tool for identifying specialty crop sites and to further enhance communications between producers of specialty crops and pesticide applicators that promote awareness and stewardship activities to help prevent and manage drift effects that sometime occur from spray operations. It currently includes the states of Colorado, Illinois, Indiana, Michigan, Minnesota, Missouri, Montana, Nebraska, and Wisconsin. This site features an easy-to-use Google Maps™ interface that clearly shows applicators the locations of registered areas so they can utilize the information in their ongoing stewardship activities before they spray. Other states, such as Maryland maintain their own, voluntary, pesticide-sensitive crop registry (http://mda.maryland.gov/Pages/homepage.aspx).

If crop damage occurs, affected growers can seek compensation by a variety of mechanisms. The pesticide applicator may have insurance to cover such losses. In many cases, growers work out an equitable settlement. Where this is not possible, state pesticide enforcement bureaus are notified to view and document the damage. EPA obtains reports of pesticide incidents from private citizens, poison control centers, states, and other government and non-governmental organizations. In some states, the applicator may be subject to fines or other penalties (Feitshans, 1999). The crop damage may also give rise to claims for legal damages in private lawsuits.

**Recorded Cases of Damages from Off-target Exposure to 2,4-D (DAS, 2013)**

USDA is not aware of a comprehensive, national database of offsite incidents from pesticide use. Incidents involving alleged pesticide spray drift may be reported by various sources to the grower, applicator, retailer, state or federal agency and/or the product manufacturer (US-EPA, 2007). Information associated with the alleged incidents and investigations is managed by each respective party or entity.

Pesticide product registrants are required under FIFRA Section 6(a)(2) to submit certain types of factual information to the U.S. Environmental Protection Agency (EPA) regarding adverse effects on human health or the environment from the use of their registered products. If the incidents are “minor” they are included in the Aggregate Incidents Database and are not included in the Ecological Incident Information system (EIIS) (US-EPA, 2007). EIIS includes information on all ecological incidents reported to the agency prior to 1998 and all major incidents reported since. For plants, a major effect is one that is alleged to have occurred on more than 45% of the acreage exposed to the pesticide (US-EPA, 2005b). EIIS also includes information on incident reports submitted through other sources, such as the States, regardless if they are "major" incidents or not. Incidents of adverse effects on lawns and other ornamentals caused by direct application of pesticide products are not entered into EIIS. When available, EIIS includes date and location of incident, type and magnitude of effects observed in various species, use(s) of pesticides known or suspected of contributing to the incident. However, the database contains a limited number of reported incidents and is not readily available to the public.

Registrants routinely submit reports on alleged incidents that have not been independently verified. Thus, due to the nature of incidents and how they are typically reported through the FIFRA 6(a)(2) process, the authenticity, validity, and/or accuracy of information contained in the reports cannot be guaranteed by the registrants and may not accurately reflect actual incidents and products involved. In many cases there is not enough information to determine if the alleged adverse effects noted were in fact the result of pesticide spray drift and not another contributing factor. Thus, spray drift allegations may be reported as plant damage which may, in fact, have been caused by diseases, insects, nutrient deficiencies, herbicide residue (carryover) and growing conditions. For its part, EPA does not require reporting of adverse effects to non-target plants at the use site when the pesticide label provides adequate notice. As a result, some incidents may not be reported because EPA is already aware of the potential for those effects to occur under certain conditions. It should be noted that none of the reports includes 2,4-D formulated with choline, a formulation designed to be less susceptible to drift, as the registration of this formulation was only recently approved by the EPA.

While accurate, comprehensive, and reliable national data on offsite incidents from pesticide use is not readily available, EPA’s Office of Pesticide Programs may publish incident data as part of its periodic review of all pesticides to ensure that their registrations continue to meet current scientific standards. Recently, EPA published a scoping document for 2,4-D acid, salts, and esters to support registration review that includes the results of a search of the EIIS and the Aggregate Incident Reports databases for ecological incidents involving 2,4-D acid and its forms (US-EPA, 2012a). They reported that, for all years, there were 422 incidents involving plants in the EIIS and 13,798 incident reports for all forms of 2,4-D in the Aggregate Incident Report database. From the details provided in the EPA summary of the EIIS reports, many of the plant incidents appeared to result from over-application of 2,4-D products to lawns or application of 2,4-D products to types of plants that are sensitive to 2,4-D. Other plant incidents were the result of spray drift in agricultural settings. Detailed information was not provided for the Aggregate Incident reports.

## 2,4-D use restrictions

EPA's registration for 2,4-D under section 3 of FIFRA includes certain restrictions on use that appear on the product's label, but EPA has not classified 2,4-D as a “restricted use pesticide” (RUP). The most frequent means by which EPA addresses potential adverse effects is through warnings, prohibitions, restrictions and directions for use on the product label (40 CFR Part 156). When registering a product, the EPA also has the ability to classify a pesticide as a RUP should it deem that the product needs additional restrictions to decrease the risk of adverse effects (40 CFR subpart I, 152.160). RUPs can only be applied by or under the direct supervision of an applicator certified by the state or EPA (DAS, 2013).

After a pesticide is registered by EPA, states can register pesticides under specific state pesticide registration laws. State lead agencies have primary authority for pesticides used within the state. In some cases, states may enact additional restrictions for use of a product to meet the uses and needs of their state. For example in Northeast Arkansas, rice, a crop where 2,4-D was used for weed control, and cotton, a 2,4-D sensitive crop, are grown in proximity. In 2006, the Arkansas State Plant Board (ASPB) received more than 100 complaints about 2,4-D drift (Bennett, 2006). The greater than usual drift was attributed in part to a very wet spring (USDA-NASS, 2006) which resulted in many applications of 2,4-D being conducted aerially and done in a short period of time. The ASPB created a 2,4-D task force and a glyphosate task force in 2006 charged with the mission of developing proposed regulations for the board to consider (Bennett, 2007). After conducting public meetings and taking testimony from representatives from various agriculture sectors, the task forces submitted recommendations to the ASPB at the end of 2006. The final rule, adopted in February 2007, called for a ban on most aerial and ground spray applications of 2,4-D in ten northeastern counties (area known as Crowley’s Ridge) between April 15 and September 15 and buffers of 2,4-D applications from susceptible crops in the remaining counties (Arkansas State Plant Board, 2007). Applications of glyphosate were limited to wind speeds no higher than 10 mph or 15 mph if using a commercially available hooded sprayer (Arkansas State Plant Board, 2007).

Currently, there are 18 states with some type of restriction on the use of 2,4-D (Figure 7-2 and Table 7-1). Types of use restrictions on registered products include general restricted use pesticide (RUP) regulations, formulation-specific restrictions, time-specific restrictions and/or location-specific restrictions.

## Types of State Restrictions

**2,4-D products designated as a RUP –** Four states, Massachusetts, New Jersey, New Mexico and Vermont have designated 2,4-D products a RUP. The RUP designation means that applicators must be certified to use the RUP product or have a licensed applicator within the vicinity of the person making the application. The applicator must also keep spray records.

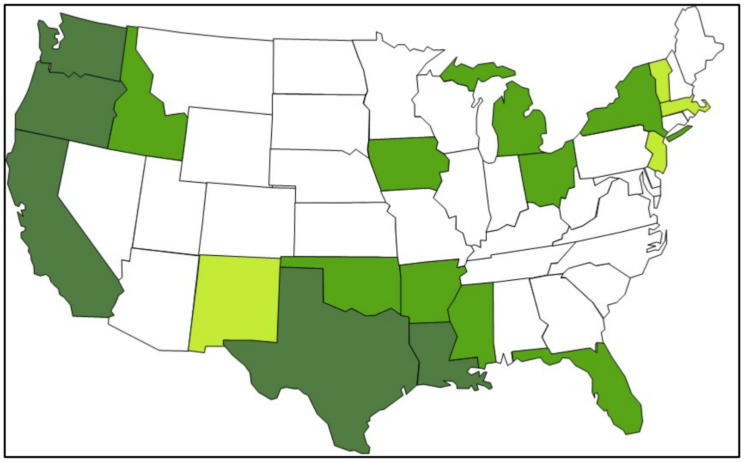


**Figure 7-2. States with restrictions on the use of 2,4-D**
Source: (DAS, 2013).

**Table 7-1. State 2,4-D Restrictions***

| TYPE OF RESTRICTION | STATE |
|---|---|
| State RUP designation, but with no spray/userestrictions (*e.g. licensed applicators, permitting, record keeping, etc.*) | MA, NJ, NM, VT |
| State RUP designation and spray/use restrictions | CA, LA, TX, WA |
| No state RUP designation but spray/use restrictions | AR, FL, ID, IA, MI, MS, NY, OH, OK, OR |
| **Total number of states** | **18** |

**State regulations subject to change.*
Source: (DAS, 2013)

**2,4-D products designated as a RUP along with spray use restrictions –** Four states, California, Louisiana, Texas and Washington designate 2,4-D as a RUP and in addition impose spray use restrictions which vary by state. In these states, applications are restricted or prohibited during certain times of the year (e.g. April through September) in designated counties. For the remaining counties in Louisiana and Texas, buffers from sensitive or susceptible crops are established.

**2,4-D products are subject to specific spray use restrictions –** Ten states, Arkansas, Idaho, Iowa, Florida, Michigan, Mississippi, New York, Ohio, Oklahoma and Oregon impose spray use restrictions though they do not designate 2,4-D as a RUP. The restrictions range from buffers to aerial versus ground spray applications to the type of 2,4-D formulations which can be applied. For example, New York has spray use restrictions in only three counties. In these counties, no 2,4-D can be applied within 100 feet of any grape vineyard and there is a 2-mile buffer for all ester formulations. In Mississippi, 2,4-D is limited to ground spray applications only from April 1 to September 30. In Iowa, ester formulations only are prohibited in five counties. The specific state restrictions of 2,4-D use are summarized in Table 7-2.

**Table 7-2. Summary of State Restrictions on the Use of 2,4-D**

| STATE | RUP | RESTRICTIONS |
|---|---|---|
| **Arkansas** | No | All 2,4-D herbicides are in Class F with use restrictions. From Apr. 15 - Sept. 15: 2,4-D use is not allowed in Clay, Greene, Craighead, Poinsett, Cross, Crittenden, St. Francis, Lee, Phillips, and Mississippi Counties. Permits may be obtained to allow exemption with key requirements recording application details. Buffer zone/wind speed requirements. Buffer zones set: e.g. 4 mile aerial; 1 mile ground. *AR Regulations on Pesticide Classification - Final Rule (Rev. 06/07):* |
| **California** | Yes | RUP for products 1 gal or greater containing over 15% active ingredient. Permits are needed to spray 2,4-D in defined areas of Sacramento, Madera, Fresno, Kings, Tulare, Kern, and San Joaquin Counties. Restrictions are based on dates, formulation type, wind speed, set-back from commercial vineyard or cotton planting. 2,4-D use restrictions exist to protect the California Red Legged Frog (buffer zones in 33 counties); 2,4-D salts and esters are designated as toxic air contaminants. *Title 3, CCR 3, Sec. 6400* |
| **Florida** | No | Sale and use of highly volatile1 forms of organo-auxin herbicides is prohibited except for those products labeled as plant growth regulators on citrus. Minimum set-back distances from susceptible crops are specified based on wind speed. Max wind speed = 10 mph. Applicator record keeping requirements are in effect. Aerial application by fixed-wing aircraft is prohibited Jan 1 until May 1 in Hendry, Palm Beach, Glades, Martin counties.*Florida Administrative Code Chapter 5E-2.033 (Effective 7-29-04)* |
| **Idaho** | No | 2,4-D ester restrictions exist in Latah, Nez Perce, and Clearwater Counties. Restrictions are based on aerial or ground application, formulation type, set-back from susceptible crop, and wind speed. Buffers from hazard areas required for 2,4-D amines and acids, MCPA, MCPB, and dicamba. *IDAPA 02.03.03 Sec. 550* |
| **Iowa** | No | The use of high volatile esters[2] formulations of 2,4-D and 2,4,5-T, the alcohol fraction of which contains five or fewer carbons, is prohibited in the counties of Harrison, Mills, Lee, Muscatine and that part of Pottawattamie county west of Range 41 West of the 5th P.M. 21—*45.27(206)* |

| STATE | RUP | RESTRICTIONS |
|---|---|---|
| **Louisiana** | Yes | 2,4-D is designated an RUP for agricultural uses. Restrictions for commercial and private applicators are based on timing, location, and wind speed. 32 parishes have restrictions. *LA Title 7, Part XXIII, § 1103* |
| **Massachusetts** | Yes | If product contains >20% 2,4-D, it is a State RUP -- application must be made by certified applicators and there are reporting requirements. *333 CMR 1.00* |
| **Michigan** | No | No use of volatile ester forms of 2,4-D and MCPA are allowed within specified regions from May 1 to Oct. 1 in parts of Berrien, Cass, Kalamazoo and Van Buren counties. There are sprayer specifications for amine forms. *MDA Reg 285.637* |
| **Mississippi** | No | For hormone-type herbicides[3], restrictions apply for aerial application. Restrictions are based on date and type of aircraft and include no use of ester formulations, a 0.5 mile set-back from cotton and susceptible crops, applications at wind speed < 5 mph. There are applicator and licensing requirements. *Miss. Code Ann. § 69-21-109 (Part 3-Ch 10-Sub 01)* |
| **New Jersey** | Yes | Concentrated 2,4-D (>20%) may only be purchased and used by certified applicators *N.J.A.C. 7:30-2.10* |
| **New Mexico** | Yes | State restrictions apply to all 2,4-D products used in agriculture. Spray restrictions in Curry and Roosevelt counties are based on timing, application method, and must be applied at windspreeds < 10 mph and only by certified applicators. Permits are required for applications of low volatile formulations. Esters and aerial applications are not permitted in these 2 counties from Apr.15 to Oct. 1. *21.17.56 NMAC* |
| **New York** | No | For 2,4-D, 2,4-5T, and MCP spray restrictions and set-backs of 100 ft from grape vineyards in portions of Chautauqua, Erie, Niagara counties are in effect. *NY ECL Art. 33 § 321-324* |
| **Ohio** | No | Restriction from use of ester formulation in Madison township of Lake County is in effect. *ORC Title IX, Ch. 921* |
| **Oklahoma** | No | Applications of products containing 2,4-D esters or dicamba to agricultural lands are prohibited in Greer, Harmon, and Kiowa counties May 1-October 15; Applications of products containing 2,4-D, dicamba, picloram, triclopyr, or clopyralid are prohibited in Jackson and Tillman counties May 1 - October. Notification and reporting procedures are required for 2,4-D applications. *2 O.S. § 3-84 (35:30-17-24.1)* |
| **Oregon** | No | Use of high volatile esters of 2,4-D in areas of Morrow and Umatilla counties are prohibited Apr 1 - Sept 1 except by permit. *OAR 603-057-0301 to 0320* |

| STATE | RUP | RESTRICTIONS |
|---|---|---|
| **Texas** | Yes | Use of 2,4-D, MCPA, dicamba, quinclorac is prohibited within 4 miles of a susceptible crop in 53 "Pesticide Regulated Herbicide Counties". No applications are permitted when wind speeds exceed 10 mph. Additional provisions are set county-by-county. *TAC 4-1-7-E §7.50, 53* |
| **Vermont** | Yes | Class A restricted use, application requirements, and reporting requirments are in effect. *6 V.S.A. Ch 87* |
| **Washington** | Yes | All phenoxy hormone-type herbicides are restricted throughout eastern Washington with additional restrictions in 14 counties: Adams, Benton, Columbia, Douglas/Chelan, Franklin, Garfield, Grant, Kittitas, Klickitat, Lincoln, Okanogan, Spokane, Walla Walla, Whitman, and Yakima. Specific restrictions are determined by county pertaining to boundaries; formulation type, application parameters, dates, and aerial or ground, set-backs. *16 WAC 16-228,232* |

*Source: (DAS, 2013)*

[1]*All pesticides registered for sale in Arkansas are assigned to a Class. Each Class carries with it one or more restrictions that must be complied with by the user, applicator, or dealer. The classification system ranges from Class A which presumably all pesticides are registered as initially, until a problem develops. The only use-restrictions assigned to Class A products are those on the product label. If problems develop with a product, the Plant Board, after a public hearing, can move a product from the Class A designation to another designation (B, C, D, E or F) which has more restrictions. Each classification carries with it all the restriction(s) that are specified for that class plus all that came before it.*

[2]*Note: High volatility esters of 2,4-D are those that have five or fewer carbons on the alcohol side chain. Currently there are no high volatility esters registered for use in the United States.*

[3]*Hormone-type herbicides include 2,4-D, 2,4-DB, aminopyralid, clopyralid, dicamba, dichlorprop, fluroxypyr, MCPA, MCPB, mecoprop, picloram, quinclorac and triclopyr.*

**New technologies for controlling drift and volatility (DAS, 2013)**

Dow conducted an extensive evaluation of various salts under conditions inducing high volatility to identify candidates that had significantly reduced volatility and thus lowered potential for injury to susceptible plants. The results led to the development of a formulation based on a 2,4-D choline salt. This novel form of 2,4-D has been tested in the laboratory and subsequently in field studies. Quantification of volatilized 2,4-D from soybean and bare soil fields demonstrated that 2,4-D ethylhexylester was the most volatile, with calculated loss rates of the 2,4-D ethylhexylester as much as two orders of magnitude greater than the 2,4-D dimethylamine (DMA) form, which is considered to be much less volatile than ester formulations (National Pesticide Information Center). The choline form of 2,4-D measured as much as 50X less volatility than the DMA form and had dramatically less injury to a variety of crops known to be sensitive to auxin herbicides under confined conditions as compared to ester and amine forms of 2,4-D (US-EPA, 2013).

Dow's new product containing 2,4-D choline and glyphosate DMA (Enlist Duo™ herbicide) will make the herbicide spray droplets larger and more uniform in size compared to a standard 2,4-D and glyphosate tank mix application. Dow has measured a 3X improvement (reduction) in driftable fines (<150 μ) for both 2,4-D choline and glyphosate under field conditions using commercial application equipment. This validates observations made under controlled laboratory and wind tunnel conditions. Coupled with using the latest in drift reduction nozzles, as much as a 10X reduction in drift was achieved compared to a standard tank mix application of the same active ingredients using conventional nozzles.

Pending registration by EPA, Dow intends to market Enlist Duo™ Herbicide with Colex-D Technology, a pre-mix of the new 2,4-D choline salt and glyphosate dimethylamine with reduced drift and volatility characteristics, for use with Enlist™ corn and soybean. Via a Technology Use Agreement, Dow will require growers of Enlist™ corn and soybean who choose to use 2,4-D in post-plant applications to purchase the 2,4-D formulation in Enlist Duo™ to provide this added protection against off-target exposure. A combination of EPA-required label restrictions, contractual obligations and grower education and outreach are expected to minimize off-target effects to neighboring crops when applications of Enlist Duo™ is made to Enlist™ corn and soybeans.

In addition to the technology innovations, the herbicide product label and product use guide do not allow applications into areas where temperature inversions are present, do not allow applications when winds exceed 15 mph, do not allow aerial applications, and require use of only the spray nozzle that was used in the spray drift evaluations and that produce a coarse droplet size. Such stewardship and responsible use requirements are expected to further minimize the potential for off-target herbicide movement.

In addition to the reduction of particle drift or volatilization due to physical properties of the herbicide formulation, other precautions have been included in conjunction with the Enlist™ Weed Control System to minimize the potential for off-target movement. Specifically, Dow will request an amendment to its pending herbicide label submitted to EPA to include language regarding sensitive crops under a new "Susceptible Plants" heading on the label and label language requiring buffer zones between areas of 2,4-D choline use and sensitive plants (Coalition, 2012). The proposed label for Enlist Duo™ Herbicide with Colex-D Technology™ label does not allow herbicide application through any type of irrigation equipment and prohibits aerial application (DAS, 2011). Individual state regulations for use of 2,4-D, such as the widespread prohibition of aerial application and restricted seasonal application, will also remain in effect. For instance, Texas has limited the application of "regulated herbicides" (such as 2,4-D) by county with the aerial application of 2,4-D being prohibited in many counties between March 10 and September 15 or outright prohibited within a given distance of any susceptible crop (4 Tex. Admin. Code §7.53). Iowa state law prohibits the use of some 2,4-D esters in some counties (21 IAC 45.27 [2013]). Mississippi prohibits the aerial application of 2,4-D by fixed wing aircraft between April 1 and September 30 (CMSR 02-001-310). However, Mississippi allows 2,4-D to be applied by helicopter between April 1 and September 30 as long as certain application criteria are met, such as the use of precision spray systems, the use of booms no longer than rotor diameter, a flight speed of no more than 30 mph during application, and wind speed of 5 mph or less at the time of application (CMSR 02-001-310).

Use of the innovative choline salt of 2,4-D, the new formulation technologies, and Dow AgroSciences' Stewardship Program is expected to help reduce the potential for off-target impacts on sensitive crops and non-crop plants/organisms.

**Proposed Herbicide Label Language for Enlist Duo™ (DAS, 2013)**

Dow has submitted to EPA for approval a proposed label for its Enlist Duo™ herbicide with Colex-D Technology™, a pre-mix of the new 2,4-D choline salt and glyphosate DMA. Dow's proposed label contains the instructions for use directly addressing the potential for spray drift and volatility. The same label instructions will be submitted for use on Enlist™ soybeans.

Dow has submitted for EPA approval the following proposed Enlist Duo™ label language specifically addressing spray drift management. During its label approval process, EPA may impose additional use restrictions or other protective measures for corn and/or soybean.

**Spray Drift Management**

Avoid drift. Use extreme care when applying this product to prevent injury to desirable plants and crops.

Do not allow GF-2726 to mist, drip, drift or splash onto desirable vegetation since minute quantities of this product can cause severe damage or destruction to the crop, plants or other areas on which treatment was not intended. The likelihood of injury occurring from the use of this product increases when winds are gusty, as wind velocity increases, when wind direction is constantly changing or when there are other meteorological conditions that favor spray drift. When spraying, avoid combinations of pressure and nozzle type that will result in fine particles (mist) which are likely to drift. **Do not apply at excessive speed or pressure**. Use of this product in any manner not consistent with this label may result in injury to persons, animals or crops, or other unintended consequences.

Avoiding spray drift at the application site is the responsibility of the applicator. The interaction of many equipment- and-weather-related factors determines the potential for spray drift. The applicator and the grower are responsible for considering all these factors when making decisions.

Do not aerially apply this product.

Droplet Size

Apply with AIXR 11004 spray nozzles with proper tank mix and pressure at 40 ± 2psi to reduce Enlist Duo™ Herbicide driftable fines. If additional nozzle/s become available and suitable for future 2,4-D choline application, US EPA will incorporate them into future label/s.

Groundboom Application

Use the minimum boom height based upon the nozzle manufacturer's directions. Spray drift potential increases as boom height increases. Spray drift can be minimized if nozzle height is not greater than the maximum height specified by the nozzle manufacturer for the nozzle selected.

Wind

Drift potential is lowest at wind speeds of 10 mph or less. However, many factors, including droplet size and equipment type, determine drift potential at any given speed. Do not apply at wind speeds greater than 15 mph. **Note**: Local terrain can influence wind patterns. The applicator should be familiar with local wind patterns and how they affect drift.

Temperature and Humidity

When making applications in low relative humidity, set up equipment to produce larger droplets to compensate for evaporation. Droplet evaporation is most severe when conditions are both hot and dry.

Temperature Inversions

If applying at wind speeds less than 3 mph, the applicator must determine if: a) conditions of temperature inversion exist, or b) stable atmospheric conditions exist at or below nozzle height. Do not make applications during a temperature inversion or stable atmospheric conditions. Temperature inversions restrict vertical air mixing, which causes small suspended droplets to remain in a concentrated cloud. This cloud can move in unpredictable directions due to the light variable winds common during inversions. Temperature inversions are characterized by increasing temperatures with altitude and are common on nights with limited cloud cover and light to no wind. They begin to form as the sun sets and often continue into the morning. Their presence can be indicated by ground fog; however, if fog is not present, the presence of an inversion can also be identified by the movement of smoke from a ground source. Smoke that layers and moves laterally in a connected cloud (under low wind conditions) indicates an inversion, while smoke that moves upwards and rapidly dissipates indicates good vertical air mixing.

Drift Setbacks from Sensitive Areas

Allow setbacks (buffer zones) upwind of sensitive area (e.g., residential areas, bodies of water, known habitat for threatened or endangered species, sensitive non-target crops other than those listed above).

No 250ft setback distance has been established at this time. Current recommendation is “to measure wind direction prior to the start of any swath that is within 30 feet of a sensitive area” based on AIXR 110-04 nozzle. No application swath can be initiated in, or into an area that is within 30 feet of a sensitive area if the wind direction is toward the sensitive area.

As stated above, no alternative setback distances have been established at this time. The Agency’s only requirement to protect sensitive areas is to maintain 30 foot upwind buffer from any area that is <u>not</u>:

- Roads, paved or gravel surfaces
- Planted agricultural field (except those crops listed that have been listed as susceptible on EPA’s label
- Agricultural fields that have been prepared for planting

- Areas covered by the footprint of a building, shade house, green house, silo, feed crip, or other man made structure with walls and  or a roof.

Susceptible Plants

Do not apply under circumstances where spray drift may occur to food, forage, or other plantings that might be damaged or crops thereof rendered unfit for sale, use or consumption. Avoid contact of herbicide with foliage, green stems, exposed non-woody roots of crops, desirable plants and trees because severe injury or destruction may result. Small amounts of spray drift that may not be visible may injure susceptible broadleaf plants. Before making an application, please refer to your state's sensitive crop registry (if available) to identify any commercial specialty or certified organic crops that may be located nearby.

Commercially grown tomatoes and other fruiting vegetables (EPA crop group 8), cucurbits (EPA crop group 9), and grapes are particularly sensitive to drift from this product. Do not apply when wind direction favors off-target movement onto these crops.

State and Local Requirements

Applicators must follow all state and local pesticide drift requirements regarding application of 2,4-D herbicides. Where states have more stringent regulations, they must be observed.

The submitted Enlist Duo™ label language also requires additional measures to avoid off- target movement and crop injury, including detailed instructions for clean-out of sprayer equipment, use of drift control additives, and boom and nozzle height instructions.

Additional Dow measures to address spray drift and volatility

As noted above, Dow will contractually require growers of Enlist™ corn and soybean who wish to use 2,4-D as an in-crop herbicide to use only Enlist Duo™. This new 2,4-D technology will provide substantially lower volatility than any other form of 2,4-D, as well as improved drift control, low odor, and improved handling characteristics.

Through its Technology Use Agreement, Dow will impose a legal and contractual obligation that will require all growers of Enlist™ corn and soybean to:

Use only EPA accepted and Dow authorized 2,4-D formulations containing Colex-D Technology™, such as Enlist Duo™, for in-crop applications to Enlist™ corn and soybean.

Read and follow FIFRA Pesticide Product Label directions.

Read and follow the Enlist™ Weed Control System Product Use Guide.

Use properly maintained and calibrated ground application equipment for Enlist Duo™ with Colex-D Technology™ with minimum boom heights.

Use nozzles that reduce the potential for physical drift of Enlist Duo™ with Colex-D Technology™.

Follow instructions for equipment clean-out after product use.

Dow will provide comprehensive training on its technology and portfolio of products to growers, dealers and distributors through a variety of formats. Education and training, reinforced through product profiles, technical bulletins, sales literature, direct mailing and websites will also be presented in multiple formats to enhance learning and mastery of core concepts related to stewardship to be employed around Enlist™ corn and soybean. A variety of educational formats will be used to promote concept learning. This training will include education on spray technology and herbicide application, including spray quality basics, as well as spray quality of Enlist Duo™, as well as how to minimize the potential for off-target movement of Enlist Duo™.

Producers who do not comply with the requirements of the stewardship program risk losing access to the Enlist™ Weed Control System. Legal penalties may also be imposed by state regulatory agencies when label instructions are not followed.

Potential Off-target Pesticide Impacts on Organic Crops (DAS, 2013)

Growers of organic crops may also face economic damages from off-target pesticide movement, even if their crops are not damaged. If a certifying agent tests a crop grown under organic production and the test reveals the presence of residues from a pesticide not approved for use under the National Organic Program (NOP), the crop may not be sold as organic if the residue is present at a level greater than five percent of the EPA tolerance for the detected prohibited residue (7 CFR 205.671). A grower whose organic crops were subject to off-target pesticide movement that resulted in residue levels greater than five percent of the EPA tolerance could then lose the organic premium he may otherwise have obtained for his crop. While some certifying agents have refused to allow organic production on fields that have been the objects of spray drift, a recent court decision found this three year ban on organic production following spray drift to be inconsistent with the NOP (Anonymous, 2012).

In finalizing the NOP, USDA described the following in regards to grower's responsibilities to protect against chemical drift (65 FR 80556):

Drift has been a difficult issue for organic producers from the beginning. Organic operations have always had to worry about the potential for drift from neighboring operations, particularly drift of synthetic chemical pesticides. As the number of organic farms increases, so does the potential for conflict between organic and nonorganic operations.

It has always been the responsibility of organic operations to manage potential contact of organic products with other substances not approved for use in organic production systems, whether from the nonorganic portion of a split operation or from neighboring farms. The organic system plan must outline steps that an organic operation will take to avoid this kind of unintentional contact.

When we are considering 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.

All of the preventions discussed above are available to organic growers and many are required by the NOP as part of their organic production plan. Similarly, insurance and legal recourse may be available to organic growers who lose premiums as a result of spray drift.

2,4-D has an extensive history of safe and effective use. It has been thoroughly reviewed and reregistered by all major regulatory agencies in the world within the last ten years. Recently (April 2012), the EPA denied a petition to cancel the tolerances and registrations for 2,4-D based on toxicological hazard. The Agency issued a denial of that petition, affirming that 2,4-D posed no unreasonable risk when used as directed (US-EPA, 2012b). Therefore the impacts to the physical environment are expected to be similar under the No Action and Action Alternatives.

**<u>Other potential sources of off-target movement (DAS, 2012b)</u>**

**Soil Leaching**

2,4-D has a relatively short half-life and is rather immobile in the soil. In 35 recent field dissipation studies across the U.S., less than 5% of applied 2,4-D moved downward more than 15 cm (6 inches). The average lowest depth detected ranged from 6 to 12 inches in soils of the southern United States, and 16 to 24 inches in low organic soils where greater movement would be expected ((Industry Task Force, 2006) cited in (DAS, 2012a)). Groundwater detections of 2,4-D, which are very rare, are largely attributed to direct introduction by misuse or spills at well sites ((Industry Task Force II, 2013)cited in (DAS, 2012a)). Proper application and avoiding filling spray equipment near well heads are standard good farming practices that minimize the potential for leaching and work effectively for 2,4-D.

**Runoff**

The environmental risks of pesticide use are assessed by EPA in the pesticide registration process and are regularly reevaluated by EPA for each pesticide to maintain its registered status under FIFRA. EPA's process ensures that each registered pesticide continues to meet the highest standards of safety to protect human health and the environment (DAS, 2012a).

Both field crop and aquatic application for weed control are registered uses of 2,4-D (US-EPA, 2005c). Glyphosate is registered for use on many food and non-food field crops as well as non-crop areas where total vegetation control is desired (US-EPA, 1993). Although the registered use of glufosinate is primarily terrestrial (US-EPA, 2008; Bayer CropScience, 2011), it may be applied to certain confined waters for irrigated crops, such as rice (US-EPA, 2002).

As described in (DAS, 2012a), as part of an ecological risk assessment, EPA recently evaluated monitoring data from the USGS NAWQA program to assess the current trend of 2,4-D concentrations in surface water and groundwater (US-EPA, 2013)). 2,4-D was detected in 47 percent of surface water samples (i.e., 434 samples from a total national dataset of 931 samples). The maximum concentrations of 2,4-D ranged from 0.008 µg/l to 8.7 µg/L. 2,4-D was detected in only 1 percent of the groundwater samples (i.e., 12 samples from a total national dataset of 1,184 samples). The maximum concentrations of 2,4-D ranged from 0.008 µg/L to 1.4 µg/L. The reported concentrations for both surface water and groundwater are lower than in the previously reported drinking water memorandum (US-EPA, 2004).

As described in (DAS, 2012a), 2,4-D is currently approved by EPA for aquatic applications to control aquatic weeds in food use areas (i.e., rice and fish farms) as well as industrial areas (i.e., drainage systems) (US-EPA, 2005c). When used for aquatic treatments (direct application to water for aquatic vegetation control), 2,4-D has a half-life of between 3.2 days and 27.8 days (US-EPA, 2005c); the half-life of 2,4-D in aerobic aquatic environments is approximately 45 days, and the half-life of 2,4-D esters in normal agricultural soil and natural waters is less than 3 days (US-EPA, 2005a; US-EPA, 2009). EPA has stated that the 2,4-D acid and amine salts are practically non-toxic to freshwater or marine fish (US-EPA, 2005c).

**Environmental Loading of Herbicides Used on Corn** **<u>(DAS, 2012b)</u>**

Dow has conducted an analysis to determine the anticipated impact on environmental loading of herbicides resulting from the use of 2,4-D choline on herbicide tolerant DAS-40278-9 corn, DAS-68416-4, soybean, and DAS 44406-6 soybean. Specifically, this analysis looked at the environmental load of herbicides applied on glyphosate tolerant corn and soybeans to control glyphosate resistant and hard-to-control weed biotypes (DAS, 2012a). The top currently available herbicide programs (excluding just increasing the rate of glyphosate alone) that are currently being recommended to control glyphosate resistant weeds in corn under scenarios representative of different key corn-growing regions were compared to projected use of Enlist Duo™. While the range of rates of these currently available alternate programs and the ones for Enlist Duo™ programs overlapped, when the average of the Enlist Duo™ program rates were compared to the average of all of these top alternates, the analysis indicated that the use of 2,4-D on herbicide tolerant DAS-40278-9 corn would reduce the per acre environmental load of herbicides compared to these top, currently available, non-glyphosate alternative programs. Reductions on corn ranged by 0.15 to 0.74 lb ai/ac, within the individual scenarios, with an overall average reduction of 0.49 lb ai/ac across all scenarios (DAS, 2012a).

Herbicide use may increase to meet the need for additional integrated weed management tactics to mitigate herbicide-resistant weeds in different cropping systems (Culpepper *et al.*, 2008; Owen, 2008; Heap, 2011; Owen *et al.*, 2011). Some of these adjustments may have the potential to impact surface water quality through increased sedimentation and agricultural chemical loading derived from exposed soils (Towery and Werblow, 2010; Owen *et al.*, 2011). Some of these adjustments have the potential to impact air quality by increased emissions from tillage equipment and release of particulate matter generated from soil disturbance during tillage operations (Madden *et al.*, 2009). Increases in herbicide resistant weeds potentially could lead to a decline in no-till and conservation tillage. Declines in such practices are expected to reduce air quality from greater use of heavy field equipment and greater release of airborne particles. Implementation of BMP to slow soil erosion and filter pollutants from surface runoff, such as vegetated strips, control of spray drift, and adherence to label restrictions governing safe application and equipment cleanup, minimize the potential for pesticide impacts to surface and groundwater.

The environmental risks of pesticide use are assessed by EPA in the pesticide registration process and are regularly reevaluated by EPA for each pesticide to maintain its registered status under FIFRA. In this process, steps to reduce pesticide drift and volatilization are included on a pesticide's label approved by EPA. EPA's process ensures that each registered pesticide continues to meet the highest standards of safety to protect human health and the environment.

Use of the herbicides glyphosate 2,4-D, and glufosinate would be contingent upon periodic reevaluation and continued approval by EPA.

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# Appendix 8. EPA Assessments of Herbicides used on DAS Corn and Soybean

## Herbicides Used on DAS Corn and Soybean

Three petitions submitted by DAS to APHIS seek determinations of nonregulated status for GE maize and soybean cultivars engineered for resistance to herbicides. The three petitions are as follows:

APHIS Petition 09-233-01p (DAS, 2010a) is for GE maize (*Zea mays*) designated as event DAS-40278-9 corn. It is engineered for increased resistance to certain broadleaf herbicides in the phenoxy auxin group such as 2,4-D (2,4-dichlorophenoxyacetic acid). DAS-40278-9 corn is also resistant to grass herbicides classified as aryloxyphenoxypropionate (AOPP) acetyl coenzyme A carboxylase (ACCase) inhibitors, such as quizalofop-p-ethyl (quizalofop), that are referred to as fop herbicides.

APHIS Petition 09-349-01p (DAS, 2010b) is for a GE soybean (*Glycine max*) variety designated DAS-68416-4 soybean. The *aad-12* gene in DAS-68416-4 soybean expresses the AAD-12 protein, which degrades 2,4-D into herbicidally inactive 2,4-dichlorophenol. DAS-68416-4 soybean also contains the PAT protein, conferring resistance to the herbicide glufosinate.

APHIS Petition Number 11-234-01p (DAS, 2011d) is for non-regulatory status determination of event DAS-44406-6 soybean, which is genetically engineered for increased resistance to certain broadleaf herbicides, including the nonselective herbicides glufosinate, glyphosate, and 2,4-D. The only difference between these two soybean events is that resistance to glyphosate in DAS-68416-4 soybean will be achieved by traditional breeding with another soybean containing the *2mEPSPS* gene, while DAS-44406-6 soybean has been genetically engineered with this gene.

A brief overview of the four herbicides (glyphosate, 2,4-D, quizalofop, and glufosinate) that are intended to be used on the three DAS events are presented in the following sections. The proposed uses of these herbicides on DAS-40278-9 corn and DAS-68416-4 soybean (which would also include DAS-44406-6 soybean) and any EPA assessments performed assessing the potential effects from the new uses are summarized.

### 2,4-D

#### Background and Current Uses

2,4-D is in the phenoxy or phenoxyacetic acid family and is listed as an herbicide, a plant growth regulator, and has been reported to elicit fungicidal properties at concentrations in excess of approved application rates. Its main use is as a selective post-emergence herbicide for controlling broadleaf weed species. The herbicide is approved for use on a wide variety of crops and has more than 600 registered end-use products for use on more than 300 distinct agricultural and residential sites, including terrestrial and aquatic settings (US-EPA, 2005b). Agriculturally, it is used on a variety of crops including corn, rice, sorghum, sugar cane, wheat, rangeland, and pasture. In addition, 2,4-D is used to control unwanted vegetative growth on utility corridors, rights-of-way, roadsides, non-crop areas, managed forest, and lawn and turf areas. It is also used to control aquatic and nuisance weeds, e.g., purple loosestrife (Industry Task Force II, 2005). 2,4-D controls many broadleaf weeds including carpetweed, dandelion, cocklebur, horseweed, morning glory, pigweed sp., lambsquarters, ragweed spp., shepherd’s-purse, and velvetleaf. It causes some plant damage to grasses at early growth stages in corn, and little to no plant damage in other grasses such as wheat and rice (Industry Task Force II, 2005).

The herbicide 2,4-D is currently available in ten molecular forms: 2,4-dichlorophenoxyacetic acid, dimethylamine salt of 2,4-D, 2-ethylhexyl ester of 2,4-D, butoxyethyl ester of 2,4-D, triisopropanolamine salt of 2,4-D, isopropylamine salt of 2,4-D, diethanolamine salt of 2,4-D, sodium salt of 2,4-D, isopropyl ester of 2,4-D, and choline salt of 2,4-D (US-EPA, 2013e). 2,4-D is formulated primarily as an amine salt in an aqueous solution or as an ester in an emulsifiable concentrate (US-EPA, 2005b).

The mode of action of 2,4-D is described as an "auxin mimic," meaning that it kills the target weed by mimicking auxin plant growth hormones, such as indole acetic acid (IAA) (Tu *et al.*, 2001). Auxins and synthetic auxinic herbicides regulate virtually every aspect of plant growth and development; at low doses, auxinic herbicides possess similar hormonal properties to natural auxin (Kelley and Riechers, 2007). However, as rates increase, they can cause various plant growth abnormalities in sensitive dicots (Tu *et al.*, 2001). Observable plant responses to 2,4-D can include epinasty, root growth inhibition, meristematic proliferation/callusing, leaf cupping/narrowing, stem cracking, adventitious root formation, senescence, and chlorosis. This uncontrolled and disorganized plant growth eventually leads to plant death when applied at effective doses (Tu *et al.*, 2001). 2,4-D controls many broadleaf weeds including carpetweed, dandelion, cocklebur, horseweed, morning glory, pigweed sp., lambsquarters, ragweed spp., shepherd's-purse, and velvetleaf (Industry Task Force II, 2005).

The 2,4-D mode of action as a synthetic auxin is not changed by the formulations, but the chemical and physical properties of each formulation influence the selection of equipment, mitigation measures adopted in the field to minimize off-target impacts, and formulation-specific safety measures. For a majority of uses, 2,4-D is combined with other herbicides because it economically enhances the weed control spectrum of many other herbicides, such as glyphosate, dicamba, mecoprop, and ALS herbicides (US-EPA, 2005b).

The degradation products of 2,4-D are 1,2,4-benzenetriol, 2,4-DCP, 2,4-dichloroanisole (2,4-DCA), 4-chlorophenol, chlorohydroquinone (CHQ), volatile organics, bound residues, and carbon dioxide. The EPA has determined that residues other than 2,4-D and 2,4-DCP are not of risk concern due to low occurrence under environmental conditions, comparatively low toxicity, or a combination thereof (US-EPA, 2013e).

Using pesticide usage data from the USDA-NASS and Private Pesticide Market Research, EPA estimated that an average of nearly 29 million pounds of all forms of 2,4-D were applied to agricultural crops in the U.S. annually between 2006 and 2010 (US-EPA, 2012a). Based on average treated fraction of acreage, the crops with the highest uses of 2,4-D were: almond (15%), apples (20%), barley (25%), cherries (15%), fallow (25%), hazelnuts (25%), nectarines (15%), oats (15%), oranges (20%), peaches (20%), pears (15%), plums (15%), prunes (15%), sorghum (20%), sugarcane (40%), tangelos (30%), wheat (30%). All other treated crops averaged 10% or less of the total acreage grown (US-EPA, 2012a). Average annual use on lawns, turf, nurseries, etc. in commercial settings decreased from 5 million to 4 million pounds per year (2002, 2004, 2006). Homeowner and aquatic weed control uses have remained fairly constant with average annual uses of 9 to 9.5 million pounds per year (2003, 2005) (US-EPA, 2013e) .

For 2,4-D, the current maximum approved usage rate is 4.0 lbs ae/A per year for asparagus, pome fruits, sugarcane, stone fruits, forestry uses, and non-cropland uses, among others. The maximum rate for aquatic uses is 10.8 lbs ae/acre foot for submerged aquatic plants. Typically, one to three applications are made per growing season. 2,4-D is currently registered in the U.S. for use on corn. The currently approved application rates for field corn and popcorn are a maximum per-year application rate of 3 lbs/acre and a maximum single application rate of 1.5 lbs/acre (US-EPA, 2013e).

2,4-D is approved for use on soybean only for pre-plant burndown application. Application rates on soybean are 0.5 or 1.0 lbs ae/A per application or 1.0 lbs ae/A per crop per year. The herbicide may not be applied any later than 7 to 15 days (0.5–1.0 lb ae/A of ester formulations) or 15 to 30 days (0.5–1.0 lb ae/A of amine formulations) prior to planting due to the potential for crop injury (DAS, 2011a).

Under Section 408 of FFDCA, EPA regulates the levels of pesticide residues that can remain on food or food commodities from pesticide applications (US-EPA, 2010b). The tolerance level is the maximum residue level of a pesticide that can legally be present in food or feed, and if pesticide residues are found to exceed the tolerance value, the food is considered adulterated and may be seized. The EPA establishes tolerances to regulate the amount of pesticide residues that can remain on food or feed commodities as the result of pesticide applications. Table 8-1 shows the current tolerances for residues of 2,4-D established for corn and soybean commodities (US-EPA, 2011a).

**Table 8-1. 2,4-D Tolerances for Corn and Soybean Commodities**

| Commodity | Residue (parts per million) |
|---|---|
| Corn, field, forage | 6.0 |
| Corn, field, grain | 0.05 |
| Corn, field, stover | 50 |
| Soybean, forage | 0.02 |
| Soybean, hay | 2.0 |
| Soybean, seed | 0.02 |

Source: (US-EPA, 2011b)

EPA is currently conducting a registration review of 2,4-D which was begun in 2012 and is currently scheduled to be completed in 2017 (US-EPA, 2013a). As part of their review, a comprehensive ecological risk assessment (US-EPA, 2013d), including an endangered species assessment, will be prepared for all uses of 2,4-D . Additionally, EPA will conduct revised dietary, residential, and occupational risk assessments, incorporating any new toxicological or other relevant data (US-EPA, 2013b). All documents related to the 2,4-D registration review can be viewed at the registration review docket:

http://www.regulations.gov/#!docketDetail;D=EPA-HQ-OPP-2012-0330

### New 2,4-D Choline Salt Formulation and Uses

DAS has developed a new herbicide formulation containing 2,4-D choline salt (DAS, 2010b; DAS, 2010a; DAS, 2011a) for additional pre- and post-emergence use with DAS-40278-9 corn, DAS-68416-4 soybean, and DAS-44406-6 soybean. The 2,4-D-resistance traits allow for a later application of the herbicide in both soybean (R2 stage) and corn (V8 stage). The new formulation is reported to be chemically more stable, making it less volatile, than the currently used amine or ester formulations of 2,4-D. In addition, the new formulation is reported to have minimized potential for physical drift in comparison to the currently used 2,4-D ester and 2,4-D dimethylamine (DMA) formulations, as well as decreased odor and improved handling (DAS, 2011a; DAS, 2011e).

2,4-D choline salt is a quaternary ammonium salt that rapidly dissociates into a 2,4-D anion and a choline cation. 2,4-D choline salt is currently registered on a number of crops including: sugarcane, rice, pome fruits, stone fruits, conventional corn and soybeans, fallow land, turf, and tree and brush control. Dow Agrosciences LLC, the manufacturer and registrant of 2,4-D choline salt, has submitted applications to EPA to add the following uses to the current 2,4-D choline salt labels: 1) DAS-40278-9 corn, 2) DAS-68416-4 soybean, 3) Enlist™ corn (DAS-40278-9 corn stacked with a glyphosate-resistance trait), and Enlist™ soybean (DAS-68416-4 soybean stacked with a glyphosate-resistance trait).

Two of the proposed registrations contain only 2,4-D choline salt as the active ingredient, whereas the other two labels are for a 2,4-D-choline salt/glyphosate mixture which DAS plans to market under the name Enlist Duo™. The latter would allow applications to GE herbicide-resistant corn and soybean with resistance to both 2,4-D and glyphosate. The 2,4-D choline formulation GF-2654 TS would be used on DAS 68416-4 soybean and the 2,4-D choline formulation GF-2654 TC used on DAS-40278-9 corn. The Enlist Duo™ formulations GF-2726 and GF-2727, containing both 2,4-D choline salt and glyphosate, would be applied on Enlist™ corn and Enlist™ soybean, respectively.

### Proposed New 2,4-D Use on Corn

Although 2,4-D is already used on corn, its use is limited beyond early seedling stages (Wright *et al.*, 2010). Applications of 2,4-D as a post-emergent herbicide at later growth stages in conventional corn can cause significant malformations (Wright *et al.*, 2010). The proposed new use of 2,4-D choline on DAS-40278-9 corn includes a pre-emergent and up to two post-emergent applications (DAS, 2011b). Table 8-2 compares the current the use patterns for 2,4-D on field corn with the proposed use patterns for 2,4-D on DAS-40278-9 corn. The comparison is also shown graphically in Figure 8-1.

The label directions indicate no more than one pre-emergence application and no more than two post-emergence applications per use season. Proposed application rates for this new use of 2,4-D on DAS-40278-9 corn are up to 1 lb acid equivalent (ae)/acre (1,120 g ae/ha) as a pre-emergent herbicide and up to two applications between 0.5 to 1.0 lbs ae/acre (560 and 1,120 g ae/ha) for post-emergence. The post-emergence applications must be at a minimum of 12-days apart during the first 3-5 weeks before the corn reaches 6-8 inches in height and again up to the V8 [48-inch] stage of corn. These application rates are based on the currently approved rates for field corn and popcorn, which establish a maximum-per-year application rate of 3 lbs/acre, and a maximum single application rate of 1.5 lbs/acre (DAS, 2011f). Post-emergence application of 2,4-D, as specified on the draft label, could not occur within 30 days of forage harvest. The proposed preharvest interval (PHI) for corn is 30 days. Applications are to be made using groundboom equipment. Aerial application and chemigation are prohibited. The new use pattern and draft label are subject to regulatory approval by EPA.

**Table 8-2: Comparison of Current and Proposed Application Rates for 2,4-D on Corn**

| **Crop Stage** | **Conventional Field Corn** | | **Proposed New Use on DAS-40278-9 Corn** | |
|---|---|---|---|---|
| | **Maximum Application Rate (lb/acre)[1,2]** | **Directions and Timing** | **Maximum Application Rate (lb/acre)[1,2]** | **Directions and Timing** |
| Pre-plant or Pre-emergence | 1.0 | Apply before corn emerges to control emerged broadleaf weed seedlings or existing cover crops | 1.0 | Apply before corn emerges to control emerged broadleaf weed seedlings or existing cover crops |
| Post-emergence | 0.5 | Apply when weeds are small and corn is less than 8 inches tall (to top of canopy). When corn is over 8 inches tall, use drop nozzles and keep spray off foliage. | 0.5 to 1.0 | Apply after crop and weed emergence but before corn exceeds growth stage V8 or 48” in height, whichever occurs first. Make 1 to 2 applications with a minimum of 12 days between applications. |
| Pre-harvest | 1.5 | Apply after hard dough (or at denting) stage. | --- | --- |
| **Total Annual Maximum Application** | 3.0 | --- | 3.0 | --- |

Source: (DAS, 2011f)

1. All values expressed as acid equivalents.
2. 1 lb/acre is the equivalent of 1,120 g/hectare.

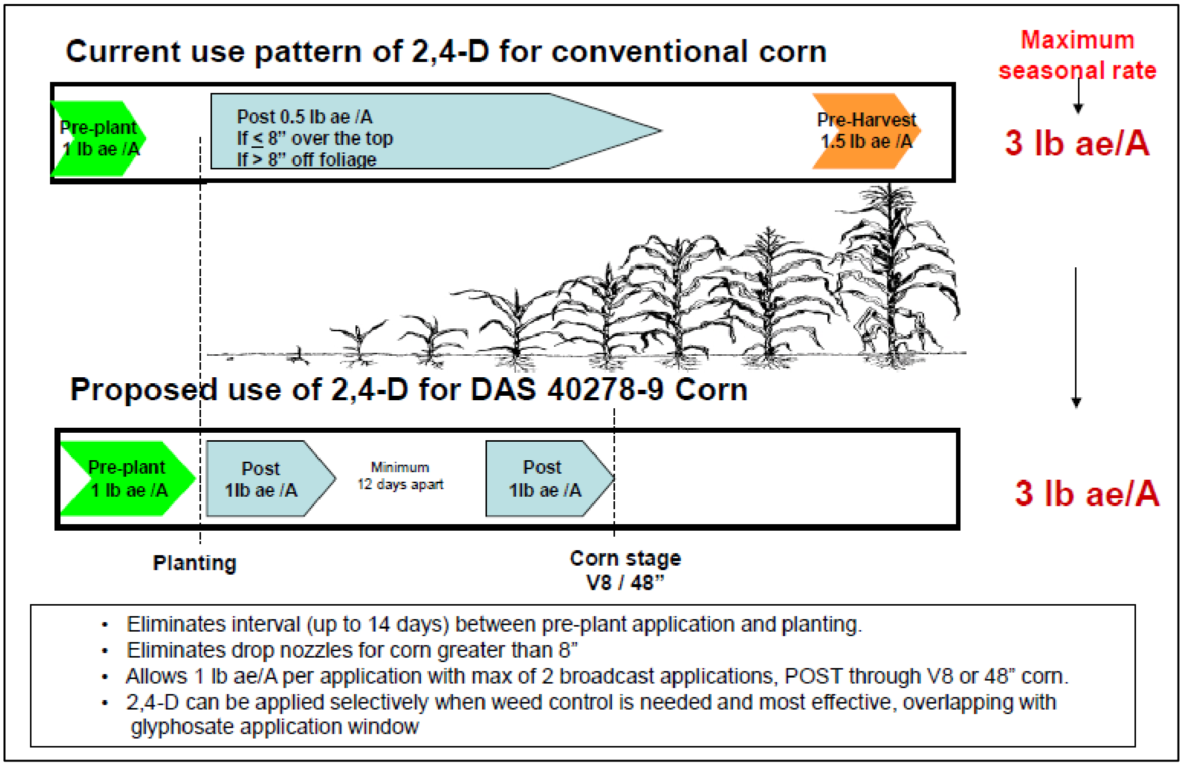


**Figure 8-1. Current use pattern of 2,4-D on conventional corn and proposed new use of 2,4-D choline salt on DAS-40278-9 corn**

Source: (DAS, 2012b).

### New 2,4-D Use on Soybean

Currently, 2,4-D is approved for use on soybean only for pre-plant burndown application. Application rates on soybean are 0.5 or 1.0 lbs ae/A per application or 1.0 lbs ae/A per crop per year (US-EPA, 2005b). It may not be applied any later than 7 to 15 days (0.5–1.0 lb ae/A of ester formulations) or 15 to 30 days (0.5–1.0 lb ae/A of amine formulations) prior to planting due to the potential for crop injury (DAS, 2010b).

The proposed new use of 2,4-D choline on DAS-68416-4 soybean (or DAS-44406-6 soybean) includes a single pre-plant or pre-emergent application and up to two post-emergent applications (DAS, 2011b). Specifically, an application of 2,4-D at pre-plant/burndown or pre-emergence (1.0 lb ae/A) without plant back restrictions would be allowed and/or one or two over-the-top post-emergence applications (0.5 - 1.0 lb ae/A) at least 12 days apart up to the R2 stage (full flower) of development (see Figure 8-2) (DAS, 2010b). Thus, the proposed maximum total seasonal application rate of 2,4-D on DAS-68416-4 soybean (or DAS-44406-6 soybean) would increase from 1.0 lb ae/A (current) to 3.0 lb ae/A per year. (This proposed new seasonal rate is the same current EPA-approved maximum annual use rate of 2,4-D for popcorn and field corn). Post-emergence application of 2,4-D, as specified on the draft label, could not occur within a PHI of 30 days (DAS, 2011a; DAS, 2011c). The new use pattern and draft label are subject to regulatory approval by EPA. Table 8-3 presents a comparison of the current and proposed application rates of 2,4-D on soybean and DAS-68416-4 (or DAS-44406-6 soybean) (DAS, 2010b).

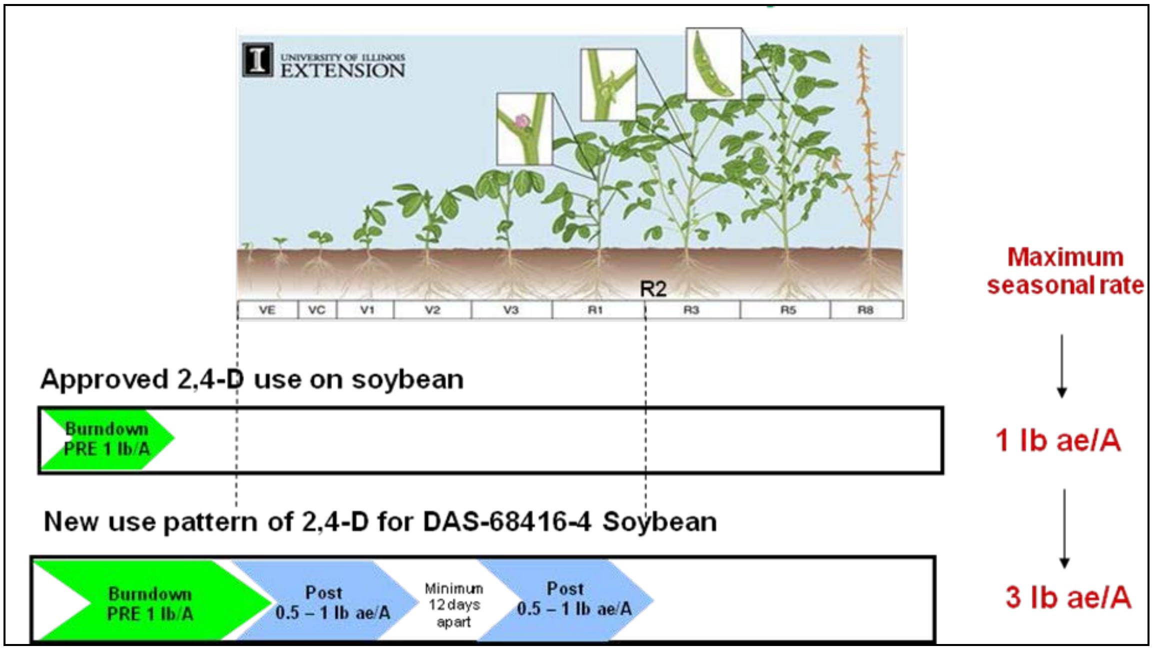


**Figure 8-2. Proposed 2,4-D Application Rates on DAS-68416-4 Soybean Compared to Current Application Rates Permitted for Conventional Soybean**

Source: (DAS, 2010b).

Note: the new 2,4-D use pattern would be the same for DAS-44406-6 soybean.

**Table 8-3. Comparison of Current and Proposed Application Rates of 2,4-D on Soybean**

| | Current Use Pattern - Conventional Soybean | | Proposed New Use Pattern – DAS-68416-4 Soybean (or DAS-44406-6 Soybean) | |
|---|---|---|---|---|
| **Crop Stage** | **Maximum Application Rate (lb/acre)[1]** | **Directions and Timing** | **Maximum Application Rate (lb/acre)[1]** | **Directions and Timing** |
| Pre-plant (burndown) or Pre-emergence | 0.5 -1.0 | **Pre-plant:** Apply before soybean emerges to control emerged broadleaf weed seedlings or existing cover crops | 1.0 | **Pre-plant:** Apply any time prior to and up through soybean planting but before soybean emerges to control emerged broadleaf weed seedlings or existing cover crops. **Pre-emergence:** Apply any time after planting but before soybean emerges to control broadleaf weed seedlings or existing cover crops. |

| Crop Stage | Current Use Pattern - Conventional Soybean | | Proposed New Use Pattern – DAS-68416-4 Soybean (or DAS-44406-6 Soybean) | |
|---|---|---|---|---|
| | Maximum Application Rate (lb/acre)[1] | Directions and Timing | Maximum Application Rate (lb/acre)[1] | Directions and Timing |
| Post-emergence | --[2] | -- | 0.5-1.0 | Apply when weeds are small and soybean growth stage is no later than R2 (full flowering stage). Make one to two applications with a minimum of 12 days between applications. |
| **Total Annual Maximum Application** | 1.0 | -- | 3.0 | -- |

[1] All values expressed as acid equivalents

[2] Not applicable

Source: (DAS, 2011c).

**EPA Assessments of Proposed New 2,4-D Choline Salt Formulation and Uses on 2,4-D-Resistant Corn and Soybean**

Under FIFRA, EPA regulates the use of herbicides, requiring registration of a pesticide for a specific use prior to distribution or sale of the pesticide for a proposed use pattern. The process of registering a pesticide is a scientific, legal, and administrative procedure through which EPA examines the ingredients of the pesticide; the particular site or crop on which it is to be used; the amount, frequency, and timing of its use; and storage and disposal practices. In evaluating a pesticide registration application, EPA assesses a wide variety of potential human health and environmental effects associated with use of the product. Prior to registration for a new use for a new or previously registered pesticide, the producer of the pesticide must provide data from tests done according to EPA guidelines. EPA must determine through this submitted test data that the pesticide will not cause unreasonable adverse effects on the environment and non-target species when used in accordance with label instructions and will result in a reasonable certainty of no harm to humans.

EPA must also approve the language used on the pesticide label in accordance with 40 CFR part 158. The EPA pesticide registration process involves the design of use restrictions that, if followed, have been determined to be protective of worker health. Growers are required to use pesticides consistent with the application instructions provided on the EPA-approved pesticide labels. The overall intent of the label is to provide clear directions for effective product performance while minimizing risks to human health and the environment (US-EPA, 2010c).

Based on the studies submitted on 2,4-D choline salt formulation by DAS, EPA has conducted draft assessments on the potential environmental fate, ecological effects, and human health effects of the proposed new uses of 2,4-D choline salt (US-EPA, 2013d; US-EPA, 2013c; US-EPA, 2013b) . The conclusions from those assessments are summarized in this section. EPA has published these complete draft analyses in the Federal Register for public comment between April 30-June 30, 2014.

### Environmental Fate and Ecological Risks

EPA Environmental Fate and Effects Division (EFED) assessed the ecological risks to listed and non-listed species associated with the proposed new uses of 2,4-D choline salt on 2,4-D-resistant corn and soybean. The assessment examined the effects of 2,4-D choline salt (and 2,4-DCP, when relevant) on aquatic and terrestrial environments primarily through the routes of spray drift, volatile (vapor) drift, and runoff. Modeled application rates represent the maximum use patterns of the proposed labels for use on 2,4-D-resistant corn and soybean.

The results are summarized as follows:

No potential direct risks from the proposed applications of 2,4-D choline salt to herbicide-tolerant corn and soybeans were identified for the following:

- Birds (chronic),
- Aquatic plants,
- Freshwater fish (acute and chronic),
- Estuarine/marine fish (acute and chronic),
- Freshwater invertebrates (acute and chronic),
- Estuarine/marine invertebrates (acute and chronic),
- Aquatic plants, and
- Terrestrial insects.

The screening level risk assessment for non-listed species identified these groups as being potentially at direct risks from exposures from the proposed new uses of 2,4-D choline salt:

- Mammals (acute and chronic),
- Birds, reptiles, terrestrial-phase amphibians (acute), and
- Terrestrial plants.

In addition, the screening level risk assessment identified all non-listed taxa as potentially at indirect risks from the proposed uses of 2,4-D choline salt because of potential dependencies (e.g., food, shelter, habitat) on species that are directly affected. Information, such as biological distribution, species biology, spray drift properties specific to the 2,4-D choline formulations, and mitigation efforts in regions where the pesticide is used, could be used to reduce the uncertainty regarding potential direct and indirect effects.

An assessment of the direct and indirect risks to listed species for which a risk was identified in the screening level assessment has been completed by EPA. This assessment addressed the specific geographical and biological characteristics of each species potentially at risk from exposures to 2,4-D. EPA has completed the ESA assessment for all species in the action area, reaching a 'no effect' on all but a few species. EPA continues to refine the exposure assessment applying exposure reduction measures such as buffers to further refine their assessment in an effort to further reduce the risk with a goal of reaching a "no effect".

A spray drift analysis using the GF2726 formulation indicated that buffers could reduce risk quotients for birds (acute), mammals (acute and chronic), and terrestrial plants below the Agency's levels of concern. The results of the buffer analysis indicated that risks below levels of concern can only be achieved through the combination of the AIXR 11004 nozzle and GF-2726 formulation. Final species-specific buffer distances remain under review and refinement. The locations of the buffers would be dependent on species distribution, species biology, and any mitigation efforts proposed by the registrant.

EPA published these complete draft analyses in the Federal Register for public comment from April 30-June 30, 2014 (US-EPA, 2013d; US-EPA, 2013c; US-EPA, 2013b).

### Human Health Risk Assessment

The EPA Health Effects Division (HED) of the Office of Pesticide Programs (OPP) is charged with estimating the risk to human health from exposure to pesticides. HED evaluated hazard and exposure data and conducted dietary, residential (non-occupational), aggregate, and occupational exposure assessments to estimate the risk to human health that will result from the proposed new use of 2,4-D choline salt on 2,4-D-resistant corn and soybean. Based on their draft human health risk assessment, EPA HED recommends for a registration for the use of 2,4-D choline on 2,4-D-resistant corn and soybean. EPA identified additional data needed, specific tolerance recommendations, and label modifications. A summary of the results of the assessment are provided, below. The draft assessment has been published by EPA in the Federal Register for public review and comment (US-EPA, 2013c).

***Hazard Characterization:*** Based on its review of hazard data, EPA concluded that 2,4-D's principal toxic effects are changes in the kidney, thyroid, liver, adrenal, eye, and ovaries/testes in the rat following exposure *via* the oral route at dose levels above the threshold of saturation of renal clearance. No systemic toxicity was observed in rabbits following repeated exposure *via* the dermal route at dose levels up to the limit dose. Neurotoxicity was observed in the acute neurotoxicity study in rats at the high dose. In an extended 1-generation reproductive toxicity study in rats, reproductive toxicity, developmental neurotoxicity, and immunotoxicity were not observed, and the thyroid effects observed at dose levels up to/approaching renal saturation were considered treatment-related, although not adverse. Maternal and developmental toxicity were observed at high dose levels exceeding the threshold of saturation of renal clearance. There are no residual uncertainties for pre- and/or postnatal toxicity. 2,4-D is not acutely (lethal) toxic via the oral, dermal, and inhalation routes, is not a dermal irritant or a dermal sensitizer, but it is a severe eye irritant. 2,4-D has been classified as a Category D chemical, i.e., not classifiable as to human carcinogenicity.

***Dietary Exposure and Risk Assessment:*** Acute and chronic aggregate (food + dietary drinking water) exposure and risk assessments were conducted for the new proposed use of 2,4-D choline salt. EPA HED determined that the resulting acute food plus drinking water risk estimates are not of concern to (≤100% of the acute population adjusted dose (aPAD)) at the 95$^{th}$ percentile of the exposure distribution for the general population and all population subgroups. The resulting acute risk estimate for children 1 to 2 years old (the subgroup with the greatest exposure) was 14% of the aPAD at the 95$^{th}$ percentile of the exposure. The resulting chronic risk estimates are not of concern to EPA HED for the general population and all population subgroups. The most highly exposed population was children 1 to 2 years old, utilizing 15% of the chronic PAD (cPAD).

***Residential (Non-Occupational) Exposure and Risk Assessment:*** There is no potential hazard *via* the dermal route for 2,4-D, therefore the handler assessment included only the inhalation route of exposure and the post-application assessment included only the inhalation and incidental oral route of exposure. The residential handler and post-application risk estimates are not of concern for 2,4-D for all scenarios and all routes of exposure.

Exposure to drift and volatilization, and the appropriate available data, were considered in this assessment due to the anticipated market expansion. Concerning spray drift, the residential post-application exposure assessment for registered use as direct application to turf is protective of potential deposition on turf from spray drift for the proposed use of 2,4-D choline on herbicide-tolerant corn and soybean. The potential exposure to vapor phase 2,4-D residues emitted from treated fields for the proposed uses of 2,4-D choline has been evaluated in this assessment. The results indicate that volatilization of 2,4-D from treated crops does occur and could result in bystander exposure to vapor phase 2,4-D. Modeling results, however, indicate that airborne concentrations, even at the edge of the treated fields, are not of concern.

***Aggregate Risk Estimates:*** The acute aggregate risk assessment include only food and water exposure. The resulting acute food plus drinking water risk estimates are not of concern to EPA HED (≤100% aPAD) at the 95$^{th}$ percentile of the exposure distribution for the general population and all population subgroups.

The short-term aggregate risk assessment includes food, water, and residential exposure. According to EPA HED, the resulting short-term aggregate risks are not of concern (margins of exposure (MOEs) > level of concern (LOC) of 100) for adults and children.

There are no intermediate-term residential exposure to 2,4-D; therefore the intermediate-term aggregate risk assessment include only food and drinking water exposure. Furthermore, the chronic aggregate risk assessment includes only food and water exposure. The chronic food plus drinking water risk estimates are not of concern to EPA HED for the general population and all populations subgroups.

***Occupational Exposure and Risk Assessment:*** Occupational handlers may apply 2,4-D choline with groundboom equipment. There is no potential hazard *via* the dermal route for 2,4-D, therefore the occupational handler assessment included only the inhalation route of exposure. Occupational handler inhalation risk estimates are not of concern (i.e., MOEs > LOC of 300) for all scenarios for use of 2,4-D choline on herbicide-tolerant corn and soybean. At baseline personal protective equipment (PPE) (i.e., no respirator), the occupational handler inhalation MOE is 4,900 for mixer/loaders and 3,200 for applicators using groundboom equipment.

There is no potential hazard via the dermal route for 2,4-D; therefore, a quantitative occupational post-application dermal risk assessment was not completed. Furthermore, a quantitative post-application inhalation risk assessment was not performed for workers at this time; although the assessment was not performed, other exposure scenarios are expected to be protective of potential worker post-application inhalation exposure. The minimum Worker Protection Standard (WPS) restricted entry interval (REI) of 48 hours is adequate to protect agricultural workers from post-application exposures to 2,4-D.

## Glyphosate

### Background and Current Uses

Glyphosate acid is a broad spectrum, nonselective systemic herbicide widely used to control most annual and perennial grass and broadleaf weeds in agricultural crops and non-agricultural sites. The herbicide is registered for pre- and post-emergence application on a variety of fruit, vegetable, and field crops, as well as for aquatic and terrestrial uses. Labeled uses of glyphosate include over 100 terrestrial food crops as well as other non-food sites including forestry, greenhouse, non-crop, and residential. Glyphosate can also be used as a plant growth regulator and accelerate fruit ripening. Additionally, glyphosate is registered for use on GE glyphosate-resistant crops, including canola, corn, cotton, soybeans, alfalfa, and sugar beets. Glyphosate is the most widely used herbicide on U.S. corn and soybean.

Glyphosate was first introduced under the trade name of Roundup™ by Monsanto in 1974. Glyphosate salts serve as the source of the active ingredient (ai) *N*-(phosphonomethyl) glycine and improve handling, performance, and concentration of the glyphosate acid. Glyphosate is distributed in several forms, including technical grade glyphosate, isoproplyamine salt, monoammonium salt, diammonium salt, N-methylmethanamine salt , trimethylsulfonium salt, or potassium salt (US-EPA, 2009c). Isopropylamine salt is the most typically used form in formulated products (Henderson, 2010).

Glyphosate acid is a nonselective Group 9 herbicide and kills plants by inhibiting the 5-enolpyruvylshikimate-3-phosphate synthase (ESPS) enzyme. This enzyme is essential for the biosynthesis of aromatic amino acids (e.g., tyrosine, tryptophan, and phenylalanine) and other aromatic compounds in algae, higher plants, bacteria and fungi. By creating a deficiency in EPSP enzyme and aromatic amino acids production, glyphosate affects protein synthesis and plant growth (US-EPA, 2009c). Glyphosate is absorbed across the leaves and stems of plants and moves throughout the plant, concentrating in the meristem tissue (Henderson, 2010).

Based on pesticide usage data from USDA-NASS, private pesticide market research, and California Department of Pesticide Regulation (DPR), EPA estimated glyphosate usage from 2004 through 2011. The crops with the highest glyphosate uses (based on average treated fraction of acreage) were: almond (85%), apples (55%), apricots (55%), asparagus (55%), avocados (45%), barley (20%), blueberries (20%), canola (65%), cherries (65%), corn (60%), cotton (85%), cucumbers (20%), dates (20%), dry beans/peas (25%), fallow (55%), figs (40%), grapefruit (80%), grapes (70%), hazelnuts (70%), kiwifruit (30%), lemons (70%), nectarines (45%), olives (45%), onions (30%), oranges (90%), peaches (55%), peanuts (20%), pears (65%), pecans (35%), peppers (20%), plums (65%), pumpkins (20%), rice (25%), sorghum (40%), soybeans (95%), squash (20%), sugar beets (50%), sugarcane (45%), sunflowers (55%), tangelos (55%), tangerines (65%), tomatoes (35%), walnuts (75%), and wheat (25%). All other treated crops averaged 15% or less of the total acreage grown (US-EPA, 2012e).

The CP4 EPSPS protein confers resistance to glyphosate and has been used in many Roundup Ready™ crops (e.g., canola, corn, cotton, soybean, and sugar beet). Glyphosate may be used premergent, preplant incorporated, or postemergent with Roundup Ready™ crops. As listed on the Roundup™ herbicide labels, Roundup Original MAX™, Roundup WeatherMAX™, and Roundup PowerMAX™ products contain 48.8 percent of the potassium salt of glyphosate, equivalent to 4.5 lb of glyphosate ae per gallon (540 g glyphosate per liter (L)). Glyphosate is also commonly used in conjunction with many other herbicides as a tank mix for both pre-plant/pre-emergence weed control up through the 12-leaf stage or until the corn reaches a height of 30 inches (see, e.g., Loux *et al.*, 2011).

The current approved maximum pre-emergence application of glyphosate on glyphosate-resistant corn or soybeans is 3.7 lbs ae/acre. A glyphosate post-emergence application from 0.75 to 1.5 lbs ae/acre (total 2.25 lbs/acre/season post-emergence) and an additional pre-harvest application of 0.77 lbs/ae/acre are permitted. The current maximum total seasonal use rate for glyphosate on glyphosate-resistant corn and soybean is 6 lbs ae/acre (DAS, 2012c).

Pesticide residue tolerances for glyphosate are listed in 40 CFR Part 180.364, representing combined residues of glyphosate, N-(phosphonomethyl)glycine and its metabolite N-acetyl-glyphosate (expressed as glyphosate) (US-EPA, 2010a). Table 8-4 shows the current tolerances for residues of glyphosate established for corn and soybean commodities.

**Table 8-4. Glyphosate Tolerances for Corn and Soybean Commodities**

| Commodity | Residue (parts per million) |
|---|---|
| Corn, field, forage | 13 |
| Corn, field, grain | 5 |
| Corn, field, stover | 100 |
| Soybean, forage | 100 |
| Soybean, hay | 200 |
| Soybean, hulls | 120 |
| Soybean, seed | 20 |

Source: (US-EPA, 2010a).

EPA is currently conducting a registration review of glyphosate which was begun in 2009 and is currently scheduled to be completed in 2015 (US-EPA, 2009b). According to EPA, as part of their review, "the Agency plans to require a number of ecological fate and effects studies, an acute and subchronic neurotoxicity study, and an immunotoxicity study through a data call-in, which is expected to be issued in 2010. The new information will be used to conduct a comprehensive ecological risk assessment, including an endangered species assessment, as well as a revised occupational human health risk assessment, for all glyphosate pesticidal uses (US-EPA, 2009b)."

All documents related to the glyphosate registration review can be viewed at the registration review docket:

http://www.regulations.gov/#!docketDetail;D=EPA-HQ-OPP-2009-0361

### Glyphosate Use on DAS-40278-9 Corn, DAS-68416-4 Soybean, and DAS-44406-6 Soybean

DAS' new pre-mix of 2,4-D choline and glyphosate DMA, the Enlist™ Duo formulations GF-2726 and GF-2727, will be formulated as an approximate 1:1 ratio of 2,4-D choline to glyphosate DMA. If approved by EPA, glyphosate could be applied to Enlist™ Corn and Enlist™ Soybean (DAS-40278-9 corn and DAS-68416-4 soybean stacked with a glyphosate-resistance trait (or DAS-44406-6 soybean) at pre-plant/burndown at 0.5 to 1.0 lb ae/acre and up to two post-emergence applications at 0.5 to 1.0 lb ae/, for a maximum total seasonal application rate of 3.0 lb ae/acre. This compares to current glyphosate use on glyphosate-resistant corn and soybeans of a maximum pre-emergence application of 3.7 lbs ae/acre and post-emergence applications from 0.75 to 1.5 lbs ae/acre (total 2.25 lbs/acre/season post-emergence) and an additional pre-harvest application of 0.77 lbs/ae/acre. The current maximum total seasonal use rate for glyphosate on glyphosate-resistant corn and soybeans is 6 lbs ae/acre (DAS, 2011f; DAS, 2012a).

## Quizalofop

### Background and Current Uses

Quizalofop-p-ethyl is a selective, systemic post-emergence phenoxy herbicide that is toxic to many annual and perennial grasses. It belongs to a subclass of phenoxy compounds known as aryloxyphenoxys ("fops"). Quizalofop-p-ethyl is absorbed from the leaf surface and is moved throughout the plant. It accumulates in the active growing regions of stems and roots. Most non-graminaceous plants (dicots and sedges) are tolerant to quizalofop. Dicotyledonous (or dicot) plants contain a prokaryotic form of ACCase (an enzyme found in chloroplasts) which is insensitive to "fop" herbicides. In contrast, monocotyledonous (or monocot) plants contain a sensitive eukaryotic form of ACCase in the plastid (DAS, 2010a). This is the primary reason that the "fop" herbicides are generally good graminicides[1], with little activity on dicot plants. In addition, some grass species, including some cereal crops and weeds (e.g., annual bluegrass and wild oats), are tolerant of some of these herbicides (i.e., clethodim, quizalofop, and others) due to their ability to metabolize the herbicides to inactive forms (Devine and Shukla, 2000; Powles and Preston, 2009).

The aryloxyphenoxypropionates (AOPP) herbicides inhibit chloroplastic ACCase, which catalyzes the first committed step in fatty acid biosynthesis, causing plant death (Burton *et al.*, 1989). The herbicidal activity of quizalofop-ethyl ester was first reported in 1983, and quizalofop-ethyl was first approved for use in a registered herbicide product in the U.S. in 1988 (DAS, 2010a; DuPont, 2010).[2] However, all end use product registrations were cancelled prior to 1996 and it was replaced by the more active quizalofop-P-ethyl (pure R-enatiomer of quizalofop racemic mixture), which first was approved for use in a registered product in 1990 (DuPont, 2010).

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[1] A graminicide is an herbicide used for the control of grass weeds (of the former family "Gramineae').'

[2] Reference to the DuPont Assure® II label is for illustration only, and is not intended to infer any recommendation for the use of this product by APHIS or the USDA.

The “fop” herbicides (AOPP ACCase inhibitors) have been registered for crop use for more than 20 years (USDA-APHIS, 2010). The “fop” herbicides traditionally have not been used to control weed species in cornfields because, as a grass (Poaceae family) species, corn is damaged by AOPP ACCase inhibitor activity. The registration and use of “fop” herbicides has been primarily on broadleaf crops, such as soybean, to control grass weed species, although certain cereal plant varieties have a level of tolerance to some “fops” (see DuPont, 2010). According to the USDA-NASS Agricultural Chemical Use Database, “fop” type herbicides were used for weed control on at least 23 food crop species between 1990 and 2006, totaling more than 16 million pounds of active ingredient (USDA-NASS, 2011).

The currently registered uses include canola, crambe, cotton, crops grown for seed, eucalyptus, dry beans (including Chickpea), dry and succulent peas, flaxseed, hybrid poplar plantings, lentils, mint (spearmint and peppermint), pineapple, ryegrass grown for seed, snap beans, soybeans, sugar beets, sunflowers, and noncrop areas. Current allowable rates for this herbicide vary from 0.0172 to 0.344 lb ai/acre, depending on crop and weed conditions (see EPA approved label for Assure II) (DAS, 2010a; DuPont, 2010).

Pesticide residue tolerances for quizalofop are listed in 40 CFR Part 180.441. As quizalofop is not currently approved by EPA for use on corn, only residue limits for soybean commodities are shown in Table 8-5, representing combined residues of combined residues of quizalofop ethyl, quizalofop, and quizalofop methyl (US-EPA, 2012b).

**Table 8-5. Quizalofop Tolerances for Soybean Commodities**

| Commodity | Residue (parts per million) |
|---|---|
| Soybean, flour | 0.5 |
| Soybean, hulls | 0.02 |
| Soybean, meal | 0.5 |
| Soybean, seed | 0.05 |
| Soybean, soapstock | 1.0 |

Source: (US-EPA, 2012b)

Note: quizalofop is not currently approved for uses on corn.

The Registration Review for quizalofop was begun in 2007 and a final workplan was completed in June of 2008. EPA has not published a proposed decision schedule for quizalofop as of this assessment:
http://www.epa.gov/oppsrrd1/registration_review/schedule.htm

Documents related to the EPA review are posted as part of the Registration Review of Quizalofop-ethyl (128711) and quizalofop-p-ethyl (128709) docket (EPA-HQ-OPP-2007-1089):

http://www.regulations.gov/#!docketDetail;D=EPA-HQ-OPP-2007-1089

### New Use of Quizalofop on DAS-40278-9 Corn

DAS-40278-9 corn is a GE corn line that has increased resistance to treatment with phenoxy auxin herbicides (e.g., 2,4-D) and resistance to AOPP ACCase inhibitor (“fop”) herbicides (DAS, 2010a). DAS has indicated that “fop” herbicides could be used to maintain seed purity in DAS-40278-9 corn breeding nurseries, hybrid production fields, and generally for the control of grass weeds in corn. As quizalofop is not currently registered for use as a post-emergent herbicide on corn, this is a proposed new use (DAS, 2010a).

Quizalofop-P ethyl is the active ingredient in DuPont Assure II™ herbicide (EPA Reg. No. 352-541). DuPont has submitted petitions to EPA to add the new use of quizalofop on DAS-40278-9 corn. Since most grass crops, including corn, are highly sensitive to the herbicide, quizalofop could only be used on field corn that has been GE to be resistant to the herbicide, such as DAS-40278-9 corn.

DuPont proposes a maximum single application rate of 0.082 lb ai/acre corn (DAS, 2011f). The proposed maximum application rate also is the seasonal maximum application rate (DAS, 2011f). The proposed PHI is 30 days for forage; a PHI for corn grain or stover is not specified (US-EPA, 2011). This maximum application rate is less than that currently approved by EPA for use of quizalofop for the control of grassy weeds in soybeans and cotton, where a seasonal maximum application rate of 139 g ai/ha (0.124 lb ai/acre) is approved (DAS, 2011f). Applications of quizalofop would be made by broadcast foliar application by ground; aerial applications would be prohibited. EPA currently is reviewing the proposed label change for quizalofop and has not granted the registration yet. Table 8-6 provides a summary of the proposed application rates and directions for use on DAS-40278-9 corn.

**Table 8-6. Comparison of Current and Proposed Application Rates for Quizalofop**

| **Crop Stage** | **Current Use Pattern for Quizalofop on Soybeans and Cotton** | | **Proposed New Use on DAS-40278-9 Corn** | |
|---|---|---|---|---|
| | **Maximum Application Rate (lb/acre)[1,2]** | **Directions and Timing** | **Maximum Application Rate (lb/acre)[1,2]** | **Directions and Timing** |
| Post-emergence | 0.082 | Apply 0.034 to 0.082 lb/acre per application. Do not exceed a total of 0.124 lb/acre per season. | 0.034 to 0.082 | Apply 0.034 to 0.082 lb/acre per application from V2 – V6 Growth stages. Do not make more than 2 applications. Do not exceed a total of 0.082 lb/acre per season. Do not apply later than V6 growth stage. |
| **Total Annual Maximum Application** | 0.124 | --- | 0.082 | --- |

Source: (DAS, 2011f).

Notes:

1. Active ingredient.
2. 1 lb/acre is the equivalent of 1,120 g/hectare.

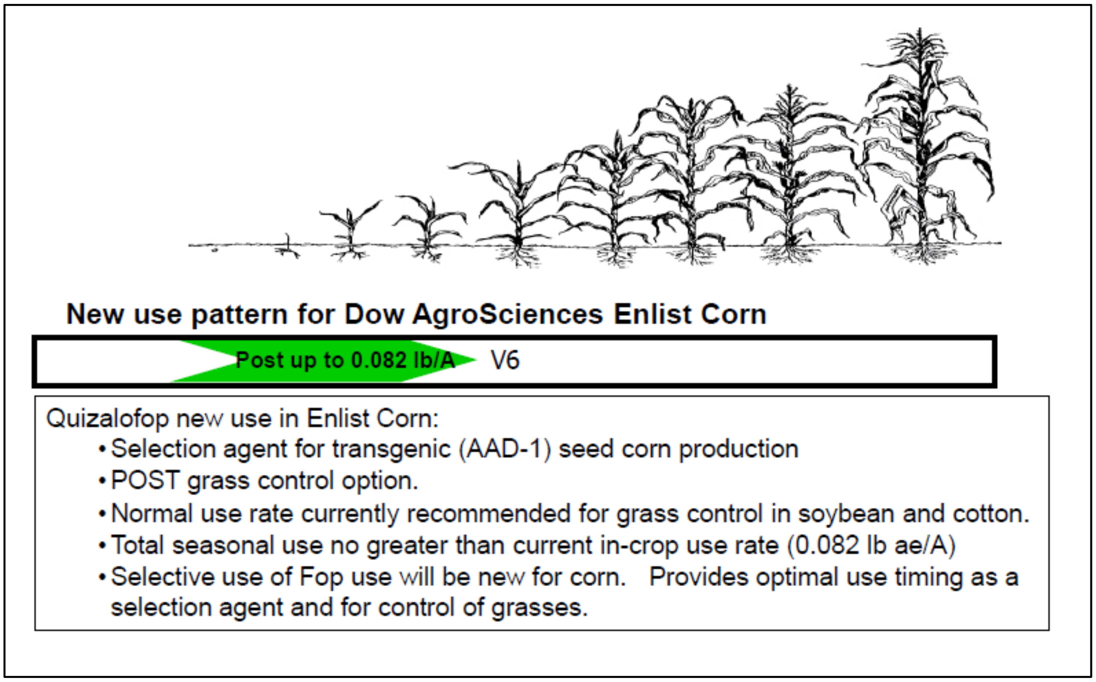


**Figure 8-3. Proposed Quizalofop Application Rate on DAS-40278-9 Corn**
Source: (DAS, 2010b).

### EPA Assessments of Proposed New Use of Quizalofop on DAS-40278-9 Corn

#### Environmental Fate and Ecological Risks

As part of the approval process, EPA EFED performed a screening level ecological risk assessment for listed and non-listed species for the proposed label for quizalofop. The screening-level analysis for quizalofop-p-ethyl concluded that the proposed new agricultural use for quizalofop shows the possibility for direct effects to mammals (chronic dose-based risk), and terrestrial monocots. Direct risks were also assumed for aquatic vascular plants, and estuarine/marine fish (acute) because of an absence of data. Chronic risks were assumed for terrestrial birds because of nondefinitive toxicity endpoints. Since birds serve as surrogates for terrestrial-phase amphibians and reptiles, these taxa may also be at direct risk from the new uses of quizalofop-p-ethyl. Indirect effects were determined by assessing the potential for reduction of prey base or habitat modification of listed taxa. Given that monocots are at risk, there is the potential for habitat modification to indirectly affect all listed taxa. On July 14, 2014 EPA issued a Proposed Interim Registration Review Decision for quizalofop (US-EPA, 2014). The Agency's final registration review decision for quizalofop will be issued once an ESA Section 7 consultation with the Fish and Wildlife Services has taken place and an Endocrine Disruptor Screening Program FFDCA section 408(p) determination has been made (US-EPA, 2014).

#### Human Health Risk Assessment

EPA HED evaluated hazard and exposure data, as well as dietary, residential (non-occupational), occupational, and aggregate exposures to estimate the risk to human health that could potentially result from the proposed new use of quizalofop on DAS-40278-9 corn. Based on their draft human health risk assessment, EPA HED recommends for a registration for the use of quizaolfop on DAS-40278-9 corn. EPA identified additional data needed, specific tolerance recommendations, and label modifications. A summary of the results of the assessment are provided, below. The draft assessment will be published by EPA in the Federal Register for public review and comment.

***Hazard Characterization:*** Quizalofop ethyl has low acute toxicities via the oral, dermal, and inhalation routes. It is not an eye or dermal irritant nor a skin sensitizer. Following oral administration, quizalofop ethyl is rapidly absorbed and excreted via urine and feces. Liver is the target organ as evidenced by increased liver weight and histopathological changes in the liver.

There were no effects observed in oral toxicity studies that could be attributable to a single-dose exposure. Hence, a dose and endpoint have not been selected for assessment of acute exposure. Similarly, there was no observed toxicity in a dermal subchronic study at the highest dose tested (above the limit dose) so no dermal risk assessment is needed. Inhalation toxicity studies for occupational exposure assessment are waived based on the low exposure expected by the current and proposed use patterns. A chronic reference dose (cRfD) was established based on a combined chronic toxicity/carcinogenicity study in rats. Mutagenicity studies conducted on quizalofop ethyl did not demonstrate evidence of mutagenic potential. The Cancer Peer Review Committee determined that quizalofop ethyl should be classified as Category D (not classifiable as to human carcinogenicity). As such, a cancer risk assessment was not conducted.

Developmental studies in rats and rabbits and a two-generation reproduction study in rats showed no evidence (qualitative or quantitative) for increased susceptibility following *in utero* and/or pre/post-natal exposure to quizalofop ethyl.

***Dietary Exposure and Risk Assessment:*** An acute dietary risk assessment was not performed, as an acute endpoint was not identified in the hazard assessment. Similarly no cancer risk assessment was needed, as quizalofop ethyl was not classifiable with regard to carcinogenicity.

A chronic dietary exposure assessment was conducted using the maximum application rate per season for quizalofop ethyl on dry peas in Michigan. Under this scenario, children (1-2 years) were found to have the maximum chronic dietary risk at 29 percent of the chronic population adjusted dose (cPAD). This is well below HED's level of concern of 100% of cPAD.

***Residential Risk:*** Quizalofop ethyl has no registered homeowner or ornamental uses and none are being proposed.

***Aggregate Risk Estimates:*** Aggregate risk estimates take into account dietary and non-dietary residential sources of exposure. As there are no registered or proposed uses of quizalofop that would result in non-dietary residential exposure, the aggregate risk estimates are equivalent to the chronic dietary risk estimates discussed above and are below HED's level of concern.

***Occupational Exposure and Risk Assessment:*** No doses or endpoints for dermal or inhalation exposure were selected or needed. Therefore, a quantitative estimate of occupational risk was not determined. The acute toxicity categories are IV for both routes of exposure, and a 12-hour re-entry interval (REI) was established under the worker protection standard (WPS).

### Glufosinate Ammonium

Glufosinate is a contact herbicide which is taken up by the plant primarily through the leaves. There is no uptake from the soil through the roots, presumably because of the rapid degradation of glufosinate by soil microorganisms. There is limited translocation of glufosinate within the plant.

Glufosinate is manufactured and labeled by Bayer Cropscience for pre-plant burndown on conventional or GE soybean, corn, cotton, canola, or sugar beet and post-emergence use on crops designated as LibertyLink™ (soybean, corn, cotton, canola, and rice). The PAT protein expressed in DAS 68416-4 and DAS 44406-6 soybean soybean is similar to PAT found in other commercially-grown glufosinate-resistant crops (e.g., LibertyLink™ soybeans, corn, cotton, canola, rice). Since the PAT protein has been included as an herbicide tolerance marker in products containing plant incorporated protectants (PIPs), it has been reviewed by EPA as a PIP inert ingredient (US-EPA, 2005a). Based on their environmental risk assessment, EPA determined that the PAT protein presents a low probability of risk to human health and the environment and granted an exemption from the requirement of a tolerance for this PIP inert ingredient (40 CFR 180.1151; 62 FR 17719, Aug. 11, 1997).

Based on pesticide usage data from USDA-NASS, private pesticide market research, and California Department of Pesticide Regulation (DPR), EPA estimated glufosinate usage from 2003 through 2010. The crops with the highest glyphosate uses (based on average treated fraction of acreage) were: almond (15%), canola (25%), grapes (15%), and pistachios (20%). All other treated crops averaged less than 15% of the total acreage grown (US-EPA, 2012d).

DAS has indicated that the proposed glufosinate application rate for use on DAS-68416-4 soybean and DAS 44406-6 soybean will be consistent with the current use pattern of glufosinate on other glufosinate-resistant soybean (i.e., LibertyLink™ soybean) (DAS, 2010b). As there is no change from the current EPA-approved labeled use pattern, no petition has been submitted to EPA for a change in the glufosinate label. The EPA-approved label for Liberty™ (i.e., glufosinate ammonium) use on glufosinate-resistant soybean can be viewed here:

http://www.bayercropscience.us/products/herbicides/liberty/labels-msds

The EPA-registered use of glufosinate on LibertyLink™ soybean includes an initial burndown application of glufosinate no higher than 0.66 lb a.i./A (36 fl oz/A) with a minimum of 0.53 lb a.i./A (29 fl oz/A). A single second in-season application of glufosinate up to 0.53 lb a.i./A (29 fl oz/A) is approved on LibertyLink™ soybeans, with a seasonal maximum rate of 1.2 lb a.i./A (65 fl oz/A) permitted. Glufosinate applications on LibertyLink™ soybean should be made from emergence up to but not including the bloom growth stage and within 70 days of harvesting.

Pesticide residue tolerances for quizalofop are listed in 40 CFR Part 180.473 (US-EPA, 2012c). As quizalofop is not currently approved by EPA for use on corn, only residue limits for soybean commodities are shown in Table 8-7, representing combined residues of combined residues of quizalofop ethyl, quizalofop, and quizalofop methyl.

**Table 8-7. 2,4-D Tolerances for Corn and Soybean Commodities**

| Commodity | Residue (parts per million) |
|---|---|
| Corn, field, forage | 4.0 |
| Corn, field, grain | 0.20 |
| Corn, field, stover | 6.0 |
| Soybean | 2.0 |
| Soybean, hulls | 0.02 |

Source: §180.473 Glufosinate ammonium; tolerances for residues (US-EPA, 2012c).

Currently, glufosinate is undergoing registration review by EPA. The registration review began in 2008 and a decision is expected in 2013 (US-EPA, 2009a). EPAs website for the glufosinate ammonium registration review case can be found here:

http://www.epa.gov/oppsrrd1/registration_review/glufosinate_ammonium/index.htm

The docket containing documents related to EPAs review can be viewed here:

http://www.regulations.gov/#!docketDetail;D=EPA-HQ-OPP-2008-0190

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# Appendix 9. Response to Comments on the DEIS

## Contents

## Summary

APHIS conducted one virtual public meeting for petitions for Enlist™ corn (09-233-01p), Enlist™ soybean (09-349-01p), and Enlist™ soybean (11-234-01p) on January 29, 2014, attended by 110 participants. Twenty four participants made comments, with 9 opposed and 15 in favor of deregulation (APHIS-2013-0044). The draft EIS was released for public comment initially for 45 days from January 10 through February 24, 2014; the comment period was further extended to March 11, 2014. APHIS received 10,147 submissions on the Enlist™ corn and soybean EIS docket (APHIS 2013-0042). Of these 8940 opposed and 1082 supported the use of Enlist™ corn and soybean. The remaining 125 comments were submissions of attachments, requests for extensions, or were submissions to the wrong docket. Some of the submissions in support or opposition were petitions with signatures, letters with multiple signatures, or batches of nearly identical letters. These include the following comments (for each comment, the last term of the comment number is listed in parentheses; eg. 10159 refers to APHIS-2013-0042-10159):

**Those Opposed to Enlist™ corn and soybean petitions:**

Pesticide Action Network: petition with 19,003 signatures (10159)

Pesticide Action Network: petition with 708 signatures (10201)

Western Organization of Resource Councils: 704 nearly identical letters (9705)

Food and Water Watch: 61,132 nearly identical letters (6922)

Organic Consumers: petition with 144,689 signatures (10192)

Food Democracy Now: petition with 29,620 signatures (9946)

Center for Food Safety: petition with 216,491 signatures (7995)

Earth Justice: 137,843 nearly identical letters (9393)

Interfaith Center on Corporate Responsibility (letter with 22 signatures) (8274)

Farm and Ranch Freedom Alliance OK (petition with 6 signatures) (9416)

Sierra Club (petition with 9143 signatures) (9486)

**Those in support of Enlist™ corn and soybean petitions:**

Dow (petition with 14,811 signatures) (9702, 9704, 9706, 9707- 9, 9718, 9723-5)

IL congressman Shimkus (petition with 24 signatures) (10215)

ND congressman Cramer (petition with 198 signatures) (8190)

MO congressman Smith (petition with 150 signatures) (1877)

American Farmer Group (letter with 8 signatures) (10022)

IA congressman Latham (petition with 828 signatures) (6465)

ND Farmer Group (petition with 420 signatures) (9218)

IA Farmer Group (petition with 97 signatures) (9450)

The Response to Comments is organized by sections corresponding to the EIS. We have attempted to compile related comments by issue and correlated to the EIS sections. In cases where many similar comments were received, we have selected a representative comment and posted it verbatim (including emphasis) below. Verbatim comments have also been posted for the other unique comments. For each comment, the last term of the comment number from regulations.gov is indicated in parentheses. APHIS' response follows the comment.

## Executive Summary

**1. Comment**: *Cherry-picking results: a lack of scientific integrity* The final paragraph of the Executive Summary (p. xi) lays out a litany of disastrous consequences that "are to be expected" if 2,4-D seeds are *not* approved by USDA. The expectation is that in the absence of 2,4-D seeds, farmers will "return to more aggressive tillage practices" which in turn may worsen soil, water and air quality, drive up greenhouse gas emissions, exacerbate climate change and even harm biodiversity. The clear intent of the authors is to conclude the Executive Summary (the only portion of the EIS that many policymakers will read) with as strong a statement as possible, in support of USDA's desire to approve Dow's 2,4-D seeds. However, the main body of the report reveals that claims regarding the ability of 2,4-D seeds to forestall the doomsday scenario outlined in the Executive Summary are not actually supported by USDA's own analysis. *The USDA's selective presentation of "findings" in the Executive Summary misleads the reader, represents a lack of scientific integrity and is wholly unacceptable.* In the main body of the report (p. 83), which ought to substantiate the conclusions presented in the Executive Summary, it becomes apparent that the assumption of an increase in aggressive tillage in the absence of 2,4-D seeds is based solely on one study that noted a trend towards increased tillage in "certain areas of Tennessee." This is not sufficient basis for making a sweeping generalization about future agricultural practices across the country that may differ in other states and that may take quite a different trajectory depending on scenarios described in the section above. Nevertheless, based on this flawed analysis, the EIS goes on to assert that "Under the No Action Alternative, increases in tillage *may* occur and have an adverse impact" on the soil microbial community (p.99), water quality (p. 101), air quality (p. 106) and greenhouse gas emissions (p. 107, emphasis added). **(10203)**

**Response:** APHIS disagrees with the commenter that the intent of APHIS is to mislead policy makers by distorting the information in the executive summary. The commenter feels that the data APHIS presents on increased tillage in Tennessee is inadequate to make the generalization that as a result of glyphosate resistant weeds, tillage is increasing in soybean. APHIS disagrees because there are other unpublished data that strongly support this conclusion. For example, Figure 5 in (Mitchell, 2011) shows that no-till in soybean has declined from 2008-2009 (the last year reported) and no-till cotton has declined steadily from 2005-2009. Paul Mitchell, Professor of Agricultural and Applied Economics at University of Wisconsin, Madison, in a talk given on November 8, 2014 at the USDA ERS for a one day workshop on the Public and Private Sector Policy Implications of Research on the Economics of Herbicide Resistance Management, presented more current data that indicates this trend in declining no-till is continuing. The data is from third party proprietary information that APHIS does not have permission to publish. Monsanto submitted to APHIS third party proprietary data on tillage trends in support of the NEPA analysis for the determination of non regulated status of Dicamba tolerant soybean and cotton (Dicamba EIS Appendix 9). This analysis of tillage practices shows that no-till increased in soybean in all parts of the country from 1998-2007 but has decreased from 2007-2012 in the Midwest and the Mid-South, became flat or decreased in the East, became flat in the southeast, and continued to increase in the west. In cotton no-till increased in all regions in the country from 1998-2007 but decreased from 2007-2012 in the southeast, the Midwest, the midsouth, but continued to increase in the West. Glyphosate resistant weeds are not yet problematic in the west and this remains the only area where no-till is still increasing. In areas where glyphosate resistant weeds have become problematic, no-till is on the decline or has stopped increasing. The trend in the decline of no-till is significant and pervasive throughout the country where glyphosate weeds are prevalent. APHIS has relied on the best available information, and the commenter did not present any evidence to counter that information.

2. **Comment**: Ironically, while the EIS prediction of an increase in greenhouse gas emissions in the "No Action Alternative" notes, correctly, that the manufacture of herbicides can contribute to such emissions, the EIS does not subsequently acknowledge that this would hold equally true for the "preferred alternative" of 2,4-D seed approvals, with the corresponding reliance and expected increase in the manufacture of that herbicide (p. 145). The EIS briefly acknowledges that other options in weed management such as cover cropping and crop rotation could be encouraged and supported by existing mechanisms (p. 83). Done well, these approaches are far more likely to increase soil organic matter, conserve soil moisture, enhance farmers' ability to adapt to climate change and protect biodiversity than will an increased dependence on 2,4-D, an herbicide likely to decrease plant biodiversity in our agricultural landscapes. *Yet these weed management options and their beneficial consequences simply do not appear in the Executive Summary.* In its presentation of the positive impact of approving Dow's 2,4-D seeds (p. 143-145), the EIS points to various "*short-term*" gains that "may" be expected, *if* adoption of the 2,4-D seeds prevents aggressive tillage to manage glyphosate-resistant weeds. These include "benefits" to soil, water and air quality, and a reduction of greenhouse gas emissions, if the reliance on 2,4-D enables continued conservation tillage practices. However, *in every case*, the EIS goes on to state that in the *long term*, the expected emergence of 2,4-D resistant weeds may result in aggressive tillage practices and thereby "*negate the benefits mentioned above*." This "*negation*" of benefits is not repeated in the Executive Summary, which contains only

a vague reference to possible "limits" of the benefits. By cherry-picking which findings to emphasize in the Executive Summary (short-term benefits of 2,4-D seeds), which to de-emphasize (long term negation of benefits of 2,4-D seeds) and which to exclude entirely (benefits of non-chemical, ecological alternatives), USDA has revealed an utter disregard for scientific integrity and its responsibility to the public. In so doing, USDA undermines its own credibility. **(10203)**

**Response**: The reference on p. 145 in the DEIS to herbicide contribution to greenhouse gas emissions was not with regard to the manufacture of the herbicide but to the burning of fossil fuel from herbicide application. Under the No Action Alternative, herbicide treatment is expected to be less effective, which is expected to result in more frequent herbicide applications on soybean. For example under the Preferred Alternative, closer to two herbicide applications are expected in a season compared to the No Action Alternative, where closer to three applications are expected. Together with the increased tillage expected, additional passes over the field will result in greater burning of fossil fuel under the No Action Alternative relative to the Preferred Alternative. APHIS has clarified this point in the FEIS.

APHIS disagrees with the comment that in the body of the EIS APHIS concludes that benefits of Enlist™ crops will be negated by selection of 2,4-D resistant weeds but fails to make that same point in the Executive Summary of the EIS. APHIS has emphasized in the EIS that it is not possible to predict how long the benefits of Enlist™ corn and soybean will last because it depends on the extent to which farmers adopt best practices and stave off the selection of 2,4-D resistant weeds. APHIS also makes this same point in the executive summary of the DEIS, which concludes with the following, "However, the eventual occurrence of weeds resistant to glyphosate, 2,4-D and glufosinate will over time limit the use of Enlist™ crops and any benefit to natural resources that may arise. The magnitude of the benefit or the loss of the benefit is uncertain because decisions on crop production management are made by individual growers." (DEIS p.xi)

**3. Comment**: In its EIS, the USDA characterizes the No Action Alternative as worse than the status quo for agriculture. In the Executive summary, the USDA describes the potential negative impacts of "more aggressive tillage practices" that will have to be adopted to manage glyphosate and other herbicide-tolerant weeds. This is not an accurate assessment. First, this problem could be dealt with through alternatives to chemical weed management, like more diverse cropping systems. Additionally, any weed control benefits of the Enlist™ corn and soybean crops will be negated because just as glyphosate-resistant weeds have evolved in fields treated with glyphosate year after year, 2,4-D-resistant weeds will arise in the same manner. Like the EIS states, "the eventual occurrence of weeds resistant to glyphosate, 2,4-D and glufosinate will over time limit the use of Enlist™ crops and any benefit to natural resources that may arise." The USDA goes on to say that, "the magnitude of the benefit or the loss of the benefit is uncertain." It is hard to understand why a product with uncertain, and probably zero, benefit to agriculture and the environment in the long run would be approved, when the costs are certain and dramatic. So dramatic, in fact, that if the USDA's Preferred Alternative of deregulating three varieties of 2,4-D tolerant corn and soybeans is selected, coexistence as we know it in agriculture will be infeasible. **(6923)**

**Response**: It seems as though the commenter disagrees with APHIS' assessment that the No Action Alternative will have more negative impacts than the Preferred Alternative because of the expected increases in tillage and use of non glyphosate herbicides under the former. The comment notes that alternatives to chemical weed management could be adopted under the No Action Alternative, such as use of more diverse cropping systems, and these could have positive environmental impacts relative to the Preferred Alternative. APHIS is not aware of evidence that these practices are being adopted on a significant scale, and the commenter does not provide any evidence that alternatives to chemical weed management are likely to be adopted. Currently most crops are rotated to a different crop the following year including 82% of corn and 94% of soybean. (Wallander, 2013). Simply diversifying cropping systems further, as the commenter suggests, may not be an economic option for many growers, nor will it necessarily eliminate growers' need for herbicide and tillage weed control measures. Another non chemical practice for weed control, cover cropping, is only used on 1% of cropland. (Wallander, 2013). Organic production uses only non chemical methods for weed control, but in 2011, the most recent year data was available, organic production of corn and soybean represented only 0.25% and 0.17% of the U.S. acreage, respectively (USDA-NASS, 2012). While it is true that other non chemical alternatives exist, these alternatives are not realistic alternatives to the status quo that relies on herbicides and tillage. The USDA through the the Natural Resources Conservation Service currently offers farmers technical and financial assistance to manage HR weeds while maintaining conservation stewardship through two programs: the Conservation Security Program and the Environmental Quality Incentives Program (Robinson, 2011; 2013). Among the practices that qualify for financial and technical incentives are the use of cover cropping and crop rotation (Robinson, 2013).

APHIS does not agree with the commenter that Enlist™ corn and soybean provides uncertain and probably zero benefit to agriculture. Enlist™ corn and soybean would provide value to most corn and soybean growers that use herbicides. This includes the overwhelming majority of American farmers. Herbicides are used on 215 million acres of cropland (Gianessi and Reigner, 2007). One study estimates that U.S. crop production would decline by 20% with a loss in value of $16,000,000 if herbicides no longer were used (cited in (Gianessi and Reigner, 2007)).

## Purpose and Need for Agency Action

## APHIS Authority

**4. Comment**: Congress gave APHIS broad authority in the Plant Protection Act (PPA) to prevent the agronomic and environmental harms of the proposed crops. The agency's position flatly conflicts with the Supreme Court's *Monsanto v. Geertson Seed Farms* decision, in which the Court held APHIS had ample authority under the PPA to impose restrictions to minimize transgenic contamination and weed resistance risks. **(7992)**

**Response**: APHIS disagrees with commenter's characterization of the scope of APHIS' authority under the PPA and disagrees that APHIS' interpretation of its conflicts with the Supreme Court's decision in *Geertson*.

**5. Comment**: APHIS makes two fundamental errors in applying its PPA authority in this action. First, the agency winnows its application of its plant pest risk authority in order to avoid addressing and regulating the proposed crops based on the significant harms they will cause. Second, APHIS refuses to apply the rest of its broad PPA authority, namely its oversight over noxious weed harms. **(7992)**

**Response:** First, APHIS disagrees with the commenter's implication that the agency impermissibly interprets its plant pest risk authority in order to avoid regulating harmful crops. Second, the commenter misinterprets the regulatory structure of the PPA. 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 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 plant pests, GE organisms that are plant pests, or for which there is reason to believe are plant pests, are specifically regulated by 7 CFR part 340. APHIS' regulation of GE organisms under 7 CFR part 340 derives from Section 7711 of the PPA. APHIS does not regulate noxious weeds under 7 CFR part 340; rather, APHIS regulates noxious weeds under 7 CFR part 360. APHIS' authority to regulate noxious weeds under 7 CFR part 360 derives from section 7112(f) of the PPA. In accordance with those regulations, a party may petition APHIS to designate a plant or plant product as a noxious weed.

Pursuant to 7 CFR part 340, petitions for nonregulated status for Enlist™ corn and soybeans were submitted to APHIS, and the developer of Enlist corn and soybeans based the petition on the claim that Enlist™ corn and soybeans do not pose a plant pest risk. Therefore, APHIS must evaluate Enlist™ corn and soybeans and determine whether they should be granted nonregulated status based on their potential plant pest risk. APHIS conducts a thorough plant pest risk assessment (PPRA) in order to make its determination.

If a petition to list a plant as a noxious weed under Part 360 is received, APHIS will evaluate the plant using the noxious weed regulatory framework set forth in those regulations.

## PPA -Noxious Weed Authority

**6. Comment**: The DEIS states that USDA cannot prevent or delay development of those resistant weeds, which have significant negative agricultural and environmental impacts, because it can only address "plant pest" concerns. CSPI believes, however, that USDA does have legal authority to prevent or delay development of resistant weeds that are the result of farmers using engineered herbicide-tolerant seeds using the "noxious weed" authority in the Plant Protection Act.

USDA should finalize the proposed rules for 7 C.F.R. Part 340 (73 FR 60008, Oct. 9, 2008) that incorporated the Plant Protection Act's "noxious weed" authority into its regulation of GE organisms and then use that authority to manage and address herbicide-resistant weeds. In the Plant Protection Act, the term "noxious weed" means any plant or plant product that can directly or indirectly injure or cause damage to crops (including nursery stock or plant products), livestock, poultry, or other interests of agriculture, irrigation, navigation, the natural resources of the United States, the public health, or the environment.

Including that definition in the 7 CFR Part 340 regulations and requiring any GE organisms that may exhibit "noxious weed" characteristics to be regulated will establish science-based oversight of GE organisms and ensure that APHIS is safeguarding environmental and agricultural interests. It will require APHIS to evaluate the potential "noxious weed" impacts of a GE crop on other crops and "other interests of agriculture." Clearly, the fact that use of a GE herbicide-tolerant seed with its corresponding herbicide directly results in huge herbicide-resistant weed populations is an impact that may fall within the definition of a "noxious weed." Such an analysis then could allow USDA to impose restrictions on the use of those herbicide-tolerant seeds so as to delay or prevent the development of those herbicide-resistant weeds.

USDA has broad authority available to it to address the potential impacts that might arise from the commercial use of the herbicide-tolerant seeds that are being analyzed in the DEIS. Therefore, USDA should finalize the portion of its proposed rules for 7 C.F.R. Part 340 (73 FR 60008, Oct. 9, 2008) that incorporated the Plant Protection Act's "noxious weed" authority into the regulatory system for GE organisms, and then use that authority to delay herbicide-resistant weed development from farmers' use of 2,4-D herbicide-tolerant seeds in conjunction with Dow's Enlist herbicide. **(9596).**

**Response**: CSPI is the Center for Science in the Public Interest. Revising 7 C.F.R. Part 340 to include noxious weed authority is outside the scope of the EIS.

**7. Comment**: APHIS's now-outdated implementing regulations concerning transgenic plants, 7 C.F.R. Part 340, were promulgated pursuant to its previous, narrower Plant Pest Act authority and therefore refer to only plant pest harms. APHIS misleadingly claims the "defining mandate of the PPA is the authorization for APHIS to regulate, manage, and control plant pests," DEIS at 1, but this is contrary to the statute's plain language and completely ignores that the PPA of 2000 significantly expanded APHIS's authority, including over noxious weeds, providing the agency new tools with which to carry out its mandate. The PPA also provides "a much wider and more flexible set of criteria for identifying and regulating noxious weeds."

Elsewhere APHIS admits that it has authority over noxious weed harms as well as plant pest harms, DEIS at v, but then immediately claims its regulations require that "APHIS can only consider plant pest risks," *id.* The current GE crop regulations do not, however, purport to limit APHIS to addressing only plant pest harms in deregulation determinations; in fact, since 2008 APHIS has proposed revised regulations that "make it clear" that its GE crop regulations implement its broader authority under the PPA, expressly also including its authority to prevent noxious weed harms.]

[The proposed rules' import is their acknowledgement of APHIS's statutory discretion (and its "need[] to exercise" it). APHIS cannot negate its authority simply by delaying updated regulations that "make it clear." The agency's failure to amend its regulations to expressly require compliance with the statute does not allow it to ignore a statutory directive in the meantime. Nor do the Part 340 GE crop regulations anywhere purport to preclude application of APHIS's noxious weed authority. In any event, APHIS's regulations do not, and could not, deny its noxious weed discretion and mandate. Statutes are not limited by regulations that do not implement full statutory mandates, and APHIS may not repudiate the authority granted to it. The statutory mandate applies even without up-to-date regulations "making clear" that obligation, and APHIS's failure to consider this important factor in any way was arbitrary, capricious, and contrary to law.] **(7992)**

**Response**: Revising 7 C.F.R. Part 340 to include noxious weed authority is outside the scope of the EIS. Further, the commenter misinterprets the regulatory structure of the PPA (see response to comment #5).

**8. Comment**: USDA began the process of updating its regulations in 2004, leading to proposed regulations in 2008. Since closing the comment period, however, the agency has not taken further action. USDA should write new regulations based on existing input and then re-open the comment period given that it's been more than five years. In draft form the regulations provide weak oversight of the agricultural biotechnology industry. We agree with the shortcomings as identified by the Union of Concerned Scientists:

The proposed rule has five major regulatory defects. First, the scope provisions are set up so that over time the rule will cover fewer and fewer GE products, leaving APHIS in the dark about the activities of biotechnology companies. Second, the list of harms considered worthy of regulation ignores most of the concerns scientists have raised about the impacts of GE crops. Third, the severity of the injury required to merit consideration as a noxious weed under the rule is extremely high and would allow products that cause substantial environmental disruption to escape regulation. Fourth, the proposed rule allows GE organisms to be removed from the agency's legal jurisdiction through a non-regulatory petition process. Fifth, the rule fails to protect the food supply from pharmaceutical and industrial crops.

By defining noxious weeds as only those causing the greatest harm, earlier draft regulations under the PPA set too high a bar for the amount of harm caused by a GE crop in order for it to qualify as a noxious weed. This could allow substantial economic harm from contamination to be excluded from regulation. Instead, the noxious weed standard should set a reasonable bar for direct or indirect harm for a GE crop to qualify as a noxious weed under the PPA.

Consequences, such as increased pesticide use, pesticide drift to neighboring farms, impacts to biodiversity and soil health, are all real and common with GE products currently in use and those awaiting deregulation, including 2,4-D tolerant corn and soybeans. USDA's current analyses are incomplete because they do not sufficiently include these broader issues, all of which are critical to the ideas underpinning "coexistence" – how one system of agriculture can directly and indirectly impact the viability of the other. These updated regulations should strengthen the agency's regulatory oversight of GE crops given the shortcomings evidenced by regular contamination events, as well as other environmental impacts and remaining questions about performance and safety. The agency should use its current authority to mandate contamination prevention practices on the part of users and owners of GE products. USDA must also ensure the safe introduction of GE products, starting at the field trial stage. **(9716)**

**Response**: Revising 7 C.F.R. Part 340 to include noxious weed authority is outside the scope of the EIS.

**9. Comment**: It's true that a plant pest risk assessment is simply inadequate to look at the risks associated with these novel crops. Yet, instead of finalizing PPA rules that would be better suited to handle the risks of GE crops, the USDA has approved variety after variety of new GE crops that will create new risks in agriculture and the marketplace and impose new costs on farmers and the environment. The bottom line is that USDA must not approve any herbicide tolerant crops, including Dow's Enlist™ corn and soybeans and Monsanto's dicamba-tolerant soy and cotton which are next in the pipeline, until the Plant Protection Act rules are revised to adequately cover the risks of genetically engineered crops. Until then, the USDA should focus its attention on the proliferation of non-chemical weed control methods, because if we continue down this path of high-input agriculture, we will be fighting herbicide-resistant weeds indefinitely. Thank you for your consideration of these comments. **(6923)**

**Response**: Revising 7 C.F.R. Part 340 to include noxious weed authority is outside the scope of the EIS.

**10. Comment**: APHIS has elsewhere argued that in order to apply this authority it must be petitioned by an outside party. However, APHIS's authority to prevent noxious weed risks by restricting "any plant" does not depend on inclusion in a list; the listing process is permissive. Nothing in the PPA suggests that the agency is barred from restricting a plant that threatens agronomic and environmental damage if APHIS has not included the plant on a published list. Rather, APHIS has the authority to "prohibit or restrict any plant" if the agency "determines that the prohibition or restriction is necessary." In fact, APHIS regularly acts to prevent noxious weed risks without regard to listing. Regardless, CFS hereby submits these comments and its previous comments simultaneously as a noxious weed petition to APHIS, to apply its noxious weed authority, as part of this process, to the proposed 2,4-D crops, as the pathway for multiple herbicide, 2,4-D resistant noxious weeds. As the proposed new rules make clear, this should be a holistic, inclusive noxious weed harms-plant pest harms process, not a separate bifurcated process. Accordingly, APHIS must broaden the scope of its analysis to this action, and properly apply all its statutory authority. It cannot claim that it "must" approve the proposed crops, because it lacks plant pest authority due to its overly narrow, contradictory and arbitrary interpretation of that authority (see *infra*). Instead, it now must apply its broader authority over noxious weed harms, which can cover "any plant." APHIS therefore must make this assessment anew, beginning with a new EIS, which meaningfully considers alternatives and analyses impacts it has thus far refused to analyze, and issue a new PPA decision applying its fulsome PPA authority. **(7992)**

**Response:** As explained in the response to comment #5, APHIS regulates plant pests and noxious weeds under two separate and distinct regulatory frameworks. Plant pest risks are evaluated upon receipt of a petition under 7 C.F.R. 340. Noxious weeds are evaluated upon receipt of a petition under 7 C.F.R. 360. For purposes of this FEIS, APHIS received petitions to evaluate the plant pest risks of 2,4-D crops under 7 C.F.R. 340. The commenter acknowledges the separate framework by submitting several pages of comments to the DEIS as a noxious weed petition. APHIS has accepted the commenter's comments as a noxious weed petition and they will be evaluated separately from this EIS under 7 C.F.R. 360. A letter has been sent to the commenter accepting those comments as a noxious weed petition. These, however, remain outside the scope of this FEIS; they are being evaluated by APHIS under the appropriate regulatory framework.

**11. Comment**: Specifically, pursuant to this authority, APHIS has the power to restrict "any plant" that even "indirectly" results in noxious weed risks, and has done so. Importantly, since the statutory noxious weed definition includes both direct and indirect harms, APHIS may regulate the weeds' agricultural pathways, as well as the weeds themselves. APHIS has done this, for example, by restricting the import and requiring the pre-import treatment of *Guizotia abyssinica* (niger seed), not because niger seed itself creates noxious weed risks, but because it facilitates them, as it commonly harbors noxious weed seeds. APHIS could do this because Congress gave the agency broad authority to prevent noxious weed harms by restricting "any plant." The proposed GE crops easily fit within this broad statutory definition, because, among other harms, they will "indirectly injure" agricultural interests by promoting noxious, multiple herbicide-resistant weeds. **(7992)**

**Response:** As explained in the response to comment #10, Dow's petitions for Enlist™ corn and soybean are evaluated for plant pest risks under 7 C.F.R. Part340. Noxious weed risks are outside the scope of the regulation and this EIS. As noted in comment #10, APHIS has received and accepted a petition request pursuant to 7 CFR 360.500-Petitions to Add a Taxon to the Noxious Weed List. APHIS is considering the commenter's petition request separately from this EIS pursuant to 7 C.F.R. Part 360. The issues raised in comment #10 will be considered under this evaluation under Part 360.

## PPA-Plant Pest Authority

**12. Comment**: The PPA and Part 340 regulations by their plain language provide APHIS with ample discretion to address the 2,4-D crops' harms as plant pest risks. The PPA's plant pest harm definition includes "any living stage" of organisms that can "directly or indirectly injure, cause damage to, or cause disease in any plant or plant product." The PPA places no restriction on how such damage may occur. CFS has previously explained how Dow's 2-4,D crops "directly or indirectly injure" and "cause damage to [] plant[s] and plant product[s]," namely, to conventional and organic corn and soy (in the case of transgenic contamination), and to wild and endangered plants and cultivated crops (in the case of resistant superweeds and the herbicide application integral to the 2,4-D crop system). These are significant harms to agriculture, the environment, and the economy, the protection of which is the PPA's overarching purpose. APHIS's "plant pest risk assessment" (PPRA), the only document upon which the agency is unlawfully basing its NEPA decision, turning NEPA into an empty exercise, *see infra*, completely fails to analyze these harms or explain that failure. **(7992)**

**Response**: APHIS disagrees with the commenter's suggestion that the agency's actions are unlawful and that the agency fails to analyze plant pest harms noted by the commenter, i.e. transgenic contamination, the impacts of herbicide resistant weeds, and the environmental impacts of herbicide use. As described in the EIS (DEIS p. 66, 107), impacts from commingling of GE and non GE corn and soybean are not expected to change under any of the alternatives because over 90% of corn and soybean are currently transgenic and are likely to remain at this level under any of the alternatives. If some of the currently grown GE corn and soybean is now replaced by Enlist™ corn and soybean, no differences in the amount of commingling are expected.

The EIS covers the impacts of herbicide resistant weeds in considerable detail (chapter 5 and Appendix 6).

The alleged harms to wild and threatened species from "resistant superweeds" are not due to the Enlist™ crops themselves, but rather attributed to the use of the herbicides on the Enlist™ crops. APHIS does not have statutory authority to regulate the use of herbicides. That authority has been given to the EPA. EPA is currently reviewing the use of 2,4-D on Enlist™ corn and soybean to determine whether the herbicide would cause any unreasonable environmental risks if it were applied in accordance with its labeling instructions. APHIS defers to the expertise of the EPA. (See DEIS chapter 5 and Appendix 6). Overall, the PPA does not regulate the types of harms the commenter complains of in this comment.

**13. Comment**: APHIS's arbitrary interpretation of its plant pest authority is also belied by the agronomic facts of Dow's 2, 4-D crops. Under APHIS's regulations, GE plants are presumed to create plant pest risks—and thus regulated articles under the PPA—until APHIS determines otherwise. The agency retains control over these regulated articles, prescribing how they may be introduced into the environment and forbidding their release or movement in interstate commerce absent explicit approval. APHIS may grant permission to conduct experimental field trials of a regulated article subject to protective restrictions, after receiving sufficient data. Developers who want to commercialize a transgenic plant based on field trial data must petition USDA for deregulation, which APHIS can grant "in whole or in part." In most cases, GE crops are engineered with an *agrobacterium*, a listed plant pest under the Part 340 regulations. The existence of this plant pest in every cell of the plant makes it resistant to herbicides that the crop's manufacturers sell as part of their herbicide-resistant crop system. The use of the plant pest raises the question of how that plant pest will affect the crop, and how the plant pest engineered crop will affect the environment. Such crops then begin as regulated articles that APHIS must approve before commercial sale. **(7992)**

**Response**: APHIS disagrees with the commenter's assertion that GE plants are presumed to create plant pest risks. 7 C.F.R. Part 340 defines regulated articles in part as any organisms which have been altered or produced through genetic engineering, if the donor organism, vector or vector agent belongs to certain taxa and meets the definition of a plant pest. If the organisms do not meet the definition of a plant pest, they are not regulated articles. Some manufacturers may produce organisms through genetic engineering that are not created using plant pest sequences and do not trigger our regulatory authority.

**14. Comment**: However, Dow's 2,4-D crops are not engineered with any plant pests, as APHIS acknowledges: "No plant pest or plant pest-derived material was used to generate the DAS-40278-9 corn plants." As such, APHIS's claim that its review is limited to that of whether 2,4-D corn or soy will become a plant pest is even more unsupportable and contrary to sound science. There are no plant pests in these crops. Thus the definition of a "plant pest" harm for purposes of APHIS's authority must be interpreted to mean something other than how APHIS is presenting it. Otherwise the agency's review and authority over plant pest risks is simply whether these crops will—essentially, magically—turn into plant pests, even though they do not have any plant pests inside them. APHIS now explains its authority as threefold: "if it is a plant pest (such as certain microorganisms or insects that can cause injury or damage to plants); or, if it is created using an organism that is itself a plant pest; or, if APHIS does not know or cannot determine if the GE organism is or may be a plant pest." DEIS at i. Because Dow's 2,4- D crops contain no plant pest genes, presumably APHIS regulates them pursuant to the third prong (i.e., "if APHIS does not know or cannot determine if the GE organism is or may be a plant pest"). This regulatory posture does not, however, alter the fallacy of the agency's position. Pursuant to its own interpretation, APHIS requires an EIS, years of field trial data, and other regulatory requirements on weediness impacts and potential harm to non-target organisms, *see infra*, but all of that is superfluous. Actually, the agency is merely deciding whether the crop will transform into a plant pest, even though it does not have any plant pest genes, a scientific impossibility. APHIS's position is not supported by sound science and is arbitrary and capricious, making its plant pest review a charade. In contrast to APHIS's presentation, sound science instructs that "plant pest risk" is a flexible construct, as it must be to adapt a 1957 statute, enacted for the primary purpose of controlling pathogenic microbes, to permit regulation of plants—organisms from a different phylogenetic kingdom—and to accommodate profound scientific uncertainties about the impacts of a new technology, genetic engineering. That the regulation is based on a comparative risk standard ("unlikely to pose a greater plant pest risk than" its conventional counterpart), rather than an absolute biological one, illustrates this further. Unmoored from the insertion of a plant pest itself into the crop, it is plain that APHIS must simply apply the statutory definition, which broadly includes any direct or indirect harm to other plants or plant products. Neither the PPA nor its regulations limit the form or type this "injury, damage, or disease to plants and plant products," DEIS at i, can take. APHIS's interpretation is also belied by the regulation's data requirements. A deregulation petitioner must present a wide array of information, including weediness, impacts on agricultural practices, indirect impacts on agricultural products, and effects on non-target organisms, which encompass these crops' contamination, superweeds, consequent herbicide application, and endangered species impacts, but data that would be superfluous if APHIS needed merely to determine whether the crops will turn into a traditional plant pest, like a parasitic plant (a scientific impossibility). APHIS is internally contradictory in the DEIS, at some places attempting to limit "plant pest risk" to "plant disease or damage." *See, e.g.*, DEIS at i; DEIS at iv (purpose only to protect "plant health"). This is contrary to the plain language of the PPA, which broadly defines "harm" as to "directly or indirectly injure, cause damage to, or cause disease in any plant or plant product." In the DEIS, APHIS also contradicts statements it has made elsewhere. Indeed, APHIS has acknowledged since its first GE crop approval in 1994 (and in many approvals thereafter) that its GE crop review is "considerably broader" than its review of "traditional" plant pests, belying its present arguments: A certification that an organism does not present a plant pest risk means that there is a reasonable certainty that the organism cannot directly or indirectly cause disease, injury, or damage either when grown in the field, or when stored, sold, or processed. This approach is considerably broader than the narrow definition of plant pest risk arising from microbial or animal pathogens, including insect pests. Other traits, such as increased weediness, and harmful effects on beneficial organisms, such as earthworms and bees, are clearly subsumed within what is meant by direct or indirect plant pest risk. And again: APHIS views this [plant pest] definition very broadly. The definition covers direct or indirect injury, disease, or damage not just to agricultural crops, but also to plants in general, for example, native species, as well as to organisms that may be beneficial to plants, for example, honeybees, rhizobia, etc. APHIS's application of its plant pest authority here is contrary to this past precedent, as well as sound science. The agency refuses to address the true harms of Dow's proposed 2,4-D crops, thus failing to consider all important factors. Further, the agency's decision is contrary to the plain language of the PPA, which gives APHIS authority over broadly defined harms, including those of the proposed 2,4-D crops. **(7992)**

**Response**: APHIS disagrees with the commenter's assertion that APHIS's application of its plant pest authority here is contrary to past precedent as well as sound science. APHIS has never considered the harms raised by the commenter, transgenic contamination and impacts from herbicide use, whether direct effects on non-target organisms or selection of herbicide resistant weeds, to be harms covered under 7 CFR Part 340. Furthermore, herbicide use falls under the regulatory oversight of the EPA under FIFRA and the Clean Water Act. Transgenic contamination from deregulated crops is not a regulatory issue under part 340. APHIS acknowledges that Enlist™ corn lacks plant pest sequences. However both Enlist™ soybean events contain plant pest sequences and fall under APHIS regulation. In the case of Enlist™ corn, the company put itself under regulation by submitting applications for field testing. APHIS subsequently took the time to evaluate whether the Enlist™ corn posed a plant pest risk and concluded they did not.

**15. Comment:** Herbicides represent a tool that allows for the economical production of corn and soybean. As long as herbicides are used to produce corn and soybean, weeds will develop resistance to the herbicides used. Under all four [NEPA] Alternatives, the selection of herbicide-resistant weeds is an unavoidable impact. Growers may mitigate the rate at which weeds develop resistance by adopting best management practices as described in Section 5.3.2. Despite this blatant acknowledgment of the inevitable propagation of 2,4-D-resistant weeds, APHIS goes on to say that it "does not have the authority to regulate grower management practices nor does APHIS have the authority to regulate herbicide use." I beg to differ. The impact of GE crops like DAS-40278-9 corn, DAS-68416-4 soybean, and DAS-44406-6 soybean in the environment poses an "unacceptable" noxious weed propagating risk, in violation of the PPA and NEPA. Resistant weeds must be interpreted as "noxious weeds" that are directly and indirectly causing undue burden to U.S. agricultural interests in terms of additional costs, economic burden to farmers, especially organic farming systems, and impact to overall agricultural productivity, as well as contaminating the environment. APHIS therefore can and must use its authority to restrict further spread of these resistant, "noxious weeds" to prevent further impact on U.S. agricultural systems. Introducing into the environment GE material, the very agent which is reliant on herbicides that promote the spread of resistant weeds violates section 7712(a) of the PPA and poses "unacceptable" risk to plant health and an unreasonable risk to the environment. **(9822).**

**Response:** As explained in comment **# 11,** noxious weed risks are not regulated under 7 CFR Part 340 and are outside the scope of this EIS.

## Alternatives

**16. Comment:** Section 102(2)(E) of NEPA requires all agencies to "[s]tudy, develop, and describe appropriate alternatives to recommended courses of action in any proposal which involves unresolved conflicts concerning alternative uses of available resources." 42 U.S.C. § 4331(2)(E). Regardless of whether an EA or EIS is prepared, NEPA "requires that alternatives be given full and meaningful consideration."

CFS has previously explained at length why APHIS has failed to comply with NEPA's Alternatives analysis mandates in its proposal based on EAs. *See* Appendix A (CFS EA comments, April 27, 2012, at pp.11-14; CFS EA comments, September 11, 2012, at pp.7-9). In those comments, we identified numerous reasonable alternatives that APHIS had ignored, and still continues to ignore or unlawfully refuse to consider. *Id.* These include but are not limited to alternatives to mitigate against transgenic contamination; alternatives to mitigate against the worsening crisis of herbicide resistant superweeds; alternatives to mitigate the impacts from herbicide drift; and alternatives to address the unanalyzed risks from "stacking" with other GE crops. *Id.* APHIS should have included analyses fully exploring these alternatives. Specifically, the alternatives considered by APHIS must include a "range of reasonable actions which might meet the goals of the agency by using different approaches which may reduce the environmental impacts of the agency's action." We incorporate and expand on our previous comments here, with regard to the DEIS.

Reasonable alternatives are "the heart" of the EIS. Accordingly, APHIS's reasonable alternatives analysis must "sharply defin[e] the issues and provid[e] a clear basis for choice among options by the decisionmaker and the public." APHIS's duty to consider alternatives is more rigorous and comprehensive for this DEIS than for an EA. That is, although an EA need only include "brief discussions . . . of alternatives," now, in preparing an EIS, APHIS must "[r]igorously explore and objectively evaluate all reasonable alternatives," including the no action alternative, and, for alternatives that were not evaluated, "discuss the reasons for their having been eliminated." In so doing, the agency must "[d]evote substantial treatment to each alternative considered in detail including the proposed action so that reviewers may evaluate their comparative merits."

The DEIS purports to include "four" alternatives, from the two (proposed action/no action) that were in the draft EAs. DEIS at11. However, even this claimed expansion of choice is illusory. The two new "alternatives"—alternative 3, approval of the GE corn only, and alternative 4, approval of the GE soy only—are immediately declared impossible, because AHIS has already "made" the determination that the GE crops "are not plant pests"; thus, according to APHIS's logic, even considering these stated alternatives would be inconsistent with the agency's purpose in the proposed action. DEIS at 12-13.

First, despite the rigor required by NEPA, APHIS's DEIS presents no serious analysis of alternatives, as APHIS states repeatedly that it effectively has no alternatives. Instead, APHIS merely provides a cursory (and illusory) review of just two options it purports to have "evaluated" to satisfy this requirement: the proposed approval action and the "no action" action. APHIS attempts to simply hide this all-or-nothing approach behind alternatives 3 and 4, which are actually just variations of approval/disapproval, without restrictions. It is a classic NEPA violation to limit the consideration of alternatives simply to (1) action or (2) no action. Thus, APHIS's alternatives analysis, including its failure to consider other options, is unlawful and arbitrary. APHIS cannot sidestep the unlawfulness of its analysis by pretending to consider two other alternatives in one paragraph each, only to reject them out-of-hand in that same paragraph.

Second, the only alternative to approval that APHIS has actually "evaluated" is that of no action, i.e., denying Dow's petition. Yet even this analysis is defective. In dismissing the no action option, APHIS again states that it is forced to approve Dow's 2, 4-D crops based on its earlier "plant pest risk assessment." DEIS at vi, 11. However, APHIS is bound by NEPA to refrain from approving this action—regardless of the agency's findings in any separate, plant pest risk assessment—until the agency has completed the requisite comprehensive environmental analysis of all potentially significant environmental and ecological risks that approval presents.

Third, APHIS's alternatives analysis is fundamentally flawed because it is, like the rest of the EIS, far too limited in scope. An agency's alternatives analysis should be a function of the purpose and need of the action under review. However, "an agency may not define the objectives of its actions in such unreasonably narrow terms as to make consideration of alternatives a mere formality." But APHIS does exactly that here. On page 1 of the DEIS, when explaining its "purpose and need," APHIS starts by correctly noting its very broad mission "to protect the health and value of American agriculture and natural resources." APHIS also correctly states that it must comply with NEPA and explains that for 2,4-D crops the agency found the herbicide-resistant weeds issue to be significant, requiring preparation of an EIS "to further analyze the potential for selection of 2,4-D-resistant weeds and any other impacts that may occur." DEIS at 7. As the agency recognizes, an EIS provides "APHIS decisionmakers with a mechanism for examining the broad and cumulative impacts on the quality of the human environment that may result" from approval of 2, 4-D crops. *Id.* As an EIS is action-forcing procedure and analysis, APHIS's language parrots the correct role the agency's NEPA analysis should play: to analyze the potential impacts of a decision <u>before</u> it is made, and to meaningfully consider alternatives <u>before</u> deciding on an action.

Yet elsewhere APHIS explains its <u>actual</u> process:

> APHIS regulates those [GE] organisms that have the potential to be plant pests or to increase plant pest risks. It performs extensive, science-based analyses to determine whether or not a GE organism is a plant pest. Results are recorded by the Agency in a Plant Pest Risk Assessment (PPRA). If the conclusion of the PPRA is that a GE organism is unlikely to be a plant pest, the Agency conducts an environmental review consistent with regulations codified under authority of [NEPA] before making a formal determination about its regulatory status.

DEIS at 1. Thus, in its actual process, APHIS first severely limits the scope of such review to only what it currently considers to be "plant pest risks" or, stated alternatively other places, whether the GE crop itself is going to become a "plant pest." Then, in a separate, (20-page) non-NEPA document discussing the agency's self-determined subset of risks, APHIS cherry-picks what it does or does not consider to be such a "plant pest" risk (e.g., none of the harms caused by GE crops such as 2,4-D corn and soybeans are included). Then, because the agency has not found plant pest risks or risk that the GE crop itself will become a plant pest, APHIS declares itself without authority to disapprove commercial use of the GE crop. Here, APHIS's 2,4-D crop DEIS repeats this claim early and often, throughout. *See, e.g.*, DEIS at 7 ("If the Agency determines that a regulated article is unlikely to be a plant pest risk, a GE organism is no longer subject to the regulatory provisions of the PPA or the regulations of 7 CFR part 340."); DEIS at ii ("If APHIS concludes that the GE organism does not pose any plant pest risk, APHIS must then issue a regulatory decision of non-regulated status."). That is, according to APHIS, even before a NEPA analysis, it has no option other than full, unmitigated approval.

There are numerous problems with APHIS's approach, as discussed *supra*, but in sum, the limitations APHIS proclaims regarding its authority have no statutory or scientific basis. Rather, under the PPA, APHIS has authority over broadly defined harms, harms that fit the harms that the GE crops proposed here. APHIS admits that it has the ability to partially deregulate GE crops, but wrongly claims that it cannot use that authority here. Contrary to APHIS's overly constricted view, there is no list of factors to which APHIS is limited in determining whether to grant or deny a deregulation petition, or to deregulate "in part." Rather, APHIS may consider any risks encompassed by the statutory definitions of "plant pest" harms and "noxious weed" harms, which are very broad.

The upshot for alternatives purposes is that APHIS cannot meaningful comply with NEPA's alternatives mandates by pretending to consider other options, while simultaneously claiming to have no such options. APHIS therefore violated NEPA when it defined the purpose and need in this DEIS so narrowly as to preclude the agency from meaningfully considering any alternatives to the course of action it selected. APHIS wants the façade of alternatives, not actual alternatives. However, NEPA unequivocally requires that APHIS meaningfully consider reasonable alternatives. In contrast, by declaring that it had no authority to select other alternative, APHIS relegated the NEPA process to a pointless exercise. APHIS's process attempts to turn the NEPA review process into a charade, subverting the requirement that "[e]nvironmental impact statements shall serve as the means of assessing the environmental impact of proposed agency actions, rather than justifying decisions already made.""NEPA's purpose is not to generate paperwork—even excellent paperwork—but to foster excellent action." APHIS violates the statute's fundamental goal if it erroneously concludes that it need not or could not take into account what its NEPA analysis reveals.

In APHIS's view, all that matters is the 20-page 2012 PPRA, not the years-long NEPA process it has prepared. It is nonsensical for APHIS to suggest that it has complied with NEPA's mandate to take a "hard look" at the consequences of its action while simultaneously insisting it is precluded from allowing its approval decision to be influenced its NEPA analysis. APHIS has the NEPA analysis process precisely backwards: the NEPA analysis must inform the agency's decision-making process, not the other way around. "The 'hard look' must be taken objectively and in good faith, not as an exercise in form over substance, and not as a subterfuge to rationalize a decision already made."NEPA requires that environmental considerations be factored into government decision-making "early enough so that it can serve practically as an important contribution to the decisionmaking process and will not be used to rationalize or justify decisions already made." In addition to contravening NEPA, it is also contrary to the PPA's sound science mandate for APHIS to turn NEPA into a *post hoc* pretense.

Fourth, in considering alternatives, APHIS impermissibly relies on Dow's biased representations of its own products. In so narrowly defining the purported purpose and need to make Dow's approval a foregone conclusion, APHIS ignores that "NEPA requires an agency to 'exercise a degree of skepticism in dealing with self-serving statements from a prime beneficiary of the project and to look at the general goal of the project rather than only those alternatives by which a particular applicant can reach its own specific goals." Dow's goal is to commercialize 2,4-D-resistant GE crops; thus, commercialization cannot be APHIS's goal as well. In contrast, by law, the agency must consider the "general goals" of its purview and statutory mandate under the PPA: to protect agriculture and the environment from a broadly defined array of harms, including those of GE crops.

In so doing, APHIS must consider alternatives that are reasonable, meaning feasible from a technical, practical, and common sense perspective. As CEQ has instructed:

> In determining the scope of alternatives to be considered, the emphasis is on what is 'reasonable' rather than on whether the proponent or applicant likes or is itself capable of carrying out the particular alternative.
>
> <u>Reasonable alternatives include those that are practical or feasible from a technical and economic standpoint and using common sense, rather than simply desirable from the standpoint of the applicant</u>.

APHIS must therefore consider CFS's proposed reasonable alternatives regarding limiting approval and requiring mandatory measures to protect against transgenic contamination, herbicide-resistant weeds, and herbicide application harms from 2,4-D crops.

With regards to the herbicide-resistant weed epidemic, the entire purpose of Dow's 2,4-D crops is as the purported "solution" to this crisis, as APHIS notes:

> This nearly exclusive use of glyphosate over the past fifteen years led to the selection of glyphosate resistant (GR) weeds, weeds that could survive an application of the herbicide that once would kill earlier generations.

The primary purpose of Enlist™ corn and soybean varieties is to help growers manage GR weeds. DEIS at iii. That is, in APHIS's view, the superweeds epidemic caused by GE crop systems has necessitated Dow's new GE crop system proposal. However, as the agency has recognized, Dow's 2,4-D-resistant crops will themselves create new weed resistance problems (i.e., a new superweeds epidemic), in the form of 2,4-D resistant superweeds. In fact, APHIS correctly identified weed resistance impacts from 2,4-D crops as being so significant as to require an EIS:

> APHIS has identified the possible selection of HR weeds resulting from the change in management practices associated with the adoption of Enlist™ corn and soybean as a potentially significant environmental impact. . . . Because of the likely adverse socioeconomic impacts that would result in the event that 2,4-D resistant weeds would be selected from the expected increased 2,4-D use on Enlist™ crops, APHIS believed these impacts may be significant.

DEIS at vi.

Thus, given the breadth and significance of the herbicide-resistant weed issue that Dow and APHIS give as the fundamental need and purpose for 2,4-D crops, which APHIS believes is significant enough as to warrant an EIS, <u>NEPA requires APHIS to, at a minimum, consider and evaluate a wide range of alternatives capable of addressing the same problem</u>. For example, APHIS did not consider an alternative to Enlist crops for weed control that encourages use of agroecological weed control methods instead of herbicides or intensive tillage; USDA researchers have studied and developed successful agroecological weed control methods. Such methods include complex rotations, cover cropping, limited tillage, changes in timing of planting, and other management options.

This agroecological weed control alternative could be promoted by various incentives, subsidies, training programs, and other measures that would spur adoption.

An agency may not formulate an action's objectives arbitrarily or to mandate one particular outcome. However, in the DEIS, APHIS does precisely this, again and again claiming the limitations of its current, outdated regulations. The agency's purported scope argument is wrong, *see supra*, but even if it was correct, APHIS's purpose and need must be guided by the purpose of the <u>statute (i.e., the PPA)</u> under which the agency is taking action, not the agency's own regulations: "[T]he <u>statutory objectives</u> of the project serve as a guide by which to determine the reasonableness of objectives outlined in an EIS."

The fundamental objectives of the PPA are the "protection of the agriculture, environment, and economy of the United States." 7 U.S.C. § 7701(1). Further, as discussed, CFS is submitting its comments also as a noxious weed listing petition, triggering APHIS's broader statutory duties and oversight. In this DEIS, APHIS said nothing about these statutory goals in its purpose and need statement, instead focusing exclusively on its outdated plant pest regulations and declaring that those regulations dictate but one result: unrestricted approval. Unrestricted approval may serve the financial interests of Dow, but "[p]erhaps more importantly [than the need to take private interests into account], an agency should always consider the views of Congress, expressed, to the extent that the agency can determine them, in the agency's statutory authorization to act, as well as in other congressional directives." The Ninth Circuit has recognized "that 'NEPA's legislative history reflects Congress's concern that agencies might attempt to avoid any compliance with NEPA by narrowly construing other statutory directives to create a conflict with NEPA. Section 102(2) of NEPA therefore requires government agencies to comply 'to the fullest extent possible."

Finally, it is unlawful for APHIS to refuse to consider reasonable alternatives that the agency believes (rightly or wrongly) fall within another agency's jurisdiction. NEPA regulations require alternatives analyses to "include reasonable alternatives not within the jurisdiction of the lead agency." Thus APHIS's repeated reliance on and deferral to EPA when convenient, discussed *infra*, is not lawful NEPA compliance. As CFS has explained in great detail in our prior comments, there are significant environmental impacts due to the massive herbicide use these proposed new crops will cause. APHIS violated NEPA in failing to analyze them. The agency also violated NEPA in failing to consider alternatives to restrict and prevent such pesticide harms, even if it believes EPA also has such authority. APHIS could for example, as a condition for its action, introduce a regulatory requirement that conditions any approval to EPA similarly reviewing the crops and preventing herbicide drift and harm to non-target species. Courts have "repeatedly recognized that if the agency fails to consider a viable or reasonable alternative, the [NEPA analysis] is inadequate." **(7992)**

**Response**: APHIS disagrees with the comment and with the commenter's characterization of the requirements of NEPA under the circumstances presented here. In this instance, the agency focused on four reasonable alternatives and the reasons for choosing these particular alternatives were given in the Notice of Intent to prepare an EIS. Alternatives three and four were initially included because corn and soybean are often grown as rotation crops and the two additional alternatives could compare the potential impacts of approving petitions for one rotation crop without the other. These comparisons were made throughout the DEIS. In the end however, alternatives three and four, along with the No Action alternative, were not considered to be the Preferred Alternatives, as these alternatives were found not to meet the ultimate purpose and need of the agency's action. The purpose and need for the agency's action is consistent with its jurisdiction over plant pests pursuant to its statutory and regulatory authority.

APHIS also disagrees with the comment's assertion that APHIS must consider alternatives that mitigate against risks which the comment refers to as transgenic contamination, development of herbicide resistant weeds and herbicide drift. These enumerated risks are not plant pest risks. Despite arguments to the contrary made by the comment, APHIS does not have statutory or regulatory authority to address the risks enumerated by the comment. Thus, APHIS is not required to analyze alternatives to unconditional deregulation absent any jurisdiction to adopt them.

The fact that the agency was constrained to make the full deregulation alternative its preferred alternative in light of its current regulatory authority for genetically engineered organisms does not render the other alternatives cursory or illusory. The analysis presented for each of the four alternatives provides the agency decisionmaker and the public with as full a picture as practicable of the effects of it determination. The agency believes the analysis of the four alternatives in this document provides the decisionmaker and public with the impacts of each of these alternatives and differences in environmental impacts that would result. Even so, in the end, the analysis contained in this document does not expand the agency's authority or impose a duty to select what some view as the most environmentally friendly result.

**17. Comment**: APHIS did not consider an alternative to Enlist crops for weed control that encourages use of agroecological weed control methods that minimize reliance on herbicides and as well as soil erosion. For instance, USDA researchers have studied and developed successful agroecological weed management methods. Such methods include complex crop rotations, cover cropping, limited tillage, changes in timing of planting, and other management options. Organic farmers have also developed a rich repertoire of ingenious techniques for managing weeds and others pests while conserving soil, without resort to toxic herbicides. Many cultural techniques for weed management provide additional benefits, for instance increasing soil organic matter content, and reducing soil erosion and agrichemical runoff. While the No Action Alternative would be more consistent with such a path (relative to the Preferred Alternative), there are numerous policy instruments that would more vigorously promote sustainable weed management, which APHIS must consider in the context of a Sustainable Action Alternative.

*A third choice.* While the No Action Alternative is certainly the lesser of two evils, in that it would result in lesser toxic herbicide use and also greater adoption of beneficial practices such as cover crops (EIS at 83) relative to the Preferred Alternative, it is not in itself sufficient to move agriculture onto a more sustainable path. Below, we sketch the outlines of a Sustainable Action Alternative that APHIS should consider in the EIS.

*Weed management vs. weed eradication* Weeds can compete with crop plants for nutrients, water and sunlight, and thereby inhibit crop growth and potentially reduce yield. While less dramatic than the ravages of insect pests or disease agents, weeds nevertheless present farmers with a more consistent challenge from year to year. However, properly managed weeds need not interfere with crop growth. For instance, organically managed corn has been shown to yield as well as conventionally grown varieties despite several fold higher weed densities (Ryan et al. 2010). Long term cropping trials at the Rodale Institute reveal that average yields of organically grown soybean were equivalent to those of conventionally grown soybean, despite six times greater weed biomass in the organic system (Ryan et al. 2009). Weeds can even benefit crops – by providing ground cover that inhibits soil erosion and attendant loss of soil nutrients, habitat for beneficial organisms such as ground beetles that consume weed seeds, and organic matter that when returned to the soil increases fertility and soil tilth (Liebman 1993). These complex interrelationships between crops and weeds would seem to call for an approach characterized by careful management rather than indiscriminate eradication of weeds.

*Non-chemical weed management* Farmers have developed many non-chemical weed management techniques, techniques that often provide multiple benefits, and which might not be utilized specifically or primarily for weed control (see generally Liebman Davis 2009). For instance, crop rotation has been shown to significantly reduce weed densities versus monoculture situations where the same crop is grown each year (Liebman 1993). Cover crops – plants other than the main cash crop that are usually seeded in the fall and killed off in the spring – provide weed suppression benefits through exudation of allelopathic compounds into the soil that inhibit weed germination, and when terminated in the spring provide a weed-suppressive mat for the follow on main crop. Common cover crops include cereals (rye, oats, wheat, barley), grasses (ryegrass, sudangrass), and legumes (hairy vetch and various clovers. Intercropping – seeding an additional crop amidst the main crop – suppresses weeds by acting as a living mulch that competes with and crowds out weeds, and can provide additional income as well (Liebman 1993). One common example is intercropping oats with alfalfa. Higher planting densities can result in more rapid closure of the crop "canopy," which shades out and so inhibits the growth of weeds. Fertilization practices that favor crop over weeds include injection of manure below the soil surface rather than broadcast application over the surface. Techniques that conserve weed seed predators, such as ground beetles, can reduce the "weed seed bank" and so lower weed pressure. In addition, judicious use of tillage in a manner that does not contribute to soil erosion is also a useful means to control weeds. While APHIS makes occasional passing references to such non chemical techniques, for the most part it equates "non-chemical weed control" with intensive tillage, and gives decidedly short shrift to cultural weed control techniques. For instance, the 14 page Appendix 3 on "Weed Management and Herbicide Use" focuses almost exclusively on herbicides and tillage, and devotes barely more than one page to "cultural weed control," and even this section discusses only crop rotation (EIS at 3-9 to 3-11).

*Organic agriculture* Many of the non-chemical weed management methods discussed above were pioneered by organic farmers, or represent refined and improved versions of agricultural practices more common in the era before industrial agriculture, with its near exclusive focus on herbicides and tillage. Surprisingly, APHIS's treatment of agronomic practices utilized in organic farming (EIS at 64-66) lacks any discussion of the many well-known benefits it provides in terms of increasing soil quality and eliminating synthetic chemical use, and deals exclusively with GE contamination prevention measures. USDA Agricultural Research Service scientists have found that "organic farming can build soil organic matter better than conventional no-till farming can" (USDA ARS 2007). APHIS acknowledges that "[s]oil organic matter (SOM) is probably the most vital component in maintaining quality soil; it is instrumental in maintaining soil stability and structure, reducing the potential for erosion, providing energy for microorganisms, improving infiltration and water holding capacity" … as well as "nutrient cycling, cation exchange capacity, and the breakdown of pesticides," among other benefits (EIS at 96). Yet while APHIS credits conservation tillage with these benefits, it fails to acknowledge the superior performance of organic methods in delivering these same boons. APHIS also fails to discuss the science that casts grave doubt on some of the purported benefits of conservation tillage, or shows its negative impacts (CFS Science Soy at 73-76). Meanwhile, the problems generated by the prevailing chemical intensive weed eradication paradigm fostered by herbicide resistant crop systems such as Enlist are becoming ever more serious, and will only be greatly exacerbated if the Preferred Alternative is adopted. APHIS provides no coherent assessment of sustainable, non-chemical, cultural weed control practices, as practiced for instance in organic agriculture and low-input systems.

*Promising trends* There is increasing interest in and practice of such sustainable, nonchemical weed management techniques among farmers and agronomists. For instance, Purdue agronomist Eileen Kladivko reports that "interest in cover crops has skyrocketed over the past few years in the eastern corn belt" and that "cover crops are getting a fresh look as part of modern sustainable agricultural systems" (Kladivko 2011). Cover crops can be usefully integrated into no-till systems (Hoorman et al 2009). There has even been promising research on the use of cover crops, with or without tillage, to suppress problematic glyphosate-resistant weeds, such as Palmer amaranth, which can also "lessen dependence on chemical weed control (e.g. Price et al 2012, DeVore et al 2013). Arkansas corn and soybean growers who adopted cover crops to inhibit soil erosion are finding that they also help suppress glyphosate-resistant Palmer amaranth (Robinson 2013). However, the seductive convenience of the Enlist crop system would likely inhibit further adoption of cover crops and other sustainable techniques, at the cost of increased weed resistance, more herbicide use and tillage a few years down the line. As APHIS concedes, the Preferred Alternative would "delay the adoption of non-chemical management strategies" (EIS at xi, 139). Conversely, APHIS also concedes that "cover cropping and crop rotation, both of which have shown promise in reducing weed pressure…." would likely increase under the No Action Alternative (EIS at 83).

*Policy measures* Just as strong policy initiatives were the major force driving adoption of soil-conserving farming methods (see above under "Enlist crops, soil erosion and tillage"), so appropriate policy instruments could increase the use of more sustainable weed management techniques (Robinson 2013). Policy measures that could promote less chemical intensive and more sustainable weed management include education and outreach by extension officers, financial incentives to adopt improved practices, and regulatory requirements that prioritize non-chemical tactics (Mortensen et al. 2012).

*Assessment of "No Action Alternative" lacking in rigor* The EIS' superficial analysis of its "no action alternative" is notably lacking in rigor and depth. The EIS assumes not only that "no action" refers to "no regulatory action" taken on Dow's 2,4-D crops, but also that "no action" indicates "no progress" of any kind towards adoption of sustainable solutions in weed management at the local or national level. Instead, the scenario presented in the EIS states that without Dow's 2,4-D seed "answer" to the epidemic of Roundup-resistant weeds, farmers will resort to increased tillage and application of toxic herbicides to manage those weeds. While such a response is certainly one of several possible outcomes, the EIS fails to explore any other possibilities, such as a scenario in which a) USDA begins to dedicate resources and serious effort to the research, development and extension of non-chemical, low-till ecological weed management practices such as those demonstrated by the Rodale Institute or b) farmers begin to make such a transition towards ecological, biodiversified farming systems, and away from large-scale monocultural production of commodity crops, on their own, even without agency support. Such a transition could gain momentum as farmers are influenced by changing economic factors (the high cost of pesticides and patented GE seeds vs. lower input costs and premiums associated with production of non-GE and organic crops), a desire not to contaminate and harm their neighbor's non-GE crops, concerns for the health and well-being of rural families including their own, and the inability of the current chemical, energy and water-intensive GE model of agriculture to respond well to drought, extreme weather and other environmental stresses. Already we are seeing the beginnings of a shift away from GE production with farmers and scientists calling on USDA to devote more resources towards public breeding of non-GE seed varieties. These alternate scenarios should be included and fully assessed in the "No Action Alternative" in a revised EIS. Impacts of alternatives 2, 3 and 4 will then need to be compared with the full range of impacts possible under the various scenarios described in a revised Alternative 1. Currently, the draft EIS' "no action alternative" scenario assumes without basis or justification that USDA and U.S. farmers essentially make zero progress in transitioning towards the ecologically and economically resilient, increasingly diversified farming systems that scientists, economist and savvy investors increasingly recognize is the necessary and most robust response to climate change and to the growing array of environmental stresses facing the agricultural sector today. The EIS' assumption that progress towards truly sustainable, ecological farming practices could never take place is an insult to the intelligence of farmers –many of whom are making this transition on their own —and to the people of this country who are increasingly demanding that Congress and USDA commit resources to transitioning our food and farming system off the pesticide-GE treadmill. **(10203).**

**Response**: APHIS did not consider an alternative to Enlist™ crops for weed control that encourages use of agroecological weed control methods that minimize reliance on herbicides and as well as soil erosion because it is outside the scope of this EIS. APHIS does not set policy for the USDA, nor does it expand the scope of its regulatory authority, through its NEPA documents. Growers are free to choose to use cover cropping, organic methods, complex crop rotations, or any other ingenious methods of non-chemical weed control under any of the alternatives. As noted in the response to comment #3, only 0.25% of corn and 0.17% of soybean are grown organically (USDA-NASS, 2012). Cover cropping is used on only about 1% of US farms (Wallander, 2013). These are not numbers that suggest that a transition to ecological farming practices is happening to a meaningful degree. The commenter's premise is that APHIS should force growers to adopt such methods because most would not choose to do so without government intervention. This approach exceeds the agency's regulatory authority. The USDA through the the Natural Resources Conservation Service currently offers farmers incentives to pursue cover cropping through two programs: the Conservation Security Program and the Environmental Quality Incentives Program (Robinson, 2011; 2013).

**18. Comment**: NEPA requires that an EIS "specify the underlying purpose and need to which the agency is responding in proposing the alternatives including the proposed action." 40 C.F.R. §1502.13. Although agencies have "considerable discretion" in defining their objectives, they may not do so in "unreasonably narrow terms," so that "only one alternative from among the environmentally benign ones in the agency's power would accomplish the goals of the agency's action, and the EIS would become a foreordained formality." *National Parks & Conservation Assn. v. U.S. Bureau of Land Management* ("*NPCA v. BLM*"), 606 F.3d 1058, 1070 (9th Cir. 2010) (internal quotations and citation omitted). Thus, agencies may not simply "adopt[] private interests to draft a narrow purpose and need statement." *Id.* at 1071.

The DEIS falls far short of NEPA's purpose and need requirements because it does not evaluate the underlying need for "alternatives to currently available [genetically engineered ("GE") herbicide resistant] maize and soybean varieties." DEIS p. 3. The problem, as APHIS describes it, is that "intense reliance on glyphosate" has created "glyphosate resistance in some weeds in maize and soybean production systems." *Id*. Under NEPA, APHIS' Statement of Purpose and Need must analyze alternatives such as integrated pest management ("IPM") that do *not* rely on increasing use of ever more potent poisons such as 2,4-D. The DEIS should compare the effectiveness of the proposed action with alternatives such as IPM that may be better suited to addressing the posited problem at *less* environmental cost. Instead, by focusing solely on the narrow approval sought in DAS' petitions, APHIS has improperly curtailed the scope of its analysis.

The DEIS also fails to satisfy NEPA's requirement for an adequate alternatives analysis. The alternatives analysis "is the heart of the environmental impact statement." 40 C.F.R. §1502.14. NEPA requires that an EIS "[r]igorously explore and objectively evaluate all reasonable alternatives" so that "reviewers may evaluate their comparative merits." 40 C.F.R. §1502.14; 42 U.S.C. §4332; *City of Carmel-by-the-Sea v. United States Dept. of Transp.*, 123 F.3d 1142, 1155 (9th Cir. 1997); *Alaska Wilderness Recreation & Tourism Association v. Morrison*, 67 F.3d 723, 729 (9th Cir. 1995). Analyzed alternatives should be wide-ranging and include options that may require additional approvals or participation by others. 40 C.F.R. § 1502.14(c); *Sierra Club v. Lynn*, 502 F.2d 43, 62 (5th Cir. 1974); *see also Alaska Wilderness*, 67 F.3d at 729; 40 C.F.R. §1502.14(c). "The existence of a viable but unexamined alternative renders an environmental impact statement inadequate." *Friends of Yosemite Valley v. Kempthorne*, 520 F.3d 1024, 1038 (9th Cir. 2008).

Here, APHIS has unacceptably eliminated from detailed review feasible – and less environmentally damaging – alternatives that would address pesticide-resistant plant pests. DEIS pp. 12-14. Among others, APHIS perfunctorily dismissed the alternatives of partially approving the petitions, or of approving the petitions with conditions, or of weaning agriculture from its unhealthy and environmentally destructive dependence on increasingly potent pesticides altogether. DEIS p. 13. The three sentences APHIS spends evaluating the partial approval alternative, for example, are insufficient to fulfill NEPA's broad mandate for a "hard look." *Id*. APHIS may not claim it lacks authority to consider this broader range of alternatives, for as it points out, its own regulations allow it to "'approve the petition in whole or in part.'" DEIS p. 13 (quoting 7 C.F.R. part 340.6(d)(3)(i)). Nor may APHIS protest that GE crops are not plant pests. Its determination that GE crops are not plant pests depends on its determination that such crops do not "directly or indirectly injure or cause disease or damage in or to any plants or parts thereof, or any processed, manufactured, or other products of plants." 7 C.F.R. 340.1 (definition of plant pests). Because the application of pesticides for which the GE crops were designed qualifies as indirect injury to other plants or plant products, alternatives and mitigation measures which address such injuries must be fully considered in a revised DEIS.

APHIS also impermissibly dismissed geographical restrictions to protect growers of non- GE crops from further consideration. DEIS pp. 13-14. A combination of isolation distances and geographic restrictions could address and potentially resolve coexistence issues and concerns about risks of cross pollination and other impacts to conventional and organic crop producers. Measures that could effectuate robust protection for growers of non-GE crops include (1) planting restrictions in states which produce conventional and organic seed, (2) allowing seed fields only in geographically restricted areas, (3) labeling and identification to facilitate geographic restrictions, (4) education and training on isolation distances and geographic isolation, and (5) annual reports summarizing activities in education, training, monitoring, and compliance with geographic restrictions. Leaving the consideration of these measures to "[i]ndividuals on their own" is an abdication of the responsibility to consider feasible alternative under NEPA. DEIS p. 14.

APHIS should have considered an alternative involving mandatory weed resistance management through the imposition of best management practices. Such practices could be imposed through a mandatory stewardship program for licensed GE crop seed growers. APHIS should have considered imposing additional requirements on sales contracts between seed growers and farmers as a condition of deregulation, but declined to do so.

APHIS should also have more fully considered an alternative involving weed management systems that incorporate non-chemical tactics to control glyphosate-resistant weeds. This would fulfil APHIS' stated purpose to "provide for greater flexibility in the choices growers have when selecting herbicides to control economically important weeds" by reducing weeds that are resistant to existing pesticides. The previous introduction of pesticide-resistant crops, and resultant growth in pesticide-resistant weeds does not provide promising historical precedent for APHIS' solution of introducing yet *more* pesticide-resistant species. NEPA requires the consideration of alternatives which do not continue these old patterns of destruction. **(10158)**

**Response:** APHIS disagrees with the comment. As explained in the response to comment #16, the purpose and need for the agency's action is consistent with its regulatory authority and jurisdiction over plant pests. The comment asserts that APHIS must consider alternatives that are partial deregulation alternatives, such as deregulation with assorted weed pest management requirements or deregulation with geographic restrictions. The requirements or restrictions raised by the comment are not based on plant pest risks and, thus, are not within APHIS's authority to impose. APHIS is not required to analyze additional authorities to unconditional deregulation absent any jurisdiction to adopt them. The analysis in this EIS provides the agency decisionmaker and the public with a full picture as practicable of the effects of it determination. In the end, the analysis contained in this document does not expand the agency's authority or impose a duty to select what some view as the most environmentally friendly result.

As explained in the response to comment #16, NEPA requires the agency to consider reasonable alternatives. In this instance, the agency focused on four reasonable alternatives. The reasons for choosing these particular alternatives were given in the Notice of Intent to prepare an EIS. The purpose of NEPA is to foster better decision-making and informed public participation, and the agency believes the analysis of the four alternatives in this document provides the decisionmaker and public with the impacts of each of these alternatives and differences in environmental impacts that would result.

## Agronomic Practices

## Land use

**19. Comment:** Corn is a "high-impact" and wheat a "low-impact" crop (Wallander et al 2011, p. 1), meaning that replacing wheat with corn acres would put greater stress on natural resources and degrade the environment. Corn is more water-intensive than wheat, and is heavily irrigated in parts of the Northern Plains, especially Nebraska and Kansas (region I, EIS at 37-38), where the Ogallala aquifer is a major source of irrigation water and is being depleted at an alarming rate (EIS at 40: "Withdrawals from this aquifer greatly exceed recharge from surface waters."). Corn utilizes roughly four times as much nitrogen and phosphorous fertilizer as wheat, and in 2010 was treated with an historical high of 140 lbs./acre of nitrogen. Nitrogen and phosphate runoff cause eutrophication of rivers and bays, creating "dead zones" devoid of oxygen and bottom-dwelling aquatic life. Nitrogen fertilizer is a major source of nitrous oxide global warming gases (EIS at 41). Mineral nitrogen fertilizer stimulates decomposition of soil organic matter by microbes, leading to a decline in soil nitrogen and overall soil quality that in turn lowers productivity (Mulvaney et al 2010). Corn production also involves roughly seven-fold more herbicide use than wheat, including the great majority of the endocrine- disrupting weed-killer atrazine, which is a common contaminant of surface and drinking water contaminant, and banned in the European Union. By generating 2,4-D-resistant weeds that spread to wheat fields, Enlist crop systems would likely exacerbate the water-depleting and environmentally-damaging replacement of low-impact wheat acres with high-impact corn. APHIS must assess these impacts in the EIS. The few sentences APHIS devotes to this issue are illogical and inconsistent. First, APHIS maintains that the Preferred Alternative would not lead to displacement of wheat by corn and soybeans in regions G and I (Northern Plains states) "unless this [Enlist] strategy for weed control *reduces costs* compared to the No Action Alternative" (EIS at 120). On the contrary, *more expensive* wheat production due to 2,4D-resistant weeds would have the same effect, since what matters to the farmer is the relative profitability of his/her options. APHIS itself concedes that farmers might stop growing small grains due to resistant weeds (EIS at 121), and profitable corn would then be the most attractive alternative**. (10202)**

**Response**: APHIS agrees that corn utilizes more inputs (nitrogen, pesticides, and water) to grow than wheat and that the replacement of wheat with corn would have greater impacts on the environment. However, APHIS does not agree that it is likely that the emergence of 2,4-D resistant weeds would lead to greater plantings of corn. Also as stated correctly by the commenter, APHIS does not believe that the acreages of corn and soybean planted in regions A-M will change under the Preferred Alternative relative to the No Action Alternative because "other factors such as corn and soybean prices will have a greater influence on planting decisions." (EIS at p. 121). For example such other factors serve as the basis for the decrease in corn planting and large increase in soybean planting predicted for 2014 (USDA-OCE, 2014). Just as the commenter concluded that favorable economic conditions might have favored more corn plantings in the past, based on the current situation, it looks like soybean and cotton are the favored crops (USDA-OCE, 2014). Cotton uses less water than wheat and soybean would require less nitrogen. Further, it is possible that some wheat growers, who find it unprofitable to grow conventional wheat as a result of 2,4D resistant weeds, may find it economically feasible to produce wheat organically as there is a substantial price premium to produce organic products and it is less costly to continue to grow wheat than to invest in the equipment needed to grow another crop. From 2006 to 2011, acres planted to organic wheat increased by nearly 50% (USDA-ERS, 2013b). So it is far from evident that alternative crops to conventional wheat will lead to adverse environmental impacts as asserted by the commenter.

APHIS believes that the commenter has oversimplified the effect of nitrogen fertilizer on declines in productivity. While it is true that Mulvaney et al 2009 found that mineral nitrogen fertilizer can lead to a decline in soil nitrogen and overall soil quality that in turn lowers productivity (Mulvaney *et al.*, 2009), this effect was observed in cases for continuous cropping of corn or corn rotation to other cereals. When a legume such as soybean or alfalfa was included in the rotation, mineral nitrogen led to an increase in productivity (Mulvaney *et al.*, 2009). The fact that most corn is rotated to soybean but most wheat is rotated to other cereals (EIS figure 10), suggests that the adverse effects of mineral nitrogen fertilization is expected to be worse for wheat plantings than for corn plantings contrary to the commenter's assertion.

**20. Comment:** Directly after noting the historically high acreage planted to corn in 2012 and 2013 (97.2 and 97.4 million acres, respectively), APHIS states: "Under the No Action Alternative two to four million acres of land *currently used for other crops* are expected to be converted to corn cultivation in the next decade. (USDA-OCE 2011a)." (EIS at 60, emphasis added) The reference cited–USDA--OCE (2011a) says no such thing, and certainly does not project 99-101 million acres of corn (97 + 2 to 4) in the next decade**. (10202)**

**Response**: APHIS acknowledges the error though it does not change the analysis. The 2011 citation referred to an increase in acreage of 2-4 million from 2010 where only 88 million acres of corn were planted. APHIS has corrected the error in the FEIS. The most recent projection is that corn plantings will drop to 88.5 million acres through 2023 (USDA-OCE, 2014) and APHIS uses this estimate in the No Action Alternative.

**21. Comment**: Under the Preferred Alternative, the Enlist-driven spread of 2,4-D-resistant weeds could well make wheat growing less profitable and spur still further abandonment of wheat in favor of corn. **(10202)**

**Response**: APHIS acknowledges that the abandonment of wheat in favor of corn is a possibility but considers it unlikely that overall corn plantings will increase because other economic factors are likely to play a larger role. In 2014, corn acres are expected to decrease from 97.4 million acres to 91.7 million acres (USDA-NASS, 2014b)) and in the long term corn plantings are expected to decrease further to about 88 million acres through 2023 (USDA-OCE, 2014). The decrease in overall corn acres is expected to come as a result of increases in soybean, cotton, rice, and about 2.8 million less planted acres of field crops overall.

## Herbicide Use

## Increase in use of toxic herbicides

**22. Comment**: Noted agricultural scientist Charles Benbrook projects that widespread planting of Dow's Enlist corn alone could trigger as much as a 25-fold increase in use of 2,4-D, from an estimated 4.2 million pounds at present to over 100 million pounds by 2019. The USDA, while recognizing the 2,4-D has numerous health and environmental impacts, has failed to address the inevitable increase in its use that will occur if these crops are approved for commercial planting. Food & Water Watch analyzed data on herbicide use in the United States since the commercialization of GE crops in a report released in July 2013. Herbicide use on corn, soybeans and cotton did fall in the early years of GE crop adoption, dropping by 42 million pounds (15 percent) between 1998 and 2001. But as weeds developed resistance to glyphosate, farmers applied more herbicides. Total herbicide use increased by 81.2 million pounds (26 percent) between 2001 and 2010. Total 2,4-D use declined after glyphosate was widely adopted, but its use has increased since glyphosate-resistant crops became widespread, growing 90 percent (3.9 million pounds) between 2000 and 2012. Dave Mortensen, a Pennsylvania State University weed ecologist, predicts that the commercialization and widespread use of crop systems resistant to 2,4-D would result in 70 percent more total herbicide use. If 2,4-D corn is adopted as quickly as Roundup Ready corn (about 1 million acres a year between 1997 and 2001), 2,4-D application on corn could easily increase by nearly three fifths from 3.5 million pounds to 5.5 million pounds within two years of 2,4-D-tolerant corn's introduction. **(6922)**

**Response**: APHIS analyzes projected herbicide use for the four alternatives in Appendix 4 of the DEIS. APHIS considers that Benbrook overestimates 2,4-D use for the reasons stated in Appendix 4. Because herbicides are used at widely varying rates, it is misleading to analyze the trend in total herbicide use based on pounds of use when comparing different herbicides. In the DEIS, herbicide use trends were based on the number of acres treated by each herbicide application. For example, ALS inhibitors, which have been largely replaced by the use of glyphosate, are used at 1% the rate of glyphosate. Thus as glyphosate use has increased and replaced ALS inhibitors, the same amount of treated acres would seemingly appear to have resulted in a 100 fold increase in herbicide use. APHIS agrees with the commenter that 2,4-D use is likely to increase if Enlist™ corn and soybean are deregulated. APHIS' estimates, based on assumptions of Enlist™ crop adoption provided by Dow, are found in Table 4-14 in Appendix 4 of the FEIS. Actual 2,4-D use on corn and soybean in 2011 is already at 5.4 million pounds for each crop. Under the No Action Alternative, 2,4-D use on corn and soybean is expected to increase to 16.2 and 13.5 million pounds, respectively by 2020. Under the action alternatives, 2,4-D use on corn is expected to increase up to 32 million-85.9 million pounds by 2020 depending on the scenario. For soybean, the increase is expected to be in the range of 31-70.1 million pounds.

**23. Comment:** According to agricultural scientist Dr. Charles Benbrook, widespread planting of 2,4-D corn could trigger as much as a 30-fold increase in 2,4-D use on corn by the end of the decade, given 2,4-D's limited use on corn at present. Overall 2,4-D use in American agriculture would rise from 27 million lbs. today to over 100 million lbs. 2,4-D soybeans and cotton would boost usage still more. Yet USDA has provided no analysis of the serious harm to human health, the environment or neighboring farms that would result. **(6905-007)**

**Response:** As stated in its response to comment #22, APHIS considers that Benbrook overestimates 2,4-D use. EPA, not APHIS has regulatory oversight over pesticide use. EPA regulates the pesticide used on those seeds or crops under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) and the pesticide residues remaining in or on food from those uses under the Federal Food, Drug, and Cosmetic Act (FFDCA). EPA has examined the effects of 2,4-D use to human health in the Human Health Risk Assessment (US-EPA, 2013b) and the environment in the Ecological Risk Assessment (US-EPA, 2013c). EPA has proposed label conditions that are expected to minimize drift limiting harms to neighboring farms. EPA has determined that use of the choline salt of 2,4-D in the Enlist Duo product would reduce volatility and off-site movement of the herbicide compared to other forms of 2,4-D. To ensure there is reduced off-target movement, the EPA's proposed registration decision pertains only to the same formulation as that employed in Dow's drift studies (US-EPA, 2014b). In addition, the proposed registration decision requires a 30-foot in-field buffer zone to help minimize spray drift from the intended use area (US-EPA, 2014b). The proposed label also specifies that Enlist Duo™ cannot be applied when the wind speed is over 15 mph (US-EPA, 2014b). No aerial applications would be permitted (US-EPA, 2014b).

**24. Comment**: APHIS's analysis of the risks associated with the expected increase in use of and exposure to 2,4-D is inadequate for three primary reasons: 1) it underestimates the rate of increase in 2,4-D use, 2) it does not fully explore the potential human health impacts related to increased 2,4-D exposure, and 3) it relies too heavily on EPA's assessment and regulation of 2,4-D's impacts and its use. The DEIS estimates that 2,4-D use will increase by approximately 75 to 300 percent from future predicted levels under the No Action Alternative. Other analyses, however, show that the use of 2,4-D could increase between 5- and 30-fold within the next decade as a result of deregulation of DAS 40278-9 corn alone. The estimate for a potential 5 fold increase in 2,4-D use is based on the following assumptions and calculations. The National Agricultural Statistics Services (NASS) indicates that as recently as 2010, farmers used approximately 1/3 lb per acre per application of 2,4-D, which is a fraction of the maximum label rate of 2 lbs per acre per application. Dow has indicated that, to be effective when used with DAS 40278-9 corn, growers need to apply 1 to 2 lbs per acre of 2,4-D. This will cause increase the per field use of 2,4-D, even though the label rate may not change. The change in actual application rates would increase the use of 2,4-D by 3-6 fold. The data also show that 2,4-D is used on approximately 10 percent of corn fields. Conservative, rough estimates suggest that 20-30 percent of corn fields will adopt DAS 40278-9 corn and use 2,4-D. This suggests a 2-3 fold increase in 2,4-D use based on the increased percentage of corn fields that had not previously, but will now be using 2,4-D. Taking the most conservative assumptions, at a minimum, we can expect at least a 5-fold increase in 2,4-D use due to DAS 20478-9 corn. This failure to reflect the true possibilities of 2,4-D's expansion likely renders APHIS's assessment inaccurate and insufficiently protective of public health and the environment. **(8094)**

**Response**: APHIS summarized its projections for 2,4-D use under the various alternatives in Table 4-14 in Appendix 4 of the draft EIS. The commenter feels that APHIS inaccurately estimated 2,4-D use under the Preferred Alternative. The commenter expects at least a 5 fold increase whereas APHIS concluded the increase would be 75% to 300% on all crop uses. In reviewing the commenter's detailed footnote (included in the comment above), APHIS notes that the commenter did not specify whether the 5 fold increase in 2,4-D use was just on corn or whether that increase applied to total 2,4-D use on all crops as APHIS calculated. If the former, there is no discrepancy between the commenter's calculation and APHIS'. For example, from the values in Table 4-14, APHIS predicts that 2,4-D use on corn would increase from 5.4 million pounds in 2011 to 32-85.9 million pounds in 2020 depending on assumptions. That would be an increase of 5 fold to 15 fold on corn (32-5.4)/5.4 to (85.9-5.4)/5.4. APHIS also noted a 4.7 to 12 fold increase on soybeans. Adding these amounts to 25.6 million pounds, the volume of 2,4-D used on crops in 2011, and assuming 2,4-D use on all other crops remains constant, APHIS calculated that crop use would increase from 25.6 million pounds to 77.8 to 176 million pounds depending on the scenario. These projections indicate a 2-6 fold increase in 2,4-D on all crops under the Preferred Alternative relative to the crop use in 2011. However APHIS noted that 2,4-D use has been dramatically increasing in corn and soybean. As noted in Appendix 4, 2,4-D use has increased 38% in corn over the past 3 years and over 80% on soybean in the past 5 years. APHIS expects that 2,4-D use would continue to increase under the No Action Alternative as greater numbers of corn and soybean growers use 2,4-D as a preplant burndown treatment in an effort to control glyphosate resistant weeds. APHIS estimated this number would grow from about 10% of corn and soybean growers currently to about 30% by 2020 resulting in an increase of 2,4-D crop use to 44.5 million pounds. The 75%-300% increase prediction by APHIS noted by the commenter is the predicted increase under the Preferred Alternative relative to 44.5

million pounds (the predicted future crop use) rather than 25.6 million pounds (the 2011 crop use).

EPA fully explores the potential human health impacts related to increased 2,4-D exposure in its risk assessments (US-EPA, 2013b; 2013a). APHIS disagrees that it relies too heavily on EPA's assessment and regulation of 2,4-D's impacts and its use. EPA has authority under FIFRA to regulate pesticide use. APHIS does not have such authority under the Plant Protection Act.

**25. Comment**: APHIS projects unchanged use of glyphosate in agriculture by 2020 under all Alternatives, assuming 225 million lbs./year (2011), based on third party proprietary data supplied by Dow (EIS at 4-33 and Table 4-13 at 4-35). However, the U.S. Geological Survey finds 250 million lbs. of glyphosate are used agriculturally, and that the long-term increase has not shown any signs of slowing (see figure below). APHIS reproduces a USGS map that portrays glyphosate use a decade ago (EIS at 4-27). Since that time, glyphosate use on corn has risen dramatically from 7.5 million lbs. to roughly 80 million lbs., while soybean use has increased from 70 million to roughly 100 million lbs. (see bar graph on USGS chart below). APHIS should replace that map with an up-to-date version that gives a true picture of glyphosate use today. **(6907).**

**Response**: APHIS has revised the FEIS to include the USGS estimate of 250 million pounds/year of glyphosate use and to update the most recent glyphosate use map. These revisions did not change any conclusions in the EIS. APHIS does not agree that glyphosate use has not shown any signs of slowing down. From the USGS pesticide use map for glyphosate from 2011 (Figure 4-10), the only crop showing an increase is corn. All the other crop uses are relatively stable and in some cases such as cotton and soybean, appear to be decreasing. The planting of glyphosate resistant corn has increased more gradually than the other crops but as of 2013 reached 85% which is near saturation (USDA-ERS, 2013a). For comparison, glyphosate resistant soybean has not increased beyond 90-93% over the last 8 years (USDA-ERS, 2013a). It is unlikely that glyphosate use on corn will increase beyond another 5% and this may be compensated by a decrease in glyphosate use on cotton and soybean. Consequently, APHIS does not expect glyphosate use to continue to increase beyond 250 million pounds/year.

**26. Comment:** It is not surprising that APHIS found that "glufosinate use on soybean could increase" in its draft Environmental Assessment of DAS-68416-4 soybeans (APHIS DEA at 80). What is surprising is APHIS's entirely new and unfounded assumption in the EIS: "Glufosinate use is expected to increase under the No Action Alternative *but is expected to decrease under the Preferred Alternative* based on the expectation that 2,4-D is considered a more favorable option for glyphosate resistant weed control compared to glufosinate." (emphasis added, EIS at 119) There are a number of good reasons to expect a substantial increase in glufosinate use with deregulation Enlist™ soybeans, besides the obvious fact that Dow anticipates it. First, APHIS's assumption that growers will choose 2,4-D *instead of* glufosinate for control of glyphosate-resistant and other weeds is agronomically naïve, and likely to be false in many cases where combined use is preferable. Weed scientists have found that using a combination of glufosinate and 2,4-D is more effective than using either one alone in controlling glyphosate-resistant Palmer amaranth (EIS at 2-25) as well as GR common waterhemp, barnyardgrass and Asiatic dayflower (Craigmyle 2013). Combined use of 2,4-D and glufosinate would not preclude use of glyphosate as well, especially a few years down the line as more weeds evolve resistance to 2,4-D and/or glufosinate. Second, a growing number of grass weeds have evolved resistance to glyphosate (EIS at 4-38). Because 2,4-D does not control grass weeds, a 2,4-D/glyphosate combination would be ineffective, and in such cases glufosinate (which does kill grass weeds) would be a logical choice. Third, there has been a tremendous rise in glufosinate use on both cotton and soybeans over the past few years by growers battling GR weeds. In fact, adoption of glufosinate-resistant soybeans (Bayer's LibertyLink varieties) and glufosinate use have both tripled from just 2011 to 2012 (see table below). These developments show increasing receptivity to use of this herbicide by a growing number of farmers plagued by glyphosate-resistant weeds, especially in the Southeast. This trend would likely continue with introduction of Enlist soybeans. CFS estimated that glufosinate use on soybeans could rise to 19.2 million lbs. by 2025, based on current glufosinate usage rates and 45% adoption of Enlist soybeans by that time (CFS Science Soy, 10-11). This would represent a more than 12-fold increase in use over the 1.536 million lbs. used in 2012. Elsewhere in the EIS, APHIS concedes indirectly that Enlist soybeans would lead to increased glufosinate use, in direct contradiction to its statements quoted above. For instance, APHIS admits that: "Selection of weeds resistant to glyphosate, auxins, chloroacetamides, ALS inhibitors, *and glufosinate* will still occur under the Preferred Alternative" (emphasis added, EIS at 139), which implies glufosinate use on Enlist soybeans. Similarly, APHIS admits that such weeds will erode the utility of Enlist soybeans: "weeds resistant to glyphosate, 2,4-D, *and glufosinate* will limit the use of this product [Enlist soybeans] and any benefit to soil that may arise" (emphasis added, EIS at 144), which would not be the case if glufosinate were not applied. APHIS must revisit the issue of glufosinate use with Enlist crops, and provide a projection of its increased use that accords with known facts and trends. **(6907)**

**Response**: APHIS acknowledges that the wording at DEIS 119 was unclear and has made a revision. The point that APHIS intended to convey is that the use of glufosinate is expected to be less under the Preferred Alternative than under the No Action Alternative because the availability of the Enlist™ cropping system will reduce the reliance on glufosinate. APHIS said as much on p.4-39: "Most likely, the use of glufosinate would not increase under the Action Alternatives relative to the No Action Alternative. Possibly, glufosinate use will decrease relative to the No Action Alternative if 2,4-D is considered a more favorable option for glyphosate resistant weed control compared to glufosinate." The commenter suggests that glufosinate use on soybeans could rise to 19.2 million pounds by 2025 based on current glufosinate usage rates and 45% adoption of Enlist™ soybeans. However, the commenter fails to mention that glufosinate resistant varieties are currently available under the No Action Alternative and could account for this increase in the absence of Enlist™ corn and soybean. In other words, anyone who would have chosen to use glufosinate on Enlist™ soybean would probably have also chosen to use glufosinate on a glufosinate tolerant soybean such as Liberty Link®. Furthermore, it is reasonable to expect that if Enlist™ soybean is not available to control glyphosate resistant weeds, that there would be even more growers who chose to use a glufosinate based cropping system compared to the situation where an Enlist™ cropping system is available, because not every Enlist™ user is going to need to use glufosinate. APHIS considers the relative herbicide use between the No Action and the Action Alternatives and stands by its original conclusion that glufosinate use is not expected to increase relative to the No Action Alternative and that the increase in glufosinate under the Preferred Alternative is likely to be less than the increase under the No Action Alternative.

**27. Comment:** In its draft Environmental Assessment for Enlist corn, APHIS found that DAS-40278-9 "is expected to result in an increase in the use of the herbicide 2,4-D in corn, as well as the new use of quizalofop on corn" (DEA at 42). As with glufosinate, APHIS has made an about face in the EIS and projects declining use of quizalofop under the Preferred Alternative (EIS at 119) where it had earlier projected increasing use. APHIS assessment is wrong here as well.

Enlist corn is endowed with resistance to grass "fops" herbicides like quizalofop and cyhalofop by virtue of the same AAD-1 gene that confers 2,4-D resistance. Quizalofop is not currently applied to corn, because, as a grass-family crop, quizalofop would kill it. Enlist corn provides a new option for corn growers seeking to control grass weeds, especially but not only those with glyphosate-resistance. While most GR weeds are broadleaf plants, a growing number are grasses. APHIS notes that six grass weeds that have evolved glyphosate-resistance in the U.S.: junglerice, goosegrass, Italian ryegrass, rigid ryegrass, annual bluegrass and Johnsongrass (EIS at 4-38). In fact, there are 17 distinct populations of these glyphosate-resistant grass weeds in eight states, and nine of them are found in corn, soybeans and/or cotton, and of course corn and soybeans are very frequently rotated on the same fields. APHIS assumes that quizalofop will not be used "in the near future" to control such weeds because "the affected area is still small," without however providing any documentation (EIS at 4-38). In any case, a "near future" assessment is not adequate in an agricultural landscape with continuing rapid evolution of glyphosate-resistance. For instance, Dow projects that two serious corn weeds will evolve resistance to glyphosate within five years (barnyardgrass and foxtail). Clearly, one can expect some corn growers to make use of quizalofop to control GR grass weeds of the present or near future. Others would choose it to control one or more of the 16 grass weed species that APHIS notes are problematic in corn and soybeans (9) or just corn (7), whether glyphosate-resistant or not (EIS at 5-10, Table 5-2). CFS projects that Enlist corn could reasonably lead to 868,000 lbs./year quizalofop use on corn (versus zero at present), assuming that Enlist corn is grown on 55% of overall corn acres, and that just 20% of those growers use quizalofop at the proposed annual label rate of 0.082 lbs./acre (CFS Corn I, p. 9). APHIS's argument for a reduction of quizalofop use is speculative and illogical (EIS at 4-38 and 4-39), and rests primarily on assuming no use on Enlist corn, which as argued above is highly unlikely. APHIS asserts (without documentation) that soybean growers who presently use quizalofop on soybeans employ it mainly to eliminate volunteer corn in their soybean fields, and that if those same growers *also* adopt Enlist corn, they would no longer be able to use it for this purpose. However, only 2% of soybean acres are presently treated with 120,000 lbs. of quizalofop. Even if some of this current usage were eliminated, it would not come near to counterbalancing the increased use of quizalofop on Enlist field corn. **(10202)**

**Response**: APHIS disagrees with the commenter. Grasses are effectively controlled in corn, not just with glyphosate but with other herbicides that are commonly used such as acetochlor, metalochlor, and atrazine. The commenter notes that barnyardgrass and foxtail are expected to develop resistance to glyphosate in the next five years and this is a reason that quizalofop use might increase on corn. According to the International Survey of Herbicide Resistant Weeds (Heap, 2013) and as noted in Appendix 6, many problem grass weeds of corn and soybean have already developed resistance to quizalofop in the US including barnyard grass, foxtail, johnsongrass, crabgrass, wild oat, downy brome, and Italian ryegrass. APHIS does not expect quizalofop to be used for grass control on corn because several more effective herbicide chemistries are available.

**28. Comment:** Roundup Ready (RR) cropping systems are instructive. Glyphosate use increased by astronomical proportions after RR crops were adopted, an increase of 527 million pounds of herbicides applied between 1996 and 2011.In Iowa alone, the nation's leading soybean state, 952,000 pounds of glyphosate were applied on 15 percent of the state's soybean acreage the first year RR soybeans were offered (1996). Within ten years, glyphosate use grew eight-fold. Farmers applied 12 million pounds of glyphosate on more than 90 percent of Iowa's soybean acreage. This increase is not surprising given the intent was inherent in the design of the seed. Not only has the RR trait increased herbicide use, it has compounded weed problems. Glyphosate resistant weeds are now recognized as one of the largest production challenges for farmers who operate in infested areas. In 2012, nearly half of U.S. farmers responding to a survey said they have glyphosate-resistant weeds on their farm, up from 34 percent of farmers in 2011. This survey also estimated that more than 61 million acres of U.S. cropland are infested with glyphosate-resistant weeds, a number that has almost doubled since 2010. Research suggests that if 2,4-D corn is introduced, we could see more than 103 million pounds of 2,4-D applied to U.S. corn fields by 2019. By comparison, in 2010, about 3 million pounds were applied to U.S. corn fields. Such an increase is unacceptable, and will only exacerbate the serious outbreak of weeds resistant to glyphosate, 2,4-D, and other herbicides. This increase is also unacceptable given the unnecessary health risks to farmers and their communities. **(9716)**

**Response:** As noted in the response to comment # 22, APHIS does not agree with the high estimate of 2,4-D use noted in the comment. APHIS also does not agree with the commenter that herbicide use compounds weed problems. Herbicide use offers a solution to weed problems, even if only for the short-term. If weeds become resistant to the herbicide, that may result in a loss of benefits obtained with the herbicide resistant crop. In the worst case, the production challenges are no worse than under the No Action Alternative. Growers may increasingly adopt integrated weed management techniques that prolong the usefulness and benefits of the technology.

**29. Comment:** We note the USDA states, "The primary purpose of Enlist™ corn and soybean varieties is to help growers manage GR weeds." We also note the USDA states: "Based on the existing trend of increased used of 2,4-D over the last decade (ie, without these 2,4-D resistant crops), APHIS projects that 2,4-D use will increase by nearly 75% by 2020 under the No Action Alternative. If EPA registers Enlist Duo™ herbicide for Enlist™ corn and soybean and APHIS adopts the Preferred Alternative, APHIS expects that 2,4-D use will further increase by ***another*** two fold to six fold (depending on the assumptions made) relative to current use."

Taken together these are an astonishing admission that previously deregulated GM crops have not only failed to perform as expected, but that they have caused such serious agronomic difficulties that the USDA now feels compelled to take the dramatic action of knowingly increasing the toxic load on our bodies and habitats despite the clear evidence that this approach is ultimately futile (as the development of further, spreading weed resistance is effectively assumed by USDA throughout the EIS8). Coupled with the ongoing failure to properly assess known compositional differences in GM crops (which clearly demonstrates that we know GM itself is causing something fundamental to happen in the crops but we don't fully understand what, how much, how severe, where or its implications, again rendering substantial equivalence seriously problematic as a concept) this response based on escalating reliance on GM technology for such large swathes of food production and economic activity is seriously flawed.

The lessons of this approach are wearing through now, as weeds and pests resistant to alleged GM "fixes" are now serious problems for US farmers. US farmers simply would not be facing the astonishing superweed and superpest problems they now grapple with, or any of the economic penalties they bring, if GM was not there. The USDA itself says:

"Because of the likely adverse socioeconomic impacts that would result in the event that 2,4- D resistant weeds would be selected from the expected increased 2,4-D use on Enlist™ crops, APHIS believed these impacts may be significant."

The rise and ongoing spread of superweeds are sufficient plant pests for USDA to reject these crops outright. Further exacerbating the problem cannot be justified as a "Preferred Alternative".

We also object because Europeans will be directly affected by these problems, including because Europe imports a good deal of GM material, particularly for animal feed, which we also oppose. **(7680)**

**Response**: As noted in the response to comment #5, APHIS does not regulate herbicide resistant weeds under 7 CFR part 340.

APHIS does not agree that the selection of herbicide resistant weeds, as a result of the use of herbicides on herbicide resistant crops, represents a failure of herbicide resistant crops. Many commenters noted that herbicide resistant crops offer the best weed control available (see for example comments 36-45). The unprecedented adoption rate (85% of corn and 93% of soybean grown in the U.S. (USDA-ERS, 2013a)) is a testament to the value that farmers derive from growing these crops. As noted in response to comment #28, the worst case scenario of herbicide resistant weeds is a loss of benefits that return farming to the status quo prior to the introduction of the technology.

The commenter does not explain what is meant by "superpest" and whether there is any distinction from "superweed". APHIS is familiar with the term "superweed"-it is often used by critics of biotechnology to describe plants that are resistant to glyphosate. However despite the inference, these plants are indistinguishable from sensitive plants except for their resistance to the herbicide. The commenter makes it seem as though widespread selection of herbicide resistant weeds are a unique property of herbicide resistant crops. Rather they are a function of over reliance on herbicides for weed management and have occurred with conventional crops too. For example, there was a time when farmers were over reliant on ALS inhibitors onconventional crops and now ALS resistant weeds are much more widespread than glyphosate resistant weeds. One weed scientist asserted that half of the waterhemp plants in any given field in Illinois are estimated to be resistant to ALS inhibitors (Tranel *et al.*, 2011). Another weed scientist noted in comment #43 that weeds have developed resistance to nearly all forms of weed management including herbicides, tillage, mowing and even hand weeding.

**30. Comment**: The DEIS also fails to provide essential and basic data concerning the amounts of the other three herbicides over time. The analytical value of disclosing herbicide use in this context can only be determined if we know the amount of quizalofop used each year during that time period, and current to 2013. This failure does not provide the detail necessary to fulfill NEPA's hard look and scientific integrity requirements. These data are readily available from EPA. In conclusion, the EIS must include a year by year disclosure of the amounts of all 4 herbicides used nationally. This should date back to the earliest records for which data are available, and conclude with data for 2013. **(3105)**

**Response**: APHIS disagrees with the comment that the DEIS fails to provide essential and basic data concerning the amounts of the other three herbicides over time. APHIS has indicated the trends in the use of all the major herbicides used on corn and soybean grouped by site of action spanning years ranging from 1990-2011 in Figures 4-1 and Figure 4-3. In Appendix 4, APHIS has analyzed the predicted use of quizalofop, glufosinate glyphosate, and 2,4-D use under the Preferred Alternative finding that quizalofop and glufosinate use are likely to be unaffected or decline, that glyphosate is unlikely to change, and that 2,4-D use is likely to increase relative to the No Action Alternative.

**31. Comment**: USDA also says, "Glyphosate use on corn and soybean are not expected to increase under the no action and Preferred Alternatives because of market saturation." This may be true, but it at best glosses over the fact that glyphosate use is already on the rise to control GR weeds, and since industry tends to push responsibility back onto farmers for control of resistant weeds advising use of "additional herbicides or tank mixes", a more reasonable assumption would be that both glyphosate *and* 2,4-D *and* other chemical use will rises considerably as weed resistance spreads. **(7706)**

**Response:** APHIS disagrees with the comment. In areas such as the southeast where glyphosate resistant weeds are problematic, glyphosate use is decreasing (Appendix 4). APHIS has noted in the DEIS that other chemistries such as chloroacetamides may continue to increase. Certain chemistries such as ALS inhibitors and PPO inhibitors, where resistance has been or is becoming a problem, are likely to decrease.

**32. Comment:** The effects of combinations of toxic chemicals, particularly of low-level long-term sub-lethal exposure, to either humans, animals or the environment are little understood. According to PAN, a review of 2,4-D by the UK Advisory Committee on Pesticides noted that, "Approval holders must generate a number of toxicology/operator exposure studies to allow a full risk assessment to be made." If adding to this burden in ignorance is the "preferred" option, this is an admission that authorizing this crop, coupled with ineffective enforcement of the mitigation measures put forward as the solution to the problem, will store up serious problems for the future, not least for farm workers. The USDA admits that the toxic load on the environment will increase, saying, "Growers are expected to become less reliant on glyphosate for the control of weeds it is no longer effective in controlling. Growers will likely continue to use the herbicide because it is still effective on hundreds of weed species. However, farmers are expected to depend on additional chemical and non-chemical methods to control the glyphosate resistant weeds, too." This is an admission that the promises made for the Roundup Ready generation of GM crops have proved entirely empty and that the U.S. Government's rush to adopt the technology uncritically has painted regulators into a corner whereby the problems caused are now so great something must be done to mitigate. Wisdom and hindsight would suggest that repeating that mistake with a new class of herbicides is short-sighted and has potentially vast implications for U.S. food production – as more herbicides are rendered useless by overuse on GM crops, and since USDA admits that, "Fewer growers would be expected to adopt aggressive tillage when herbicides remain effective for weed control", and since *Science* reports, "…[A]t an American Chemical Society symposium, chemists said they have little to offer: Few new weed killers are near commercialization, and none with a novel molecular mode of action for which there is no resistance, a more prudent course of action would be to protect the efficacy of remaining herbicides by restricting their use rather than giving a green light to increase their use, and certainly not by the percentages predicted by the USDA, with little or no monitoring." **(7706)**

**Response:** EPA, and not APHIS, regulates pesticide use. In an effort to address the emergence of herbicide resistant weeds, EPA is requiring DAS to develop a stewardship program that will promote resistance management efforts (US-EPA, 2014b). The plan mandates that DAS must immediately investigate any claims of non performance (US-EPA, 2014b). The label includes a requirement to scout fields to determine weed species present as well as their stage of growth (US-EPA, 2014b). Scouting 7-21 days after herbicide application will be used to assess the performance of weed control (US-

EPA, 2014b). Possible incidents of resistance must be promptly investigated and resolved (US-EPA, 2014b). DAS must take immediate action to eradicate likely resistant weeds in the infested area (US-EPA, 2014b). Several management practices that are designed to help users avoid initial occurrences of weed resistance will appear on the product labeling under the Resistance Management heading of the label (US-EPA, 2014b).

**33. Comment:** The AAD-12 enzyme that makes both Enlist soybean events resistant to 2,4-D and related chlorophenoxy herbicides also confers resistance to pyridyloxyacetate herbicides such as triclopyr and fluroxypyr (Dow Petition at 116; EIS at 4). However, APHIS fails to specify that DAS-68416-4 and DAS-44406-6 soybeans are in fact resistant to these herbicides (EIS at 2, 152), perhaps because (to our knowledge) Dow has not explicitly proposed their use with Enlist soybeans at this time, or petitioned EPA for the needed registrations. However, Dow scientists clearly envision at least the potential for such use. In a scientific paper, they demonstrated that a model plant (*Arabidopsis*) genetically engineered to contain the AAD-12 enzyme found in Enlist soybeans survives high rates of triclopyr and fluroxypyr (2.24 kg ae/ha = 2 lbs/acre). Based on the activity of the AAD-12 enzyme in "degrading the synthetic auxin herbicides triclopyr and fluroxypyr", they stated: "This activity gives AAD-12 potential utility for providing resistance to a wider repertoire of synthetic auxins beyond 2,4-D and thus enables expanded broadleaf weed control" (Wright et al 2010). APHIS should amend the EIS to include pyridyloxyacetate herbicides such as triclopyr and fluroxypyr among the herbicides to which Enlist soybeans are resistant (e.g. EIS at 2, 152). CFS concedes that it would be difficult to model potential use of these herbicides under the Preferred Alternative. However, because farmers have in the past made use of an undisclosed herbicide-resistance trait in a GE crop by applying the corresponding herbicide post-emergence against the advice of both crop and herbicide developers (Golden 2010), it is important that the EIS be amended to reflect the biological possibility of applying these herbicides to Enlist soybeans. **(10202)**

**Response**: APHIS acknowledges that Enlist™ soybean is also resistant to herbicides such as triclopyr and fluroxypyr. However, Dow has informed APHIS that they currently have no intent to register these herbicides with EPA for use on Enlist™ soybean. Without registration, it is unlawful to apply triclopyr, fluoroxypyr, or any other pyridyloxyacetate herbicides to Enlist™ soybean. In the case of Golden 2010 cited by the commenter (Golden, 2010), glufosinate was used on widestrike cotton against the advice of both crop and herbicide developers because the variety had a low level of resistance and could be damaged by the treatment. While not recommended, the use of glufosinate on cotton is lawful because its use has been registered on cotton. In contrast, no other auxinic herbicides are registered for post-emergent use on soybean. Therefore it is not reasonably foreseeable that these herbicides will be used on Enlist™ soybean and they will not be analyzed in the EIS.

**34. Comment**: If these seeds are approved, it is likely that the use of triclopyr and fluroxpyr will also increase. Fluroxypyr is marketed by Dow as Starane. Triclopyr is marketed as Garlon and is also contained in Crossbow. These are very potent and persistent broadleaf weed killers. Yet the agency's EIS does not address the impact of the herbicides on other crops, the environment, or human health. **(9377)**

**Response**: see response to comment #33

**35. Comment:** APHIS relies excessively on "third party proprietary" herbicide use data provided to it by Dow, which did not even give the name of the firm that provided it with the data. APHIS merely assumes that these data were "reported correctly" by the unnamed firm to Dow, and by Dow to APHIS. APHIS's justification for reliance on these data – "In recent years, herbicide use data has generally not been publically available" (EIS at 4-2) – is entirely inadequate. APHIS is referring here to gold-standard pesticide (including herbicide) usage data collected periodically by USDA's National Agricultural Statistics Service. While USDA NASS does not collect data for all crops every year, it has collected pesticide use data for all of the years in many of the tables and graphs in Appendix 4 of the EIS (e.g. EIS at 4-5). APHIS could have made use of NASS data if for no other purpose than to check the veracity of the proprietary data in years where the former were available, especially recent NASS data for corn (2010) and soybeans (2012), to which APHIS makes no reference. **(10202)**

**Response**: APHIS does not agree that it relied excessively on "third party proprietary" herbicide use data. NASS data is incomplete for the years included in the EIS analysis. The latest year NASS published herbicide use data for corn and soybean in the same year was 2003 for 2002 data. Furthermore, NASS data is limited in its description of how herbicides are used. For example, it does not include the number of sites of action applied per acre, or the herbicide used when only one site of action is used. Nor does it indicate whether the herbicides are used pre or postemergent or reveal use by market segment. APHIS relied on third party proprietary data accessed by Dow from GfK Kynetec's AgroTrak Agricultural Pesticide Usage Data. This source of pesticide usage data is the most comprehensive in the industry and is the same data source used by other government agencies that report on pesticide usage, namely the EPA and the US Geological Survey (US-EPA, 2012b; USGS, 2012). APHIS also relied on data from the EPA (Table 4-7) and USGS (Figure 4-8, Figure 4-9, Figure 4-10) however these data are also based on data derived from GfK Kynetec's AgroTrak Agricultural Pesticide Usage Data.

**36. Comment**: Recently, I served as lead author on a herbicide resistance paper commissioned by USDA-APHIS, accepted for publication in *Weed Science*, that outlines the best management practices (BMPs) that can be used to mitigate the risk of herbicide-resistant weeds evolving, general challenges to adoption of BMPs, the current level of adoption of BMPs, and recommendations for academia, industry, and governmental agencies to overcome obstacles to adopting the BMPs. Below, the BMPs as outlined in the publication are included:

1. Understand the biology of the weeds present.
2. Use a diversified approach toward weed management focused on preventing weed seed production and reducing the number of weed seed 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 (MOAs) that are effective against the most troublesome weeds or those most prone to herbicide resistance.
7. Apply the labeled herbicide rate at recommended weed sizes.
8. Emphasize cultural practices that suppress weeds by using 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 after harvest to prevent a buildup of the weed seedbank.
12. Prevent an influx of weeds into the field by managing field borders.

I have modeled resistance of Palmer amaranth to glyphosate in cotton and used this and other research as the basis for several of the above BMPs. For instance, it is known that multiple effective modes of action are necessary to minimize selection pressure placed on a weed from any single herbicide. Unfortunately, there are no over-the-top control options for Palmer amaranth in cotton, other than glufosinate in Liberty Link cotton, due to resistance to both glyphosate and the acetolactate synthase (ALS)-inhibiting herbicides such as pyrithiobac and trifloxysulfuron. In a recent screening of over 400 Palmer amaranth samples from Arkansas, more than 90% tested positive for glyphosate and ALS resistance. In soybean, postemergence control is limited to only one herbicide, that being fomesafen, in non-Liberty Link soybean, a prescription for herbicide resistance to fomesafen. Furthermore, fomesafen is only effective when Palmer amaranth is smaller than 4 inches in size. Palmer amaranth can grow in excess of 2 inches per day, making proper timing of fomesafen quite challenging. Furthermore, populations of waterhemp, a weed closely related to Palmer amaranth, have evolved resistance to fomesafen and other protoporphyrinogen oxidase (PPO)-inhibiting herbicides, and with the extensive use of this mode of action in cotton and soybean, the likelihood of resistance to the PPO inhibitors is high.

Preventing weed seed production and reducing the soil seedbank is also critical to sustainability of herbicides because the risk of resistance is closely correlated with the size of the soil seedbank. With a high density of Palmer amaranth in the soil seedbank and no over-the-top control option in cotton other than glufosinate, it is likely that resistance to glufosinate will occur rather quickly unless additional postemergence options soon become available. For certain, the $20 million spent on handweeding in 2011 is not sustainable, meaning the integration of effective herbicide options with other control strategies are desperately needed in the Midsouth.

The availability of multiple herbicide technologies and mode of action diversity is a critical component of the above mentioned BMPs. Dow AgroSciences is investing in the development of the Enlist technology that enables the use of 2,4-D, glufosinate, and glyphosate, multiple modes of action, in crops such as cotton and soybean for weed control. The herbicide 2,4-D has been well researched over the past 60 plus years and is currently labeled for use along roadsides, in range and pasture, in cereals, and as a burndown herbicide prior to planting many crops, among other uses. I have evaluated 2,4-D and glufosinate in Enlist cotton and soybean and found the herbicides, especially the two-way combination, to be an effective option for controlling glyphosate-resistant Palmer amaranth as well as other common broadleaf weeds in these crops.

Overuse of any product or technology will rapidly lead to herbicide resistance, but if properly integrated into our current production systems using the above BMPs, the Enlist technology will aid in protecting currently available herbicide modes of action. Additionally, the Enlist technology will provide an effective solution for controlling Palmer amaranth and other common broadleaf weeds of cotton and soybean. **(6165)**

**Response**: The analysis in the EIS is consistent with these comments.

**37. Comment**: We have issues with several resistant weed species on Virginia's Eastern Shore and throughout the Delmarva Peninsula including smooth pigweed (*Amaranthus hybridus*) (Whaley et al. 2006, Poston et al. 2002, Manley et al. 1998, Vencill and Foy 1988) and horseweed (*Conyza canadensis*) (Bradley and Wilson 2003, VanGessel 2001). In addition we have recently confirmed the presence of glyphosate-resistant Palmer amaranth (Vollmer et al. 2014) and suspect populations of ALS-resistant Palmer amaranth on the Delmarva Peninsula. This is not uncommon for this particular species. Additional studies have shown members of this particular genus to be resistant to multiple modes-of- action including glycines (Culpepper et al. 2006, 2008), ALS-inhibitors (Sprague et al. 1997), dinitroanalines (Gossett et al. 1992), and triazines (Foes et al. 1998). Weed scientists and growers across the country are not only looking for new ways manage these weeds, but also for ways to prevent the selection of herbicide resistant weed species. Glyphosate has the ability to control many different weeds at different growth stages; however, with the onset of glyphosate-resistance there are a limited number of herbicide options for our growers. The stacked traits in the Enlist™ system will allow our growers to plant crops tolerant to 2,4-D, glyphosate, and glufosinate. The ability to use multiple herbicides not only provides a more viable option for weed control, but it also helps to reduce selection pressure for herbicide resistant weeds. We have learned a great deal in our battle with herbicide resistant weeds; the most important lesson being not to rely on a single mode-of-action for weed control. This new technology should be used as a tool, not as a silver bullet for weed control. **(6561)**

**Response**: The analysis in the EIS is consistent with these comments.

**38. Comment**: I'm a fourth generation Indiana corn, soybean, popcorn, and wheat farmer. I work with my father and grandfather every day on our 2,100 acre farm along with one full time employee. We take great pride in tending the land we raise our crops on, and we make use of today's latest technologies in combination with many years of agronomic education and experience. We don't utilize every tool in our agronomy toolbox every year in every field, but it's good to have a wide selection of tools available to meet any challenge. Dow AgroScience's Enlist com and soybeans and Enlist Duo herbicide could be one of those tools.

Right now in Indiana we are not facing a dire problem with tough to kill weeds like Palmer amaranth as some of my farming friends in the Southern states have. However, as Enlist has been under review with USDA for 4 years now and 3 with EPA, I've seen certain weeds become more prevalent in some of our fields. Marestail (or horseweed) is becoming tough to control in recent years. This is due in part to some of the population being resistant to glyphosate, but the ability of this weed to emerge throughout the entire growing season makes it tough to control especially in soybeans. I know 2,4-D is very effective on marestail when I can spray weeds with 2,4-D in areas where I won't do damage to a crop like soybeans. Palmer amaranth showed itself on our farm this year. I found several plants during soybean harvest in 2013. I'm sure the agencies are well aware of the economic threat this weed poses as it continues to cause major issues for Southern growers.

I'm in a position now where I believe we can take care of these problem weeds before they have the devastating effects on yield farmers in the South and Southeast have witnessed first- hand. I could incorporate an Enlist crop in select fields to help push back against these difficult to control weeds. With the ability to lay down a dual mode of action herbicide like Enlist Duo in season I'm certain we can manage these weeds with a high degree of success. Enlist would be incorporated into our current weed control program that employs fall and/or spring burn downs with residual activity.

I've seen the Enlist program at work in tests both in the lab and in the field, and I must say I've been very impressed. Most impressive is the formulation of2,4-D in Enlist Duo. Drift, volatility, and odor issues with 2,4-D have been greatly improved upon. And these improvements build on decades of safe use of glyphosate and 2,4-D in agriculture and other industries. Farmers and custom applicators are very familiar with these two products as I'm sure are USDA and EPA. The industry knows these are two proven products now made even better with the Enlist program. Today anyone can walk into a home improvement store and buy glyphosate and 2,4-D off the shelf for personal use, and apply them safely and effectively by simply reading the labels. These two herbicides have been tank mixed together for decades for farm, home, and commercial use. Putting an improved formulation in the hands of experienced professional applicators seems like a safe bet to me.

Our farm is in a transition now where we are moving to more no-till acres and even incorporating cover crops on some of those acres. The rest of our acres are in minimum tillage. We believe reducing tillage whenever we can is good both for the soil and for the financial sustainability of our operation. We don't want to go back to steel as a primary method of weed control. Before Roundup Ready soybeans came along we often ran a rotary hoe two or three times before we even planted a field to soybeans. I spent countless hours walking hundreds of soybean acres trying to cut down the worst weed patches by hand which, by that point, wouldn't have saved any yield. The damage would have already been done. Now we enjoy cleaner fields with fewer inputs such as fuel, time, and equipment necessary for tillage. We are better able to practice no-till and minimum till to maintain and improve the quality of our soils. The Enlist suite of crops and herbicide can be a tool for us to continue farming in this fashion. Is Enlist the only thing that can keep us on this sustainable path? No, but it's a tool we should have access to. No farmer would rely on one wrench in his shop to fix everything. Rather he should have a large assortment of tools at his disposal to address whatever obstacles he may encounter. **(7031)**

**Response**: The analysis in the EIS is consistent with these comments.

**39. Comment**: I am a fourth generation family farmer from east central North Dakota. My family runs a small grain and row crop farm, a small private elevator, and cow/calf and heifer development program.

Up until 5-6 years ago our farm primarily focused on small grain production. We grew primarily spring wheat, winter wheat, barley, flax, peas, and sunflowers. In 2003 we were growing less than 1000 acres of soybeans and less than 800 acres of corn. Since then we are growing more than 4000 acres of soybeans and 3000 acres of corn on 13,000 acres. Most of our neighbors have switched to 100% corn and soybean rotations, while we try and maintain a 50/50 small grain row crop rotation.

In that short amount of time with the use of Glyphosate there has been a large increase in weed pressure. We are currently fighting with Glyphosate resistant kochia with resistant ragweed slowly moving in. The severity of resistance is almost evident from farm to farm depending on management practices. This past fall we were looking at renting some land 3 miles away from a current farm. When we went to inspect the field to evaluate it for the bid we were in shock at what we found. We drove through 6 foot tall kochia plants to find the soybeans that had been planted there. Needless to say we did not bid on the property as cost to get it back in shape with the resistant weed pressure would have been extremely high! My guess because of the weed pressure is the yield of that field was half of what our crop was less than 3 miles away! It will soon get to the point where management of the resistance weeds, without new chemicals and technology will be next to impossible. Our land is our livelihood and keeping the land clean and productive is our number one goal. By approving this technology you are giving the farmers another tool in which to fight this problem and help from the further spread of other resistant weeds. **(9963)**

**Response**: The analysis in the EIS is consistent with these comments.

**40. Comment**: I have a great deal of experience in the weed control field having conducted research and extension activities over the past 10 years in academia as well as over 20 years experience working with farmers advising them on row crop production practices. I believe the new Enlist technology will provide corn, soybean and cotton growers several more tools to manage weeds particularly herbicide resistant weeds which yearly are becoming more challenging.

From a weed control standpoint, in Tennessee and indeed, many states are quickly becoming infested with several glyphosate resistant (GR) weeds (Heap 2012). One that is of most concern is GR Palmer amaranth (*Amaranthus palmeri* S. Watts) which has been identified in many southern states (Heap 2012, Doherty et al. 2008, Steckel et al. 2008, Culpepper et al. 2006,). Palmer amaranth is one of the most competitive weeds in the world and left even partially controlled can dramatically reduce yield (MacRae 2008, Steckel 2007, Horak et al. 2000). Moreover the development of GR in Palmer amaranth as well as other weeds like horseweed has increased tillage in our state which is not long-term sustainable with our topography.

Up until 2005, glyphosate provided complete control of this weed. Unfortunately that is no longer the case and as of today all counties in Tennessee that grow row crops have fields infested with this new Palmer biotype. Moreover, Palmer amaranth that is resistant to glyphosate is also in most cases resistant to at least 1 and in some cases two or three other herbicide modes of action. The reason for this weed to evolve resistance to these herbicides is due to a lack of weed control diversity in our row crop agriculture. The only way to have diversity in controlling this and other weeds is to have more weed control options to utilize. The Enlist technology will provide several more herbicide options that a grower can utilize to manage weeds particularly GR weeds.

Of course, herbicides alone are only part of the management of Palmer or any weed. However, with farmers employing a complete weed management system that employs cultural methods such as crop rotation, tillage where appropriate, cover crops, etc. along with utilizing herbicides that the Enlist trait provides tolerance as well as other herbicides should provide more long-term durable weed control than what is being experienced today. This sustainability is very important to feed the growing population of the future. **(5286)**

**Response**: The analysis in the EIS is consistent with these comments.

**41. Comment**: Herbicide-resistance has significantly changed agriculture forever in the Southeast; especially for cotton growers. An in-depth face-to-face survey with growers was conducted in an effort to document the impacts herbicide resistance has had and is continuing to have on agriculture and our ability to feed and clothe the world (Sosnoskie and Culpepper 2013). To combat this pest, growers have relied heavily on herbicides, tillage, and hand weeding. Herbicide use in cotton has increased sharply with 2.5- times more herbicide active ingredient applied to cotton following the confirmation of glyphosate resistance in Palmer amaranth as compared to before documented resistance. Although grower herbicide input costs have more than doubled following the evolution and spread of glyphosate resistance, Palmer amaranth control is still not adequate. Thus, 92% of Georgia cotton growers hand-weed 52% of the crop with an average cost of $23 per hand-weeded acre, which is an increase of at least 475% as compared to hand weeding costs prior to resistance. In addition to increased herbicide use and hand weeding, growers in Georgia have indicated that they are using mechanical, in-crop cultivation (44% of acres), tillage for the incorporation of preplant herbicides (20% of the acres), and deep turning (19% of the acres every three years) to aid in Palmer amaranth control. Current weed management systems are extremely diverse, complex, less environmentally friendly, and costly when compared to those systems employed only a decade ago. Growers are in desperate need of new technologies that will aid in the management of glyphosate-resistant Palmer amaranth, and other problematic weeds, for long term sustainability **(1911)**.

**Response:** APHIS acknowledges the comment that growers are in need of new technologies that will aid in the management of glyphosate resistant weeds. As most of the comment concerns cotton, which is not the subject of the EIS, the specific information was not incorporated into the EIS.

**42. Comment:** Neither dicamba nor 2,4-D are consistently effective in controlling Palmer amaranth larger than 4 inches when applied alone (Culpepper et al. 2010; Culpepper et al. 2011; Merchant et al. 2011); however, weed management systems including these herbicides are more consistently effective than current standards (Braxton et al. 2010; Beckie 2011; Merchant et al. 2013; Richburg et al. 2012; Shaw and Arnold 2012). Weed management programs including 2,4-D or dicamba would improve a grower's ability to manage this problematic weed in the following ways: 1) improved consistency in weed control especially on dryland production acres where residual herbicides often are not activated with rainfall at planting time, 2) more flexibility with herbicide application timings because glufosinate plus dicamba or 2,4-D will consistently control Palmer amaranth up to 6 inches in height (at least 2 inches larger than todays standards), 3) less herbicide carryover to subsequent crops because growers would be less dependent on long lasting residual herbicides, and 4) less yield loss from Palmer amaranth crop competition for light, nutrients, and water (Coetzer et al. 2002; Culpepper et al. 2010; Merchant et. al 2013; MacRae et al. 2013).**(6165)**

**Response:** APHIS acknowledges the comment and has incorporated relevant information from the comment into the EIS.

**43. Comment:** USDA has voiced concerns that growers may adopt 2,4-D or dicamba technologies and rely too heavily on these herbicides thereby developing an even greater weed resistance scenario. Science has clearly shown that there is risk of resistance development to all herbicides; dicamba and 2,4-D are no exception. In fact, weeds have developed resistance to nearly all forms of weed management including herbicides, tillage, mowing and even hand weeding. Our data and surveys contrast the assumption that rapid development of resistance to 2,4-D or dicamba would occur in Georgia cotton. First, our data notes that since these auxin herbicides control only very small Palmer amaranth then they must be applied in tank mixtures with other herbicides such as glufosinate. Second, even mixtures of glufosinate plus 2,4-D or dicamba will only control Palmer amaranth less than six inches in height and since Palmer amaranth can grow as much as two inches per day selective residual herbicides must be used throughout the season. Simply put, data throughout the belt supports the fact that over-use and/or over-dependence of 2,4-D or dicamba in cotton would equal poor weed control and eventual crop failure which is a practice no grower would follow. Dicamba and 2,4-D would be an additional tool to include in the weed management program. **(1911**)

**Response:** APHIS acknowledges the comment and has incorporated relevant information from the comment into the EIS.

**44. Comment:** The greatest risk for developing herbicide resistance is actually occurring at this moment with the PPO herbicides and glufosinate. These products are being over used as growers have no other effective herbicidal options. New technologies such as dicamba or 2,4-D could be used to delay resistance development to the PPO herbicides and glufosinate and, in turn, systems could be developed using the PPO herbicides, glufosinate, 2,4-D, and dicamba extending the life of each of these chemistries. It is also critical to stress that, at least in Georgia, no weed management program relies exclusively on herbicides. The University of Georgia Weed Science Extension Team stresses to growers at more than 50 meetings each year that herbicides are only one part of the weed management program. Sustainability is only possible with the adoption and implementation of diverse management programs and Georgia grower's have accepted this message as fact (Sosnoskie and Culpepper 2013). Grower's are using programs that are complex and diverse integrating herbicides, hand weeding, and tillage or cover crops. Neither dicamba nor 2,4-D would change this approach but would simply be an additional tool to add into these management systems**.(1911)**

**Response:** APHIS acknowledges the comment and has incorporated relevant information from the comment into the EIS.

**45. Comment:** Glyphosate-resistant Palmer amaranth has increased herbicide pounds of active ingredient applied in Georgia cotton by a factor of 2.5 when compared to herbicide use prior to resistance (Sonoskie and Culpepper 2013). Programs developed by the University of Georgia for 2,4-D or dicamba technologies suggest the pounds of herbicide active ingredient may be able to be reduced by at least 30% while actually providing better weed control; similar results are also noted in other areas across the cotton belt (Edwards et al. 2013; Merchant et al. 2013; Smith and Hagood 2013; Steckel et al. 2013).**(1911)**

**Response**: APHIS predicted herbicide use rates on corn and soybean in Appendix 4. Because this comment specificially references herbicide use on cotton, it is outside the scope of the EIS.

## Conservation Tillage

**46. Comment:** APHIS claims throughout the EIS that Roundup Ready crops have reduced soil erosion by promoting farmer adoption of soil-sparing conservation tillage systems, and that Enlist crops would do likewise. These claims are without foundation. While soil erosion rates declined in the 15 years prior to Roundup Ready crop introduction, they have ***not*** declined since 1997, matching the period when these crops were massively adopted. Neither would Enlist crops reduce soil erosion. Federal farm policy enacted in 1985 has been the major driver of reduced soil erosion in American agriculture. Since Roundup Ready crops have not promoted an increase in conservation tillage, they are not responsible for the many benefits (e.g. improved air, water and soil quality) attributed to this practice. On the contrary, the epidemic of glyphosate-resistant weeds fostered by Roundup Ready crop systems has increased soil-eroding tillage, as APHIS concedes. Since Enlist crops will promote still more intractable weed resistance, their effect would be to further increase soil erosion via greater use of tillage for weed control. APHIS's assessment of these issues is fundamentally flawed.

Throughout the draft EIS, APHIS repeatedly asserts that under the Preferred Alternative, Enlist crops would enable farmers to utilize post-emergence 2,4-D applications to control glyphosate-resistant weeds, and thereby avoid soil-eroding tillage operations that would otherwise, under the No Action Alternative, become necessary to control these GR weeds. APHIS accordingly attributes to Enlist crops a whole host of benefits commonly associated with reduced soil erosion, including improved air, water and soil quality; and claims as well that soil erosion and the associated impacts would increase under the No Action Alternative.

These assertions, in turn, are based on the assumption that Roundup Ready crops have driven a reduction in soil erosion by facilitating less soil-eroding tillage practices, known collectively as "conservation tillage." APHIS argues by analogy that Enlist crops would preserve and further the benefits of reduced soil erosion purportedly conferred by Roundup Ready crops.

CFS provides a fully documented discussion that debunks the purported linkage between glyphosate-resistant and Enlist crops, adoption of conservation tillage practices, and reduced soil erosion in CFS Science Soy (62-76). We will not repeat that discussion here, but rather present new information that further supports the falsity of APHIS's view that Roundup Ready crops have, and Enlist crops would, reduce soil erosion.

The most recent data from USDA's experts at the National Resources Conservation Service (formerly the Soil Conservation Service) show that the massive reductions in soil erosion that occurred in the 15 years before Roundup Ready crops came to a virtual halt in the Roundup Ready crop era (see figure below).

On a national level, soil erosion declined by 38% from 1982 to 1997, but by just 9% from 1997 to 2010. Roundup Ready crops were introduced in 1996, and RR varieties now comprise the overwhelming majority of corn, soybeans and cotton in America, planted on over 150 million acres. If Roundup Ready crops planted on such a massive scale truly reduced soil erosion, it would be certainly be reflected in greater reductions in soil erosion post 1997 than have in fact occurred.

However, the evidence at the regional level is still more revealing. The majority of American corn and soybeans are grown in three Farm Production regions: the Corn Belt (Iowa, Missouri, Illinois, Indiana and Ohio); the Lake States (Wisconsin, Minnesota and Michigan); and the Northern Plains states (North and South Dakota, Nebraska and Kansas) (see map below). ***Soil erosion rates were entirely flat in corn and soybean country over the period of massive Roundup Ready crop adoption post 1997*** (see figure below).

It is simply impossible to reconcile no reduction in soil erosion with massive adoption of crops (Roundup Ready) that save soil. Either NRCS is wrong or RR crops have not saved soil (and Enlist crops would not). APHIS does not question NRCS soil erosion figures. Indeed, APHIS concedes in a single isolated passage that: "it is important to note that much of the reduction in soil erosion occurred prior to the adoption of GE herbicide resistant crops…" (EIS at 97), consistent with NRCS data. However, APHIS nowhere concedes the crucial fact that soil erosion has ***not*** declined in the Midwest since 1997.

It is extremely important to note that ***this purported but illusory reduction in soil erosion is the sole pretext for Enlist crops, a pretext that APHIS repeats*** **ad nauseum** ***throughout he EIS to make the enormous increase in herbicide use and increased weed resistance under the Preferred Alternative more palatable, and to create the false negative impression of increased soil erosion under the No Action Alternative.***

Rather than analyze this issue, of such importance to APHIS's central thesis in the EIS, APHIS merely alludes to the major factor driving reduced soil erosion in American agriculture, the 1985 Farm Bill (EIS at 67, 97), without however acknowledging the enormous impact it had in reducing soil erosion, or the mechanism that made it so successful – namely, providing farmers with extremely strong financial incentives to adopt soil-saving techniques by making their subsidies dependent on implementation of conservation tillage. CFS Science Soy (62-76) provide a full discussion of the issue.

In conclusion, it should be noted that reducing soil erosion has for three decades and longer been a leading goal of U.S. agricultural policy - deservedly so, for rich topsoil is one of the most important factors that makes American agriculture so productive; and its loss through soil erosion was the major cause of one of our country's worst agricultural and human disasters – the Great Dust Bowl of the 1930s. Topsoil once lost is not readily restored, and thus preservation of this invaluable resource is of crucial importance to America's long-term well-being. Thus, the misconception that HR crop systems like Enlist and Roundup Ready serve this laudable goal represents much more than deceptive pleading for deregulation of Enlist crops. It also obfuscates the true causes of soil erosion, which lie more in the policy arena, and thereby diverts attention and political will from enacting the policies needed to effectively address it. **(10202).**

**Response**: APHIS agrees that conservation tillage became more widespread over the period from 1982-1997 prior to the introduction of Roundup Ready® crops and that the greatest decline in soil erosion occurred over this period. However APHIS disagrees with the commenter's reasoning that Roundup Ready® crops have little to do with conservation tillage and the associated reduction in soil erosion because most of the decline in soil erosion occurred prior to the time that Roundup Ready® crops were widely adopted. A key component to conservation tillage has been the availability of effective herbicides for weed control in the absence or reduction of tillage (see also comment # 49 and #50). Over the period of 1982-1997 several types of herbicide chemistries were adopted by growers including Photosystem I (PSI) and II (PSII) inhibitors, acetolactate synthase (ALS) inhibitors, and protoporphyrinogen oxidase inhibitors (PPO). These other herbicides were critical for the successful implementation of conservation tillage. However one by one, these herbicides became less effective as weeds resistant to each herbicide were selected. Without an effective herbicide to control weeds, most growers will abandon conservation tillage in favor of conventional tillage and soil erosion will increase. TheRoundup Ready® cropping system enabled glyphosate to substitute for the herbicides that were no longer effective for maintaining no-till cropping systems. In this way, the introduction of the Roundup Ready® cropping system has enabled the reductions in soil erosion to be sustained and to continue to decline. The fact that tillage rates are increasing again, now that glyphosate is no longer as effective, is strong evidence demonstrating the link between the adoption of Roundup Ready® crops and conservation tillage (see also response to comment #1). Based on the increase in tillage occurring now, it is highly likely that an increase in conventional tillage would have occurred in 1997 or shortly thereafter, if the Roundup Ready® system were not introduced at the time, reversing the decline in erosion observed over the period from 1982-1997.

**47. Comment:** It also is not reasonable for APHIS to assume that adoption of 2,4-D resistant varieties of corn and soybean would directly correlate to beneficial conservation practices such as no-till, while keeping 2,4-D out of the marketplace would have the opposite impact. In fact, conservation and tillage practices vary widely by neighborhood within our state and largely reflect the social behavior of farmers choosing to follow what they see their neighbors doing. It certainly is the case that glyphosate-resistant seed varieties have created an opportunity for the adoption of no-till and other beneficial conservation practices, but it is not the case that all farmers using glyphosate-resistant seed varieties have chosen to adopt those practices. This is evident in the continuing problem of topsoil loss in Iowa despite the large number of acres currently being planted to glyphosate-resistant corn and soybeans across the state. At the same time, farmers choosing to plant non-glyphosate-resistant varieties of corn and soybeans have a variety of methods available to avoid relying heavily on tillage for weed control, including pre-emerge herbicides, crop rotations and cover crops. **(8007)**

**Response:** APHIS agrees that not all adopters of glyphosate resistant seed varieties utilize conservation tillage, as there are other factors to be considered such as crop rotation, soil characteristics, nutrient management, herbicide program, planting equipment, and management ability and risk (Randall *et al.*, 2002). No-till soybean production is not suitable for all producers or areas. For example, no-till soybean production is less successful in heavier, cooler soils more typical of northern latitudes (Kok *et al.*, 1997; NRC, 2010). Nevertheless, many more growers of HR crops adopt no-till compared to those who plant conventional soybean varieties. For example, based on 2006 data, (Fernandez-Cornejo *et al.*, 2014) reported that of soybean growers adopting herbicide resistant varieties, greater than 80% used conservation tillage while less than 40% of those planting conventional varieties did so. Over 40% of those planting herbicide resistant varieties used no-till while less than 5% of those planting conventional varieties did so. Much larger numbers of growers adopt no-till and conservation tillage when they have an effective herbicide control option. Trends throughout the country show that conservation tillage is decreasing where glyphosate resistant weeds are becoming a problem but increasing in the west where they are not (see comment #1).

Contrary to the view of the commenter, APHIS considers it reasonable to expect that 2,4-D, which will help manage glyphosate resistant weeds, will reverse this trend of increasing tillage in areas where glyphosate resistant weeds are a problem.

**48. Comment**: In a February 2012 Issue Paper, the Council for Agricultural Science and Technology acknowledged that GE crops favor rapid evolution of specific weeds, and weed resistance threatens conservation practices because farmers are returning to deep tillage to manage weed infestations. Increased tillage can lead to soil erosion, decreased soil moisture, surface water degradation and higher equipment and operations costs for farmers.

Dow's new crops will only address the glyphosate-resistant weed problem until new weed resistance to 2,4-D arises. The EIS clearly states that Dow's Enlist system is just a short- term solution whose costs will eventually outweigh its benefits. **(6923)**

**Response**: APHIS agrees with the first paragraph of the comment. APHIS did not conclude that Dow's Enlist™ is just a short-term solution whose costs will eventually outweigh its benefits. APHIS concluded that Enlist™ offers clear short term benefits and made no prediction in the long term because it would depend on the extent to which growers adopted best management practices.

**49. Comment:** In 1990, Missouri ranked second among all states for the amount of soil erosion from crop land. The state average was nearly 10 tons/acre - a figure far too high to sustain crop productivity. Soil that erodes from cropland has far-reaching negative impacts on society as a whole and nature.

Missouri farmers with the assistance of University of Missouri extension and several federal agencies have greatly reduced soil erosion. One of their more effective tools is planting crops without tillage – a practice commonly known as no-tillage. No-tillage can reduce soil erosion by up to 90%. The key characteristic of no-tillage is the plant residue left on the surface. That residue intercepts raindrops and dissipates their energy. Because soil particle dislodgement by raindrops is the first and essential step of water-caused soil erosion, the simple act of allowing plant residue to remain on the soil surface can greatly reduce soil erosion. Unfortunately, nearly any amount of tillage reduces the area of the soil surface covered by plant residue and allows soil to be eroded.

The increasing presence of glyphosate resistant weeds and several hard to control weed species has renewed farmer interest in tillage. Farmers are reluctant to return to intensive tillage because they understand the effects of tillage on their soils. But, they have few, if any, alternatives. The deregulation of Enlist corn and soybean traits will put a powerful tool in the hands of Missouri farmers to combat hard to control weeds without resorting to tillage. Missouri farmers are fortunate that these traits are possible. Deregulation will help farmers, but more importantly, deregulation will benefit all Missouri citizens because farmers will be able to retain and use their most important soil erosion reduction technique.

One of the essential parts of a no-tillage system is the use of burndown herbicides before planting. Complete weed control before planting helps ensure successful planting and crop emergence. We recommend a mixture of herbicide modes of action. One mode action commonly used is exhibited in 2, 4-D because of its ability to control several difficult but competitive weeds. Unfortunately, current herbicide labels require planting delays of up to two weeks. Our agronomic research indicates that timely planting is one of the most effective ways to increase corn and soybean yields. Deregulation of Enlist traits will allow for timely planting. Timely planting will increase crop productively and allows for the establishment of a crop canopy earlier, and this helps protect the soil.

One final comment related to soil conservation. There has been renewed interest in the use of cover crops in soybean and corn cropping systems. Cover crops reduce soil erosion in much the same way as crop residue found in no-tillage. Plant leaves intercept raindrops and dissipate their energy. In addition, roots slow water runoff and hold the soil in place. Plant species in the legume family are popular inclusions in a cover crop mix – especially in corn cropping systems – because of their ability to fix nitrogen. Glyphosate sometimes struggles with providing good legume control. Addition of 2, 4-D to a burndown mix greatly increases cover crop kill, but label restrictions may delay corn or soybean planting. Deregulation of Enlist traits will increase timely corn planting and reduce early competition from cover crop plants. **(5139)**

**Response**: APHIS acknowledges the comment and has incorporated relevant information from the comment into the EIS.

**50. Comment**: Conservation tillage (CT) has also been an important part of our ability to produce soybeans efficiently. CT provides several distinct benefits for Georgia double crop soybeans. (1) CT allows for soybeans to be planted without delay behind winter crop harvest. (This is an issue here because up to half of Georgia double crop soybeans are planted after the optimum planting time.) (2) CT allows for much improved erosion control on sloping soils which represent about ¾ of Georgia planted acreage. (3) CT helps improve double crop soybean stands by moderating surface soil temperature and conserving soil moisture. (This is also a big issue because bare soil surface temperatures often climb to in excess of 110°F in June.) Plant residue can modify this adverse temperature by 15-20°F) (4) CT helps reduce the incidence of lesser corn stalk borer insect damage. This insect is a major threat to soybean stands, especially during hot dry periods. (4) CT usually helps reduce equipment and fuel costs for soybean production.

In order for conservation tillage systems to be successful, they must have an effective herbicide/weed control component.

As of 2012, there are a number of good herbicide/weed control options for soybean weed control. But our ability to get effective, economical soybean weed control is becoming more difficult. With shifting weed populations and emergence of weeds resistant to currently available herbicides, there is critical need of new herbicides and/or technologies for soybean weed control. **(5523)**

**Response**: The analysis in the EIS is consistent with these comments.

**51. Comment**: No-till production systems have significantly reduced erosion throughout the Midwestern U.S. This soil conservation strategy is dependent on cost effective weed management strategies. We currently face glyphosate-resistant giant ragsweed, common waterhemp, and horseweed in the region. Weeds that are not only resistant to glyphosate, but also resistant to other modes of action have increased in the past few years. I am concerned that if we do not utilize technology such as 2,4-D resistant com and soybean that we may increase the amount of tillage that is required. This would cause us to revert to management systems that were common when I was a child, which included increased tillage.

Multiple modes of action provide farmers with weed management choices. Currently, some farmers only have one or two products available for control of difficult to-control weeds such as common waterhemp. I have observed Enlist Duo herbicide technology in field research and it is an effective tool for the management of glyphosate resistant common waterhemp in particular when applied at recommended rates and timings. I feel that 2,4-D fits well in an integrated weed management program that includes multiple modes-of-action. Education programs have been extensively emphasizing the importance of herbicide resistance and stewardship of crop protection management systems. Extensive education programs have also emphasized the importance of drift management using this technology.

As a farmer and researcher, I am aware of the importance of resistance management. I will continue to educate farmers on ways to reduce herbicide resistant weeds and the need to implement best management practices in order to reduce off-target herbicide movement. I am concerned about the environmental impacts of weed management systems that require extensive tillage. I hope that we can maintain the environmental and fuel conservation benefits of no-till and this technology provides us with an additional tool to maintain current conservation tillage programs in the region. **(7015**)

**Response**: The analysis in the EIS is consistent with these comments.

**52. Comment**: Herbicide resistant weeds pose significant crop production challenges in the arid central Great Plains where limited rainfall often causes major constraints for crop production. What moisture is available must be conserved for crop production. Timely and effective weed management is critical to eliminate competitive moisture use by unwanted weeds. At national and global levels, herbicide resistant weeds pose a major threat to the production of adequate global food stock levels as well as major gains in soil conservation efforts made possible by substituting chemical weed control for mechanical tillage in crop production fields. Thus, the environmental benefits of modern crop production are becoming vulnerable to herbicide resistant weed issues, especially when a return to mechanical tillage appears to be the only alternative. Approval of the Enlist corn and soybean traits will enhance growers' abilities to continue to utilize reduced tillage crop production technologies where soil and water conservation are paramount to reliable crop production.

One of the major recommendations for sustainable weed management is the use of multiple modes of action when weeds are sprayed with herbicides. This provides multiple ways to kill weeds while reducing the chance for development of herbicide resistance. In some cases, compatible mixtures of different herbicides is currently feasible, but in other crops such as soybeans and cotton, several potentially helpful mixtures are not feasible because of crop safety issues. **(10011)**

**Response**: The analysis in the EIS is consistent with these comments.

**53. Comment**: As the spread of glyphosate-resistant Palmer amaranth occurred, the adoption of tillage including deep turning of the land with moldboard plows has become common (Sosnoskie and Culpepper 2013). The return of conventional tillage has led to increased wind and water erosion. Neither 2,4-D nor dicamba technologies would eliminate tillage, but they would greatly reduce the need for deep tillage allowing many growers to return to more reduced tillage production systems. This opportunity to return to reduced tillage systems would be in response to a more consistently effective management program. **(1911)**

**Response**: APHIS has reached a similar conclusion in the EIS.

## Volunteer corn and soybean

**54. Comment:** Volunteer corn becomes much more of a weed threat when it is herbicide-resistant, because difficulty of control is a prime attribute of weediness and herbicides are major weed control options. In 2007, volunteer glyphosate-resistant corn (Roundup Ready) was rated as one of the top five weeds in Midwest soybean fields (Morrison 2012). Things have become worse with adoption of SmartStax corn, which is resistant to two herbicides – in this case glyphosate and glufosinate (Brooks 2012, Morrison 2012). Enlist corn volunteers would be still more persistent by virtue of "improved fitness which translates into fewer options for the removal of volunteer plants" (Enlist Corn PPRA15 at 9). When volunteer corn emerges in soybeans, one tactic is to apply "grass" herbicides like quizalofop to kill it (effective on corn since corn is a grass family crop, EIS at 4-38). This tactic would no longer be effective on Enlist corn volunteers, since they would be resistant to quizalofop and other "fops" herbicides like cyhalofop (Enlist Corn PPRA at 10). In addition, Dow has already "stacked" 2,4- D and quizalofop resistance into SmartStax corn (Scherder et al 2012), which as noted above is resistant to glyphosate and glufosinate. Glufosinate – otherwise an effective means to control volunteer corn – would also be ineffective.

Contrary to APHIS, neither glyphosate nor glufosinate would be effective control options (Enlist Corn PPRA at 10). Such volunteer corn plants would be resistant to four major modes of action, and would present still more serious control problems, leading to use of additional herbicides specifically to control volunteer corn that would otherwise not be needed, or to increased use of soil-eroding tillage. As APHIS concedes: “If the volunteer corn is stacked to express both glyphosate and glufosinate resistance, inter-row cultivation [a form of tillage] is the only option for post-emergence control within corn.” (EIS at 95). APHIS did not assess increased use of toxic herbicides or soil erosion resulting from cultivation to control Enlist volunteer corn. Even if additional herbicides are used, they are often not very effective. APHIS initially found that “dim” (e.g. clethodim) and ALS inhibitor herbicides would effectively control Enlist corn volunteers (Enlist Corn PPRA at 10), but in the EIS concedes that neither provides control adequate to prevent yield losses in soybeans under some circumstances (EIS at 95). It is reasonably foreseeable under the Preferred Alternative that Enlist corn varieties would be offered with resistance to additional herbicides. In Dow’s 2009 patent on the 2,4-D resistance trait, the company envisions crops with combined resistance to not only 2,4-D, glyphosate, “fops” herbicides like quizalofop and glufosinate – but also to one or more additional classes of herbicide, including: ALS inhibitors, bromoxynil, HPPD inhibitors, PDS inhibitors, photosystem II inhibitors (e.g. atrazine), photosystem I inhibitors (e.g. paraquat), PPO inhibitors, phenylurea herbicides, dicamba and others (DAS Patent 2009, paragraph 0082). Thus, Enlist corn or soybean volunteers could be offered in varieties resistant to most or potentially all major classes of herbicide on the market today. The more herbicide resistance traits are stacked into Enlist crops, the less likely it is that they would be susceptible to effective control; and the more damage they would cause in terms of reduced yield and harvesting problems. The time, expense, toxicity and natural resource impacts of weed control would also increase, as farmers apply herbicides specifically to control crop volunteers that they would otherwise not utilize, or employ soil-eroding tillage. While the discussion above focuses on Enlist corn volunteers, Enlist soybean volunteers would also be weedier and negatively impact crop production (CFS Science Soy, 39-40). **(10202)**

**Response**: Clethodim is currently one of the top five most actively used herbicides on soybean (EIS-Table 4-5). Apparently any detrimental effect on yield is not sufficient to limit its widespread utility. Clethodim is expected to control corn volunteers in soybean with little if any change in agronomic practices. The commenter seems to assume that if multiple herbicide resistance traits are available, growers will only grow crops with every trait that is available. As each trait increases the cost of the seed and growers are being encouraged by the Weed Science Society, herbicide manufacturers, and University extension agents to rotate the herbicide chemistries used for weed management, a more likely scenario is that growers will limit the traits they purchase and rotate them for an optimal weed management strategy. Furthermore, for growers who have committed to conservation tillage and who plant successive corn crops, their herbicide control options will remain if their successive corn crops are chosen to rotate herbicide resistance traits. For example, if a grower intends to plant two successive corn crops followed by soybean, the first crop may be Enlist™ corn (glyphosate and 2,4-D resistance) followed by corn stacked with glyphosate and glufosinate resistance, followed by Enlist™ soybean (glyphosate, 2,4-D, and glufosinate resistance). Volunteers could be controlled in the second corn crop with glufosinate and in the soybean crop with clethodim just as under the No Action Alternative. As growers who have adopted conservation tillage have invested years to achieve this end, it seems unlikely they will abandon these practices when herbicide control of corn volunteers in corn is possible with just a little bit of planning. There may be some growers who prefer to use inter-row tillage to manage corn volunteers in continuous corn. However, it is expected that such growers will be comprised primarily of those still practicing conventional tillage because they have not invested in conservation tillage practices.

The commenter cites a report (York *et al.*, 2005) where soybean volunteers were found in no-till cotton fields especially where the previous soybean crop harvest was prevented by hurricane and consequently many seeds remained in the field. According to this report, soybean volunteers are becoming more common as Roundup-Ready® technology has led to an increase in the adoption of no-till and a decrease in the number of herbicides used in rotation crops (York *et al.*, 2005). For similar reasons, soybean volunteers are also now appearing in corn, too. (Gunsolus, 2010). York (York *et al.*, 2005) reported effective control of soybean volunteers in cotton with normal levels of the ALS herbicide, trifloxysulfuron, an herbicide that also controls Enlist™ soybean. In corn, volunteer soybean can be effectively controlled by atrazine, dicamba, and clopyralid (Gunsolus, 2010). Use of these herbicides in corn would not be a departure from current agronomic practice, as all three are among the ten most commonly used herbicide on corn (DEIS Table 4-1). APHIS expects that the same or similar practices will be used to control corn and soybean volunteers under the No Action and Preferred Alternatives.

**55. Comment**: Enlist corn volunteers would exacerbate a serious plant pest, corn rootworm. Enlist corn volunteers would also exacerbate one of the most serious plant pest issues facing American farmers today: the rapidly evolving resistance of corn's worst pest, corn rootworm, to the genetically engineered toxins found in most corn varieties. The majority of GE herbicide-resistant corn on the market today is sold in "stacked" versions with genetically engineered resistance to corn rootworm and above- ground pests like European corn borer. Insect resistance is conferred by various toxins (e.g. Cry3Bb1) derived from the soil bacterium *Bacillus thuringiensis* (Bt). According to USDA, these "stacked" gene varieties that combine herbicide- and insect-resistance were planted on 71 % of U.S. corn acres in 2013, versus just 14% with herbicide-resistance alone. APHIS assumes in the EIS that under the Preferred Alternative: "Enlist crops could be crossed with any currently available variety including GE varieties no longer regulated by APHIS" (EIS at 119). Enlist corn would thus be offered primarily in versions stacked with "Bt" resistance to corn rootworm. Bt-resistant corn rootworm is already becoming a full-blown problem in up to 11 states (CFS Rootworm 2013), in part because the corn produces low levels of Bt toxin that tends to foster evolution of resistance (Gray 2011, Porter et al 2012). Krupke et al (2009) have found that *volunteer* corn produces *still less* of the insect- resistance toxin. The lower-level Bt toxin expression of volunteer corn relative to parent corn allows many corn rootworm to persist into the next season, and also fosters rapid evolution of resistance in them (Stahl 2013, Morrison 2012). As noted above, Bt corn is usually stacked with glyphosate resistance; because glyphosate is often the only herbicide used in soybean fields, stacked volunteer corn is more likely to persist, which makes the problem worse. Krupke et al (2009) conclude that "weedy volunteer corn plants stacked with GR [glyphosate-resistance] and Bt traits may accelerate the development of Bt-resistant WCR [western corn rootworm] populations, circumventing the current [Bt insect-resistance] management plans." In continuous stacked corn managed with glyphosate, corn volunteers producing lower, resistance-promoting levels of rootworm toxin would be still more likely to escape control than in soybeans, since harder to distinguish as volunteers in a field of corn. Enlist corn would exacerbate the plant pest risk presented by stacked glyphosate- resistant/Bt volunteer corn. Combined resistance to 2,4-D, quizalofop, glyphosate and likely other herbicides would diminish control options, and thus Enlist volunteer corn would be more likely to survive to foster resistant corn rootworm. This is still more likely to be true given that recommended control practices for Enlist volunteer corn are not very effective (as discussed above), and so in many cases may not be utilized. Thus, many growers would likely leave such volunteers uncontrolled. CFS requested that APHIS address this serious plant pest issue in scoping comments for the EIS (EIS at 2-8, 2-47), yet APHIS completely failed to assess it. **(10202)**

**Response**: For the reasons stated in the response to comment #54, APHIS does not agree with the commenter that corn volunteers will be more difficult to control in the Preferred Alternative relative to the No Action Alternative and therefore the issue of Bt resistance in Western Corn Rootworm is not expected to be different under the Action alternatives relative to the No Action Alternative. APHIS discusses control of volunteers in section 4.1.2 of the EIS.

## Stewardship

**56. Comment**: "This herbicide product contains a unique formulation of 2,4-D mixed with glyphosate devised to reduce the off-target movement of 2,4-D. Its use is required by a Stewardship Agreement for anyone planting Enlist™ corn and soyabean."

While this may appear superficially reassuring the USDA also states, "APHIS assumes that herbicide applications will conform to the EPA-registered uses." Assumptions on this scale are not enough, particularly when we read:

"APHIS assumes that there would be no binding enforcement mechanism to ensure that farmers follow the stewardship agreement but failure to do so could jeopardize a grower's access to the technology."

Taken together these statements show that the USDA believes adequate control of 2,4-D use will be achieved by farmers voluntarily abiding by stewardship agreements administered by the company with a vested interest in ensuring more of its products (either chemicals or seed) are sold. It is at best alarmingly naïve to believe a company will act against its own clear vested interest in this way, as in fact it will make more money if the stewardship agreements are breached, and even more if they know resources are put into monitoring agreement compliance. We already know Dow had expected to earn an additional US$1.5 billion in extra profit in 2013 from 2,4-D corn sales alone. This is not a creditable means of controlling either the quantity or manner of 2,4-D use.

Proper regulation, and enforcement of that regulation, is clearly needed before the crops can be authorised. Strong regulation and robust enforcement are justified on several grounds, including:

a) The experience of U.S. use of GM agricultural technology clearly demonstrates that stewardship "requirements", like refuges in Bt maize, are routinely ignored by farmers, which is arguably exacerbating the damage caused. For example even the EPA's own data shows:

"In Nebraska, Drs. Siegfried, Meinke, and Hunt reported that the 2011 growing season marked the fourth year where moderate to severe rootworm damage in Monsanto's Cry3Bb1 corn was apparent. As in Illinois and Iowa, these problem fields were planted to continuous corn with Cry3Bb1 for several years in a row; no rotation with other crops occurred. It was unlikely that refuges were planted."

In fact a Center for Science in the Public Interest report explained that farmer compliance fell from 90% in 2003-5 to only 75% by 2008, a level deemed "unacceptably high":

"In addition, using the compliance data and information about Bt corn adoption from USDA, it was determined that the total corn acreage out of compliance climbed from 2.29 million acres (3% of both biotech and conventional corn acres) to 13.23 million acres (almost 15% of all corn acres). This six-fold increase is due to the increase in farmer noncompliance and the increase in adoption of Bt varieties by farmers (from 35% in 2005 to 57% in 2008). Whereas non-compliant Bt farmers could rely in the past on their non-Bt neighbors' fields to supply pests without resistance to mate with any resistant pests that survived the Bt corn, that situation may not exist now or in the future for some areas of our country

"If EPA believes that protecting insect susceptibility to Bt is a 'public good' and that all farmers must comply with refuge requirements to delay resistance to Bt, then the CAP Report data should be a wake-up call to EPA that the regulatory system is not working. EPA must change the obligations it imposes on the registrants to ensure greater compliance."

b) In addition to the failure of farmers to comply with stewardship agreements, companies don't enforce their agreements either. The EPA "concludes that the registrant's current resistance monitoring program (as proposed) is inadequate and likely to miss early resistance events."

While this remains the case there seems little chance that proper enforcement will be conducted (or even possible for the vast acreage under consideration) under the USDA's "preferred" way forward. This seems to be an admission by USDA that it is more important to follow regulations regarding deregulation of GM crops than to guard against acknowledged "significant" socioeconomic pressures on farmers and the environment from their use. This in turn neglects the fact that the increase in herbicide use resulting from these crops seems likely to lead to serious long-term plant health issues and other problems as the number and quantity of applied chemicals accumulate in the wider environment.

This neglect is of serious concern because of the nature of the chemical under discussion, particularly considering the high toxic burden already shouldered by agricultural land in the United States. Again the USDA knows the problem is serious, as it clearly states, “APHIS has identified the possible selection of HR [herbide-resistant] weeds resulting from the change in management practices associated with the adoption of Enlist™ corn and soyabean as a potentially significant environmental impact…” **(7706)**

**Response**: The commenter asserts that stewardship agreements between Dow and the grower are not a credible means to regulate the quantity and manner of 2,4-D use. The commenter further asserts that EPA’s stewardship requirements over Bt crops is not working and, by inference, that stewardship requirements over 2,4-D use on Enlist™ crops is not likely to work either. APHIS acknowledges that there may be growers who do not abide by stewardship agreements. APHIS does not agree that Dow’s enforcement of stewardship agreements is likely to be lax, as it is against their interest to allow 2,4-D resistant weeds to become widespread. If 2,4-D resistant weeds are rapidly selected, Enlist™ technology becomes less valuable and they will sell less seeds and herbicide over the long run. EPA is also requiring that DAS develop a stewardship program that will aggressively promote resistance management efforts (US-EPA, 2014b). See the response to comment # 32 for a description of Dow’s stewardship requirements to EPA and to comment #75 for stewardship commitments Dow has made to the Save Our Crops Coalition.

## Socioeconomics

**57. Comment**: Like the EIS states, “the eventual occurrence of weeds resistant to glyphosate, 2,4-D and glufosinate will over time limit the use of Enlist crops and any benefit to natural resources that may arise.” The USDA goes on to say that, “the magnitude of the benefit or the loss of the benefit is uncertain.” It is hard to understand why a product with uncertain, and probably zero, benefit to agriculture and the environment in the long run would be approved, when the costs are certain and dramatic. So dramatic, in fact, that if the USDA’s Preferred Alternative of deregulating three varieties of 2,4-D tolerant corn and soybeans is selected, coexistence as we know it in agriculture will be infeasible. It is imperative that the USDA denies Dow’s petition for nonregulated status of its 2,4-D tolerant corn and soybeans. **(6923)**

**Response**: The commenter mistakenly asserts that the benefits of Enlist™ corn and soybean are uncertain and probably zero because 2,4-D resistant weeds may one day be selected. Even though glyphosate resistant weeds have become a problem, glyphosate is still 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 one of the most common herbicides used on corn. Consequently, glyphosate resistant crops are still widely used and expected to be widely used despite the increasing prevalence of glyphosate resistant weeds. Similarly, if 2,4-D resistant biotypes are selected, Enlist™ crops are likely to still provide benefits to agriculture. While the benefits may diminish over time, they are still expected to be tangible over the long-term. The commenter does not justify why coexistence as we know it in agriculture will be infeasible with the deregulation of Enlist™ corn and soybean. APHIS believes that coexistence is not likely to be impacted because Enlist™ corn and soybean will not increase the amount of GE corn and soybean produced in the US.

**58. Comment**: In addition to contamination risks, the presence of 2,4-D-resistant weeds that will arise soon after the introduction of these crops will cost farmers millions of dollars. An analysis of the costs of herbicide-resistant weeds showed that farmers face significant costs from herbicide-resistant weeds from reduced yields and increased production costs to combat weed infestations. These costs can range from $12 to $50 an acre, or as much as $12,000 for an average-sized corn or soybean farm or $28,000 for an average cotton farm. In 2010, herbicide-resistant weeds cost farmers $17 an acre from reduced yields. In 2012, 92 percent of surveyed cotton farmers reported that their losses due to weed control were at least $50 per acre. In Tennessee, glyphosate-resistant horseweed has increased soybean farmers' production costs by $12 per acre; and Georgia and Arkansas cotton producers have seen additional costs of $19 per acre due to glyphosate-resistant Palmer amaranth.

Since U.S. farmers have found herbicide-resistant weeds in their fields, they have changed farming methods to control them, resulting in higher weed-control costs and even a return to tillage and hand hoeing. In 2009, farmers in Georgia were forced to weed half of the state's 1 million acres of cotton due to the spread of pigweed, costing $11 million. The USDA must consider these additional financial burdens for farmers when evaluating the approval of 2,4-D-tolerant corn and soybeans. **(6923)**

**Response:** The increased costs noted by the commenter are due to a loss of benefits, not an incremental cost. The Enlist™ system is expected to reduce costs of weed control relative to the No Action Alternative. If 2,4-D resistant weeds become widely prevalent, weed control costs are expected to reach but not surpass the costs under the No Action Alternative.

**59. Comment**: NGFA and NAEGA do continue to have concerns related to the marketability of certain biotech enhanced agricultural commodities that are authorized for planting and production in the United States, but which have not received approval from competent foreign governmental authorities for import as food, feed or for further processing. It is our understanding that Dow AgroSciences has submitted applications for such approval to Canada, Brazil, Australia, New Zealand, China, Colombia, European Union, Japan, Korea, South Africa and Switzerland. Although approvals for one or more of the crops have occurred in numerous countries, only Canada, Australia, and New Zealand have approved all three events thus far.

U.S. agriculture and the world's consumers are best served by a combination of appropriate commercial and regulatory actions after products achieve non-regulated status from APHIS. Recent disruptions in U.S. corn and distillers dried grains shipments to China involving a different company's biotech-enhanced trait exemplify how costly and damaging commercialization of such traits can be if done prior to export market authorizations. In this regard, we have met on several occasions with representatives from Dow AgroSciences concerning the company's plans for launching, stewarding and directing these traits in an appropriate manner so as not to disrupt export market channels.

Further, the U.S. plant-based biotech value chain, including NGFA and NAEGA, is investing significant time and resources in a broad-based U.S. Biotech Crops Alliance to develop best practices within the value chain on addressing these marketability-related challenges associated with crop biotechnology innovation and commercialization. NGFA and NAEGA are optimistic this effort will build successfully upon existing biotech industry best practice guidelines for product launch, and ultimately be implemented by Dow AgroSciences and the entire biotechnology provider community in the future.

NAEGA and NGFA also work toward the facilitation of trade in safe and wholesome agricultural products from all methods of production and marketing. Policies that result in timely regulatory acceptance of crops that may contain biotechnology-enhanced traits are critically important to achieving this objective. While value-chain stakeholders continue coordinated efforts to achieve that ultimate goal, deregulation of biotech-enhanced traits in the United States – including the three cultivars of herbicide-resistant corn and soybeans that are the subject of this petition from Dow AgroSciences – does create the potential for trade disruption if the presence of such traits is detected in shipments to countries where they are not yet approved.

The simple reality is that bulk grain and oilseed shipments "may contain" a biotech-enhanced event that has been made available to producers for commercial production. Any biotechnology trait present in such shipments that lacks approval in a country of import will confront an impossible-to-achieve zero tolerance in that country. The consequences of such occurrences, as has been demonstrated recently, can be dire, including impeding the ability of importing countries to provide for food security, imperiling present and future market opportunities for U.S. farmers, and imposing unrecoverable and extensive product and shipment-rejection costs on the U.S. production and grain marketing system.

To counteract this potential, NAEGA and NGFA continue to urge all technology providers to respect systems for approving biotechnology-enhanced events established by foreign governments, and to provide for the necessary commercial responsibility throughout the lifecycle of their products. **(9692)**

**Response:** APHIS acknowledges and agrees with the comment.

**60. Comment**: *Impacts on Export Markets* Although the United States has rapidly approved GE crops and products, many countries, including key export markets, have not. More than three quarters of consumers in Japan, Italy, Germany and France are skeptical of the safety of GE foods. Europe has been restrictive in its approval of biotech foods because of uncertainty over the safety of the products for human consumption. European Union (EU) member states currently only allow animal feed imports to contain up to 0.1 percent trace GE material. Additionally, the EU requires all foods, feeds and processed products containing more than 0.9 percent biotech content to bear GE labels. Japan does not grow GE crops and require mandatory labeling of GE foods. Countries that ban GE foods typically have strict rules to prevent unauthorized GE imports. The cost of tracking and separating these various GE crops to avoid contamination of non-GE crops and its effect on exports are not evaluated in USDA's analyses and must be considered.

Contamination of conventional or organic corn and soybeans with Dow's Enlist trait could have serious global ramifications. In August 2013, a Washington state farmer reported that his alfalfa was rejected for export due to the presence of a genetically engineered trait. However, the USDA decided not to take any action to investigate transgenic alfalfa gene flow or to address ways to prevent contamination. In addition to alfalfa, GE wheat — which hasn't been field-tested since 2005 — was found on an Oregon farm in May 2013, causing Japan and South Korea to suspend some U.S. wheat imports. Any future contamination issues could have substantial impacts on our trade relationships with countries that have stricter regulations that the United States and cause financial harm for U.S. farmers. **(6923)**

**Response:** Dow has requested approvals in all major corn and soybean import markets. Table 9 of the FEIS lists the approval status of Enlist™ corn and soybean in various countries as of July 8, 2014. Commingling of conventional and organic corn and soybeans with Dow's Enlist™ trait is a market issue outside the scope of this EIS. The cost of tracking and separating approved GE crops is a market issue outside the scope of this EIS.

**61. Comment**: The costs to organic farmers: While USDA claims, "No cumulative impacts are expected on organic growers because these growers do not use herbicides such as 2,4-D for weed control," the fact cannot be ignored that organic growers can nevertheless find their land contaminated with GR (or new) resistant weeds, including by transfer of migrating birds outside regulatory control, and the fact that precisely because they do not use herbicides the impact on them of such contamination will be disproportionately higher. It is economically myopic to ignore this and to fail to protect organic production which, although less widespread than conventional growing, the USDA admits is more lucrative, saying, "Although conventional corn yields tend to be higher than organic yields, net returns from organic acres continue to be greater than that from conventional acres, with a 16 percent premium received for organic growers reported in 2008." Similarly the emergence of 2,4-D resistant weeds would present small grain growers with "less flexible and more costly" weed control; would "increase management costs" with impacts on major crops cotton, soya and corn due to impacts on use for fallow and burndown; and "weed management costs for sorghum would likely increase". It is difficult to understand the justification for effectively sacrificing the profitability and ease of operation of these businesses in this way. The ongoing costs of segregation, testing and tracing of GM crops disproportionately falls on the non-GM businesses wishes to remain non-GM. It is an extraordinary example of one sector wishing to bring a product to market and forcing the costs onto other operators in the market. It is high time that the burden of producing GM crops is borne by those who wish to sell it, including when they produce more lucrative and less damaging crops. This, coupled with fully transparent labeling for GM ingredients and feed, is the only way to ensure the market operates properly. **(7706)**

**Response:** Because organic growers do not use herbicides APHIS does not understand and the commenter does not explain how organic farmers will be impacted by glyphosate resistant or new resistant weeds and why the costs should be disproportionately greater. Existing or new herbicide resistant weeds are not expected to be distinguishable from herbicide sensitive weeds, and whatever methods of weed control are used by organic farmers should be equally effective on resistant and sensitive biotypes. The market issues of costs for identity preservation and labelling are outside the scope of this EIS.

**62. Comment:** HR crop systems like Roundup Ready and Enlist foster simplified weed control practices that rapidly generate HR weeds. APHIS credits this "simplicity" of RR crop systems as an unmitigated boon in some contexts [EIS at iii], yet concedes that it gives rise to GR weeds and all the harms they entail in others. In similar fashion, APHIS views "diversity" or complexity of weed control as a negative attribute in some contexts, while acknowledging that this very diversity is the only way to slow or prevent weed resistance in others. APHIS's inconsistent valuation of "simplicity" and "diversity" in weed control undermines its assessment of the costs and benefits of both the Preferred and No Action alternatives, and is closely related to the issue of short-term and long-term impacts. Weighing short-term "benefits" against longer-term costs APHIS describes at great length the presumed short-term "benefits" of the Preferred Alternative, but heavily discounts the medium- to long-term costs. As discussed further below, APHIS could and should have projected these countervailing costs and "benefits." To this end, APHIS must first explicitly define time frames (e.g. short-term = five years; medium-term 5-10 years; long-term > 10 years after introduction of Enlist crops). Second, quantitative or semi-quantitative estimates of various parameters are needed to provide a basis for balancing costs and "benefits." For instance, of what short-term value is the "convenience" of Enlist crop weed control? What are the medium- and long-term costs in terms of 2,4-D-resistant weeds? APHIS must assess the short-, medium- and long-term costs and benefits (worker safety, environmental, socioeconomic) of Enlist crops versus the No Action alternative. APHIS's projections of 2,4-D use provide the beginnings of such an assessment, and could be used as the basis for estimating the evolution and prevalence of 2,4-D and multiple herbicide-resistant weeds over time. The costs and environmental impacts of controlling these Enlist-generated weeds should also be modeled. Several scenarios could be constructed based on differing assumptions (as for projections of 2,4-D use). In the draft EIS, APHIS does little more than note that 2,4-D-resistant weeds generated by the Enlist system would impose financial costs on 2,4-D-using growers of certain crops, but gives no estimate, however rough, of their magnitude, much less estimate other adverse impacts. **(10202)**

**Response**: Socioeconomic impacts from selection of herbicide resistant weeds are thoroughly covered in chapter 5 cumulative impacts. APHIS estimated that weed control costs would be higher under the No Action Alternative for corn and soybean growers and less under the Preferred Alternative. For crops in which 2,4-D is used other than corn and soybean, APHIS evaluated weed control costs for these crops in the event that 2,4-D was no longer effective if 2,4-D resistant weeds became widely prevalent. APHIS identified growers of wheat and small grain crops as being the most susceptible to increased costs and further identified regions where small grains are growing in proximity to corn and soybean. APHIS disagrees that additional modeling and quantitative analysis is needed. The output of such analysis would be tentative because there is so much uncertainty regarding when and the extent that 2,4-D resistant weeds would occur, as well uncertainty regarding the specific weed management program that would be adopted as a consequence.

**63. Comment:** Concerning the registration of Dow AgroSciences Enlist™ Duo herbicide technology; I tested this technology for use in cotton weed management during 2010 and 2011. We have glyphosate and sulfonyl-resistant palmer pigweed and glyphosate-resistant horseweed in row crop fields in Alabama that severely reduce crop yields and cause the increased use of both foliar and soil residual herbicides. These measures also increase the cost of weed management by 50 to 100 percent. Enlist technology has the ability to help control these herbicide-resistant weeds and as a result increase the yield and profitability of Alabama row crops like cotton, corn, and soybean. **(5866)**

**Response:** The analysis in the EIS is consistent with these comments.

**64. Comment**: Herbicide-resistant weeds threaten the sustainability of Midsouth agriculture. New herbicides and/or technologies are needed to manage the weeds that have evolved resistance. By far, Palmer amaranth is the most troublesome weed of cotton and soybean in the Midsouth. In Arkansas, glyphosate-resistant Palmer amaranth was first documented in 2005. Since then, Palmer amaranth has spread to 2.5 million acres of cotton and soybean in Arkansas alone based on a 2011 survey. Unfortunately, loss of cotton and soybean fields as a result of this one weed is a common occurrence. In Arkansas, farms have been foreclosed because of the inability of producers to control glyphosate-resistant Palmer amaranth and produce a profitable crop. My colleagues and I estimated that glyphosate-resistant Palmer amaranth reduced soybean yields in Arkansas in 2011 by 5%, which equates to a loss of more than $60 million in revenue. In addition to lower yields in cotton and soybean, more than $20 million was spent hand removing Palmer amaranth from cotton and soybean fields, not including the other weed management costs such as herbicides, cultivation, etc. Most certainly cotton and soybean producers in Arkansas are in need of new tools that will help in managing Palmer amaranth and other herbicide-resistant weeds. **(6165)**

**Response:** The analysis in the EIS is consistent with these comments

## Crop Damage from Off-Target Movement of Herbicides

**65. Comment**: I have personal experience with a neighbor who had damage to their crops by the long distance drift of 2,4-D. They were unable to obtain any compensation for the damage, since it was impossible to assign blame. The directly adjoining landowner had not applied the 2,4-D and the State of Wisconsin did not wish to search out the party who had applied the herbicide. The approval and wide spread use of 2,4-D will result in many victims of herbicide damage suffering losses that could result in the loss of their livelihoods or even their farms, since they will not be able to harvest their crops, nor get compensation for that loss. The USDA has stated that all types of farming are encouraged in the United States. The expansion of our local foods movement will be halted in its tracks and greatly diminished, due to the losses suffered by the greatly expanded use of 2,4-D. The USDA should not allow this new generation of 2,4-D resistant crops to be deregulated. These two proposed 2,4-D herbicide resistant plants are plant pests, because they will encourage the expanded use of 2,4-D which will damage or kill both annual and perennial specialty crop plantings in a wide area surrounding its use. **(10054)**

**Response**: APHIS disagrees with the commenter's assertion that Enlist™ crops are plant pests because they will encourage the expanded use of 2,4-D which will damage or kill both annual and perennial specialty crops. Expanded pesticide use on a particular crop does not meet the definition of a plant pest.

The harm noted by the commenter, off target movement of 2,4-D, is regulated by EPA and not by APHIS. APHIS discusses off-target movement of 2,4-D in Appendix 7 of the EIS. EPA considers this harm during its registration process and specifies conditions on the pesticide label to mitigate this harm on human health and the environment including drift onto neighboring fields. According to the EPA (US-EPA, 2014b), "the Agency understands and has evaluated the risks regarding the potential drift of pesticides to sensitive crops adjacent to treatment areas, and other non-target plants. EPA has examined data confirming that the choline salt of 2,4-D will reduce spray drift and volatility compared to other forms of 2,4-D currently registered. As a result, the use of the choline salt of 2,4-D would result in reduced off-site movement of the herbicide. To ensure there is reduced off-target movement, the proposed regulatory decision pertains only to the use of the same formulation (the choline salt) and specific spray nozzle employed in the registrant's submitted drift studies. In addition, the proposed registration decision requires a 30-foot onfield buffer zone to help minimize spray drift from the intended use area. The proposed label also specifies that Enlist Duo™ cannot be applied when the wind speed is over 15 mph, and no aerial application is permitted. With employment of these label restrictions, drift from the treated field in not expected, protecting non-target plant species."

In addition, Dow has actively engaged growers of 2,4-D sensitive crops to formulate a stewardship program expected to minimize harms from off-target movement (see comment #75). The group of growers named the Save Our Crops Coalition (SOCC) reached an accord with Dow and "believes that the commitments made by Dow, (noted in comment #75), should be deemed effective measures to protect against non-target plant damage."

The cost of Enlist Duo™ is currently unknown. Nevertheless, Dow has committed to price its technology (both its seeds and its herbicide) competitively to maximize the use of 2,4-D choline salt (and disincentivize the use of non-choline salt formulations of 2,4-D) on 2,4-D tolerant crops (see comment #75). In addition Dow commits (in their agreement with the Save Our Crops Coalitions) to utilize an independent third party to collect seed and pesticide sales data that will help identify applicators that use non-choline salt forms of 2,4-D (generic 2,4-D) in contravention of present generic 2,4-D label requirements and the Technology Use Agreement **(APHIS 2014-0042-7255)**.

**66. Comment**: Stacking of new herbicide-resistant traits with glyphosate resistance, necessitates the use of combinations of 2,4-D with glyphosate (Wright et al. 2010, Seifert-Higgins & Eberwine, 2010). Research indicates that injury resulting from combinations of 2,4-D with glyphosate can be more damaging than with either herbicide used alone (Wolfe et al. 2011), "leading to greatly increased herbicide use and inevitably to more off-site movement" (Parker, 2011) and greater drift-related injury to neighboring broadleaf crops, including most of our fruit and vegetable crops, and our hedgerows, greatly impacting biodiversity. Hedgerows and plants in a diversified farming landscape, which provide invaluable ecosystem services including food and habitat for pollinators and beneficial insects, are at risk. "Environmentally-induced" plant diseases are an "understood outcome" of off-target herbicide spray drift (Walker 1969). "The well-known history of disease syndromes caused by off-site movement of 2,4-D *and glyphosate* is such that many specialty crop growers, including organic growers, fear that their crops cannot be grown in a future landscape that will be inundated like never before with all of these active ingredients" (Parker, 2011). **(8059)**

**Response:** See response to comment #65 and comment #75,

**67. Comment**: Dow's application proposes new uses of 2,4-D choline salt and/or glyphosate on Dow's herbicide-resistant crops enable entirely novel post-emergence use of 2,4-D. These new use patterns will be characterized by more frequent application of 2,4-D during a broader application window that extends later into the season (CFS, 2012) [and] coincide with particularly vulnerable plant growth stages of neighboring broadleaf crops and specialty production (Freese, 2012), **(8059)**

**Response**: EPA's assessment considers the new uses of the 2,4-D choline salt including more frequent application and when 2,4-D can be applied. See response to comment #65 and comment #75 for mitigation measures to reduce drift.

**68. Comment**: 2,4-D is known to drift directly and through volatilization. The NDOAB is aware of Dow's promise of a less volatile formulation and proper application techniques. However, herbicide applications are often conducted in less than ideal conditions. Weather patterns are increasingly volatile and unpredictable. Farms employing GE technologies have increased their acreages as a result of Roundup Ready technology and have short windows of time to apply their herbicides and cover all their acres. This results in applications made under less than ideal conditions. Despite Dow's best educational efforts, spray drift will happen. Spray drift poses a very real threat to rural economies and farmers growing crops not engineered to withstand applications of these potent chemicals. Non-GE farmers will bear: the costs of reduced yields and lost production, the burden of proving the source of any drift event, the costs associated with litigating damages with no assurance of compensation. Increased damages will result in increased claims. Insurance agents handling farm liability insurance policies will be less than willing to have their clients "admit" liability. This will force those who have experienced damage to litigate to collect damages, provided they can prove which application resulted in damage to their crop(s). Organic farmers are particularly at risk. Pesticide drift has implications for organic certification AND the organic integrity of their farming systems. Organic farming systems are based on biodiversity and healthy ecosystems. Drift events have the potential to wipe out much of that biodiversity, harming ecosystem services, and resulting in an erosion of the resiliency of organic farming operations. The USDA has placed the burden of sorting out these complexities on farmers working in good faith with their farming neighbors. However, the harsh realities of damages, losses, and lawsuits will make it difficult, if not impossible, to talk to your neighbor about mitigating this year's risks as you are litigating last year's damages. **(8059)**

**Response**: See response to comment #65 and comment #75.

**69. Comment**: Our farmers are deeply concerned that Dow's Enlist corn system will threaten their crops. 2,4-D is known to drift — directly and through volatilization — which poses a very real threat to rural economies and farmers growing crops not engineered to withstand application of these potent chemicals. For organic farmers in particular, pesticide and gene drift has always been a significant problem. Organic farms can lose their organic status from either, and the introduction of genetically engineered 2,4-D corn and soy will present another off-farm source of contamination. Techniques currently used by organic farmers such as buffer areas and staggered planting dates may be ineffectual with 2,4-D GE crops given 2,4-D's drift and volatilization characteristics.

Under the U.S. government's current regulatory scheme for Genetically Engineered crops, the entire burden of contamination prevention falls on organic farmers, as well as other specialty crop and non GMO farmers. 2,4-D drifts over greater distances than Glyphosate, and through the additional mechanism of volatilization, will multiply the risk of contamination for farmers who do not plant crops tolerant of this herbicide. 2,4-D drift is already responsible for more episodes of crop injury than any other herbicide, and its increased and widespread use promises still more damage to crops like non-GMO soybeans, non-GMO cotton, vegetables, and fruit. There is already anecdotal evidence of contamination to organic farmers from trials of 2,4-D crops. Due to USDA's policy of not revealing geographic locations of GE trial plots, these alarming stories are taking an inordinate amount of time to verify.

The impact on the large and rapidly expanding produce industry in the Carolinas is particularly concerning, and the impact of 2,4-D drift will be economically devastating. In 2008 the following particularly 2,4-D susceptible crops were grown on the following acreages in North and South Carolina combined: green beans, 12,000 acres; melons, 15,500 acres; cucumbers, 14,000 acres; peppers, 4,000 acres; field tomatoes, 7,000 acres; squash, 4,000 acres; pumpkins, 2,000 acres; sweet corn, 8,500 acres; grapes, 3,500 acres; and peas, 900 acres. Although Dow claims it has reformulated Enlist to reduce drift and volatilization, non-Enlist forms of 2,4-D that are do not have these purported protections are widely available on the market and much cheaper than Enlist, meaning farmers will continue to use these more dangerous-to-their-neighbors variations **(10,150).**

**Response**: See response to comment #65 and comment #75.

**70. Comment**: Organic farming continues to grow both in Florida and nationally, and we should be working to help farmers adopt organic production rather than encouraging increased use of herbicide and herbicide-tolerant crops. Genetic contamination and chemical drift pose a real threat to organic farmers. Thousands of acres of crops have already been lost do to 2,4-D drift. An incident in California in 2012 saw a single application of 2,4-D result in the herbicide drifting over 100 miles, destroying a pomegranate orchard and damaging 15,000 acres of cotton. Dow's claims of new formulations that will not drift as easily do little to ease fears as there is continues to be no economic or legal incentive for farmers to buy the new more expensive formulation. **(9710)**

**Response:** See response to comment #65 and comment #75.

**71. Comment:** APHIS relies on EPA label use restrictions for 2,4-D to mitigate the potential (non-target) risks from exposure. However, label directions have been shown to have no effect on decreasing spray drift. In fact, EPA has acknowledged this and is currently attempting to review and revise pesticide labeling guidance. **(9822)**

**Response:** see response to comment #65 and comment #75.

**72. Comment:** Dow AgroSciences states that the new 2,4-D formulation (choline salt), which is to be exclusively used with the new 2,4-D resistant corn and soybeans, is anticipated to have lower volatility (50 times lower) and thus decreased drift compared to other forms of 2,4-D. However, the technical information supporting this has not been made available for public and peer review. Moreover, the surfactants and non-ionic solvents added to commercial mixtures can substantially alter volatility and these, at present, are undefined. Therefore, we believe APHIS must delay its final determination on these new GE crops and their companion 2,4-D formulation until EPA has published and held for public comment its risk assessment for this new 2,4-D form. According to EPA’s schedule, the registration review of 2,4-D and its related salts is not expected until 2017. As mentioned before, APHIS’ reliance on EPA for an assessment that has not been completed and falls short of its more expansive assessment requirements under statutes outside of EPA’s jurisdiction is unlawful. **(9822)**

**Response:** APHIS and EPA expect to complete their respective reviews about the same time and are consulting with each other about their respective findings. EPA's proposed registration for Enlist Duo™ was available for public comment from to April 30 to June 30, 2014 (US-EPA, 2014b).

**73. Comment**: Because of the potential for crop injury, pesticide spray drift and volatilization from agronomic crops is a major concern for specialty crop growers and processors. Synthetic auxin herbicides, like 2,4-D, have proven to be especially prone to both drift and volatilization. Studies have shown the drastic plant damage effects of low-level synthetic auxin drift and volatilization on broadleaf specialty crops. Applications of 2,4-D at levels as low as 1/300th of the field rate for soybeans caused a statistically significant loss of tomato crops. These facts are especially unsettling to specialty crop growers and processors when credible projections indicate significant increases in the amount 2,4-D applied to corn after the introduction of Dow 2,4-D Tolerant Corn. Thus, given the high potential for plant injury from drift and volatilization from 2,4-D to broadleaf specialty crops, we respectfully request APHIS consider 2,4-D spray drift and volatilization as an indirect plant pest effect, and address it as a factor within its Plant Pest Risk Assessment for Dow 2,4-D Tolerant Corn. Upon due consideration, APHIS should exercise its broad statutory authority to regulate "substances which can directly or indirectly injure or cause disease or damage in or to any plants or parts thereof," and deny Dow's petition for non-regulated status. **(APHIS-2010-0103; APHIS-2012-0019; APHIS-2012-0032)**.

**Response**: About 35 letters similar to the one above were submitted to the USDA dockets for the EAs on the Enlist corn (APHIS 2010-0103) and soybean petitions (APHIS 2012-0032) and resubmitted by the Center for Food Safety to the EIS docket (APHIS 2013-0042-6909). Many of the original submitters were growers raising vegetable crops or grapes and were part of the Save Our Crops Coalition whose members shared a common concern about potential drift injury from the anticipated use of Enlist Duo™. Dow and SOCC reached an accord after discussion and commitments made by Dow to foster stewardship practices by Enlist™ technology users. (See comment # 75 **(7255**) on the accord reached between SOCC and Dow). APHIS does not think a response is necessary to the original letter because as a result of the accord, SOCC has amended its comment to APHIS and stated that "the commitments made by Dow should be deemed effective measures to protect against non-target plant damage." (**7255**). Of the 35 comments that were resubmitted to the EIS docket by CFS, only one of the corresponding commenters sent in their own comment to the EIS docket. Her original and subsequent comments are as follows:

**74. Comment**: 2,4-D will drift (volatize) and cause irreperable harm to the environment. I have suffered financial loss from 2,4-D drift on my native seed farm in 2011. We filed a complaint with the Department of Agriculture in Nebraska to no avail. We suffered a 10% loss of prairie clover and echinacea plants and decreased seed production. This will happen wherever the chemical is used because it is so volatile. Roadside wildflowers are important pollen sources for native insects as well as honey bees. The ripple effect of increased use of 2,4-D will be a decrease in local biodiversity.

Increased corn production is not worth the cost to biodiversity. **(APHIS-2010-0103-1485)**

I grow native wildflowers and 2 years ago my crops suffered 2,4-d damage. Our seed production was cut 80% due to 2,4-d drift. These products not only put my "crops" at risk but also native wildflowers that grow along roadsides and field edges. Glyphosate is benign compared to 2,4-d. Native pollinators: moths, skippers, butterflies, bees, are all declining due to the effectiveness of glyphosate. The only refugia remaining are along roads and fencelines and it is likely the increased use of 2,4-d will lead to greater endangerment of these species. You must consider offsite impacts because this compound will drift. **(APHIS-2013-0042-7994)**

**Response**: EPA evaluates herbicide impacts to non-target organisms. As described in the response to comment #65, they have proposed restrictions on the label that are expected to mitigate off-site impacts to non-target plants.

**75. Comment**: "As indicated in a letter to USDA, dated June 1, 2012, Dow and SOCC have been engaged in discussions in an attempt to resolve SOCC concerns regarding injury to non-target plants. Dow and SOCC are now very pleased to announce the successful conclusion of those discussions. Through these discussions, both Dow and SOCC have achieved a better understanding of the other's perspective and have agreed to modify positions each organization has taken with respect to pending regulatory matters. In light of the commitments made by Dow, below, SOCC will amend its petitions and its comments to USDA and EPA, accordingly. SOCC believes that commitments made by Dow represent substantial measures to mitigate the non-target plant damage impacts of herbicide spray drift and volatilization associated with 2,4-D tolerant crops. As a prerequisite for approval of these crops and these herbicides, SOCC had requested that USDA and EPA not approve either the crops or the herbicides until effective measures were in place to protect against non-target plant damage. SOCC believes that the commitments made by Dow, below, should be deemed effective measures to protect against non-target plant damage. Accordingly, SOCC requests amendment of its petitions and comments regarding 2,4-D tolerant crops and the 2,4-D choline salt herbicide to reflect the substantial measures to mitigate non-target plant damage impacts adopted by Dow. Dow will request the following:1. Dow will request an amendment to its pending herbicide label submitted to EPA to include the following language under a new "Susceptible Plants" heading within the "Spray Drift Management" section on the label for 2,4-D choline salt herbicides authorized for use in 2, 4-D tolerant crops (additions emphasized):

*Do not apply under circumstances where spray drift may occur to food, forage, or other plantings that might be damaged or crops thereof rendered unfit for sale, use or consumption. Avoid contact of herbicide with foliage, green stems, exposed non-woody roots of crops, desirable plants and trees because severe injury or destruction may result. Small amounts of spray drift that may not be visible may injure susceptible broadleaf plants. Before making an application, please refer to your state's sensitive crop registry (if available) to identify any commercial specialty or certified organic crops that may be located nearby. Commercially grown tomatoes and other fruiting* *vegetables (EPA crop group 8), cucurbits (EPA crop group 9), and grapes are particularly sensitive to drift from this product. Do not apply when wind direction favors offtarget movement onto these crops.*2. In order to clarify the setback distance chart with respect to the new "Susceptible Plants" heading, above, (which does not specify safe setback distances for such crops), Dow will request the following language under the "Drift Setbacks from Sensitive Areas" heading within the "Spray Drift Management" section of the 2,4-D choline salt label (additions emphasized): *Allow setbacks (buffer zones) upwind of sensitive areas (e.g., residential areas, bodies of water, known habitat for threatened or endangered species, and sensitive nontarget crops other than those listed above) according to the following table.*

Dow commits to the following:

1. Dow commits to assist in the investigation, diagnosis and resolution of alleged nontarget claims.

2. Dow commits to include terms within its Technology Use Agreements for 2,4-D tolerant crops that require growers and applicators to keep accurate records of the locations where 2,4-D tolerant crops are planted and where authorized herbicides containing 2,4-D choline salt are applied, and to retain invoices for all seed and herbicide purchases.

3. Dow commits to include language in its Product Use Guide for authorized herbicides containing 2,4-D choline salt that recommends applicators keep accurate spray records, including application location, timing, and wind speed.

4. Dow commits to utilize an independent third party to collect seed and pesticide sales data that will help identify applicators that use non-choline salt forms of 2,4-D (generic 2,4-D) in contravention of present generic 2,4-D label requirements and the Technology Use Agreement.

5. Dow commits to price its technology (both its seeds and its herbicide) competitively to maximize the use of 2,4-D choline salt (and disincentivize the use of non-choline salt formulations of 2,4-D) on 2,4-D tolerant crops. SOCC does not have the scientific capability to evaluate product performance claims made by Dow, but notes that impressive research findings presented by Dow have been published in refereed journal articles. Specifically, SOCC notes research Dow has made available indicating the reduced drift and volatilization potential of its new herbicide, 2,4-D choline salt (here, referred to by its trade names -- the Enlist System, Enlist Duo and the Colex-D Technology)1: 1

Laboratory Studies:

1. 2,4-D choline demonstrated ultra-low volatilization and significantly less damage to sensitive crops placed only inches away when compared to other forms of 2,4-D. 2. The Colex-D formulation demonstrated a 64% reduction in driftable fines (volume percentage of droplets less than 150 μm) vs. conventional 2,4- D/glyphosate tank mix

at typical use rates. 3. Colex-D technology showed significantly less spray drift as compared to a commercial tank mix in wind tunnel tests using a range of spray nozzle types. For example, using the TeeJet AIXR 11002 air induction, Colex-D technology reduced driftable fines by 20-fold as compared to the commercial tank mix.

Field Studies: 1. Potted cotton plants placed under domes directly over treated soil showed minimal symptoms from 2,4-D volatility when Colex-D Technology was utilized (5% visual injury in 6 of 20 plants), compared to 13% visual injury in 19 of 20 plants treated with 2,4-D amine, and 65% visual injury in all 20 plants treated with 2,4-D LV ester. 2. Quantification of volatilized 2,4-D from soybean fields showed that calculated loss rates of 2,4-D choline were much lower that 2,4-D dimethyl amine and 2,4-D ethylhexyl ester. 3. The loss rate of 2,4-D ethylhexyl ester was as much as two orders of magnitude greater than the 2,4-D dimethyl amine form. Loss rates of 2,4-D choline were about 50X less than the 2,4-D dimethyl amine. Dow and SOCC request that USDA and EPA reflect these new and substantial commitments made by Dow in their response to public comments."**(7255)**

**Response**: APHIS acknowledges the comment and has incorporated relevant information in the EIS.

**76. Comment:** While many like to compare their experience with 2,4-D and dicamba applications from the past, there are relatively few who have considered such research in light of the current technologies in pesticide applications. While I have not been able to fully study the new formulations that Dow AgroSciences is proposing to use for their in-season applications of 2,4-D, the currently marketed formulations of 2,4-D are significantly less volatile compound than their predecessors based on studies that I have seen from both Dow AgroSciences and my colleagues at other research institutions. Furthermore, tools such as air induction nozzles provide the applicator with the ability to make pesticide applications with significantly less drift than the standard flat fan nozzles that have been commonly used in the past. Based on the research that I have conducted, I believe it is possible to have highly efficacious sprayer set-ups that have less than 0.5% driftable fines less than 150 microns.

Likewise, adjuvant technology has significantly improved in recent years. New drift retardants can reduce the drift potential on top of the drift reduction that we see from nozzle selection. In the same way, modifications to sprayers such as pulse width modulation and hooded sprayers have the capability to reduce drift beyond simple nozzle selection and spray solution as well. With the right nozzle, adjuvant, formulation and sprayer set-up, we have the ability to reduce drift by 99% or greater.

The development of 2,4-D- and dicamba-tolerant crops has led to the potential of having herbicides to use on weed populations that have not been previously exposed to these compounds. However, because growth regulator herbicides are "old" compounds in terms of synthetic herbicides, it has gone through great scrutiny. In my opinion, the improved technology surrounding applications is not fully recognized by most. While there are certainly risks of off-target movement via physical particle drift and volatility surrounding the new formulations, there is a dramatic improvement in the tools available to applicators today than there has ever been in history prior to this point in time.

In extensively researching pesticide drift, I do not believe that volatility will provide the largest challenge for mitigating "off-target" movement of 2,4-D. In my opinion, based on the countless number of drift studies, demonstrations, and fields that I have investigated, volatility is often blamed when physical particle drift was the cause. The use of adjuvants or formulation improvements, in conjunction with other tools for reducing drift, will significantly reduce off-target movement. We have scrutinized the new formulation of 2,4-D and find it to have much less potential for physical particle drift than any other formulation on the market at this point in time.

Having had the chance to work with Dow AgroSciences new Enlist Duo formulation, I have had the opportunity to gain first-hand knowledge on their new product. From the research studies that I have conducted, we saw the ability to dramatically reduce drift when the appropriate spray nozzles were used in combination with the new formulation. While we have not looked at every possible combination, we have conducted several robust tests and there are very few adjuvant combinations which negate the built-in drift reduction technology that the new formulation of 2,4-D contains.

While elimination of drift completely, either physical particle drift or volatility, is an impossible task regardless of what pesticide is being used, the changes made to the chemical structure of the 2,4-D compound in the Enlist Duo formulation has provided significantly reduction to the volatility of the compound in the research studies that I have seen presented both from Dow AgroSciences and my colleagues at other research institutions.

After conducting studies to look at injury and damage from 2,4-D and dicamba on sensitive crops, I have found that there are many complexities to consider when conducting actual "field drift" studies. In 2008 and 2009, we conducted studies where reduced rates of growth regulator herbicides were sprayed over the top of the sensitive crops. While this data gave us excellent indication of how sensitive tomato crops could be to growth regulator herbicides, the studies failed to produce the same droplet sizes, droplet concentrations and deposition which would occur in an actual drift situation.

While the study conducted was using Clarity (a dicamba formulation currently available on the market), the principles remain the same for 2,4-D as well. It is important to keep in mind that formulation can greatly influence the droplet size (which is one of the major factors to pesticide drift). In a field drift study we conducted (see Hillger et al. 2012 WSSA annual meeting – "Evaluating the Reduction of Driftable Fines"), we had 0.08% drift at 50' downwind with the Enlist formulation of 2,4-D. Furthermore, at 100' there was 0.05% drift downwind. Based on my calculations (from the Save Our Crops Coalition website), 2.7 g/ha (assuming a 800 g ae/ha rate) caused less than 10% injury (which is likely higher than the yield loss). Comparing this to what we had, at 100’ we had 0.4 g/ha and at 50’ there was 0.68 g/ha using an AIXR nozzle at 40 psi at 24” above the canopy when spraying in wind speeds of 3-11 mph using commercial spray equipment. However, it is important to keep in mind that the injury studies would once again have different droplet size, droplet concentration and deposition.

With a significant educational effort, applicators can be trained to make applications under environmental conditions and with spray configurations which are less conducive to drift. For this and other technologies, it will be important to have a strong stewardship plan which includes nozzle requirements, application parameters, environmental conditions and other parameters which allow for the lowest amount of off-target movement possible without compromising the efficacy of the product. However, prohibiting the use of these tools will lead to yield losses and it will further result in resistance issues with currently used herbicides by limiting diverse tools. Having new tools to manage weed populations that likely have not been previously exposed to these chemistries, if stewarded properly, will lead to less competition from weeds, more diverse weed management approaches and more sustainable cropping systems. **(10039)**

**Response:** This comment is consistent with the analysis in the EIS.

**77. Comment**: Off target movement of 2,4-D and dicamba pose the greatest limitation to the adoption of either auxin technology. Although it is currently unknown what restrictions will be in place to minimize off-target movement by herbicide labels, an enormous amount of research by the registrants and other scientists across the world is being conducted to develop methods to minimize the potential for off-target movement. These efforts include 1) improving herbicide formulations, thereby reducing volatility and/or drift, 2) improving application equipment techniques and application methods, thereby reducing drift, and 3) developing educational materials to assist growers in reducing off target movement when making pesticide applications (Bagley 2013, Huff et al. 2013; Kendig et al. 2013; Magidow et al. 2013; Newsom et al. 2013; Reynolds et al. 2013, Sandbrink et al. 2013). Benefits from these efforts will be monumental in minimizing off-target movement of ALL pesticides, not just 2,4-D and dicamba, and will greatly improve the ability of a grower to apply pesticides that stay in the targeted area. In Georgia, the University of Georgia and the Georgia Department of Agriculture are currently developing additional methods to further minimize off-target movement of auxin herbicides and other pesticides. Also, a cooperative effort between The University of Georgia, Georgia Department of Ag, Agronomic Industry leaders, and Horticultural Industry leaders is underway to further define methods to minimize off-target movement. **(1911)**

**Response**: APHIS acknowledges the comment and has reached similar conclusions in Appendix 7 of the EIS.

## Commingling of GE and non-GE crops

**78. Comment:** The draft EIS fails to adequately address the potential for adverse impacts related to contamination of non-herbicide resistant crops and seed varieties. Many of our farmer members have chosen to grow non-glyphosate resistant varieties of corn and soybeans, as well as organic varieties. These varieties of corn and soybeans, and all types of organic production require increased labor and expense on the part of the farmer, but result in a price premium when the crop is marketed. In many cases across the state of Iowa, non-glyphosate resistant and organic crop varieties are grown next to fields containing glyphosate-resistant strains of corn and soybeans. Contamination of non-GMO and organic seed by glyphosate-resistant seed or pollen results not only in the loss of the farmer's anticipated price premium, but also in the loss of seed that could be used in future growing years. As more of this contamination occurs, the more obstacles farmers will face in finding uncontaminated seed and successfully growing and harvesting non-GMO and organic varieties to meet market demand **(8007)**

**Response:** The risk of commingling is not expected to change under any of the alternatives. This is because the approval of Enlist™ corn and soybean is not expected to result in a change in the areas where GE corn and soybean is planted or the total acres of GE corn and soybean planted. In 2013 GE corn and soybean represented 90 and 93% of the corn and soybean acres planted in the US(Fernandez-Cornejo *et al.*, 2014). For soybean, this percentage has remained between 91-94% for the past 5 years (Fernandez-Cornejo *et al.*, 2014). For corn, the percentage has slowly increased from 85 to 90% over the past five years (Fernandez-Cornejo *et al.*, 2014). These trends indicate that the soybean market for GE is essentially saturated and for corn, the market has approached or is approaching saturation. Further increases in GE production are not expected as a result of the availability of Enlist™ corn and soybean. The Enlist™ crops are expected to merely substitute for other GE corn and soybean varieties currently planted. Consequently, no differences in the potential for adverse impacts related to contamination exist between the No Action and the Preferred Alternatives.

**79. Comment:** USDA should not approve another GE trait (especially in corn that easily cross-pollinates) in absence of comprehensive contamination prevention measures to protect organic and other non- GE farmers. Cross-pollination in corn threatens to increase production costs, eliminate markets, and harm the credibility of the organic label. In the event contamination occurs, organic farmers and others harmed need those who own, promote, and profit from GE products to be take responsibility for the damage contamination causes. Currently there is no recourse for those economically harmed by contamination. **(9716)**

**Response**: See response to comment #78. APHIS does not regulate market based harms that result from mixtures of GE and non GE crops.

**80. Comment:** Deregulation of GM crops has led to economic losses to organic growers. The widespread adoption of GM crops has caused economic losses to organic farmers who have experienced incidental genetic contamination of their crops, making them ineligible for sale on the higher-value organic market. A recent survey of certified organic field crop producers located mostly in the Midwest found that 95% of them plant buffer crops to protect against genetic contamination at an average annual cost per farm of $4,776 for planting, harvesting, storing, and selling buffers to conventional rather than organic markets. Three-quarters of organic corn producers and 78% of organic soy growers delay planting to protect against genetic contamination, averaging annual costs of $16,699 for organic corn growers and $8,713 for organic soy producers. (See "Organic Farmers Pay the Price for GMO Contamination," March 2014, Food and Water Watch, http://documents.foodandwaterwatch.org/doc/GMO_contamination.pdf.) This does not take into consideration the cumulative economic losses over the past 18 years due to incidental presence of transgenic sequences in organic crops that have been rejected by buyers, nor the cost to these producers of the loss of organic markets. The Food and Water Watch survey reveals that 59% of organic corn growers and 57% of organic soy producers who have found or suspected "GMO presence" on their farm had grain rejected by a buyer. **(10152)**

**Response:** APHIS acknowledges the comment and has incorporated relevant information from the comment as appropriate into the EIS.

**81. Comment:** This regulatory process does not adequately protect farmers or the environment from creation of herbicide-resistant weeds. It also does not protect non-GM producing farmers, including certified organic producers, from genetic contamination of their crops. A solution to this persistent problem is for APHIS to take the entire technology system for each GM crop into consideration when deciding whether or not to deregulate, including the increased levels of herbicide application and ability to contain and control transgenes. **(10152)**

**Response:** See response to comment #78. APHIS does not regulate market based harms that result from admixtures of GE and non GE crops. In addition, APHIS does not have statutory authority to regulate herbicide use.

**82. Comment:** GMO corn of any type, sows its pollen through the wind, and spreads its genetic material throughout a large region. NonGMO farmers will lose access to markets due to genetic contamination from this proposed new GMO corn, as well as suffer diminished crop quality through loss of genetic purity that they feed their livestock or save for their own seed. I am not arguing a health and safety issue, although I wish there were a platform for this discussion. Instead, I believe we must address the importance of protecting our seed germplasm, and how essential it is to provide the choice to growers and consumers to not have unwanted genes in the crops they grow and consume. The property rights of the nonGMO farmer are violated every time a spec of GMO pollen cross pollinates with their nonGMO crop. While nonGMO farmers are in the minority, their rights are no less important than those of the majority. **(8984)**

**Response:** See response to comment #78. APHIS does not regulate market based harms that result from admixtures of GE and non GE crops.

**83. Comment**: Both proposed GMO corn and soybean crops are pests to other plants, because they lower the value and genetic purity of nonGMO crops grown both nearby and for miles around. **(10054)**

**Response**: APHIS does not consider cross pollination per se to be a plant pest harm.

**84. Comment:** The minimal benefits of these seeds against glyphosate-resistant weeds may be easily exceeded by their higher costs. Biotech corn seeds already cost nearly $40 more per acre than non-GE seeds, and the cost of biotech corn seeds nearly tripled from $103 per 80,000 seeds in 1998 to $285 in 2013. The new 2,4-D resistant seeds, once stacked with glyphosate-tolerance, could cost more than the biotech corn seeds that have been on the market for years, so the cost to farmers could be even higher. USDA's cost analysis, taken directly from Dow's data, acknowledges that the purported benefits do not consider the technology fees or cost of the new 2,4-D formulation.

USDA must fully evaluate and consider the impact of potential contamination of non-GE corn and soybeans by the proposed traits. The USDA's evaluation of the socioeconomic impacts associated with the petitioning crops does not evaluate all risks involved with domestic production. These GE crops in the pipeline could negatively impact non-GE and organic farmers, while barely benefiting those that choose to grow them.

For example, organic soybean cultivation represents less than 1 percent of total U.S. soybean production, so USDA assumes that these operations will likely not be affected by GE soybeans. And, organic corn cultivation only represents 0.21 percent of total U.S. corn production in the target states, so USDA assumes that these operations will likely not be affected. But any contamination or damage to organic corn and soybeans could result in huge economic losses for farmers. Data supplied by the Organic Trade Association illustrates that some grain buyers reject loads with more than 0.9 percent GE presence, resulting in 0.25 percent non-GE soybean and 3.5 percent non-GE corn rejections. A rejection from the loads' intended market means a lost premium for that non-GE product. The estimated loss from market rejections alone is $40 million annually. A 2014 survey conducted by Food & Water Watch and the Organic Farmers' Agency for Relationship Marketing (OFARM) found that one out of three organic farmers responding to the survey have dealt with GE contamination on their farm. USDA must fully evaluate the economic impacts of GE contamination for organic and non-GE growers. **(6923)**

**Response:** The cost of biotech seeds is outside the scope of the EIS. The fact that growers purchase biotech seeds despite their greater cost indicates that the growers obtain value from the seeds. APHIS concluded that organic soybean and corn production would not be impacted under the Preferred Alternative because Enlist™ corn and soybean would not lead to an increase in the percent of GE corn and soybean acres in the United States (see response to comment #79) and not because organic corn and soybean represents a very small amount of the corn and soybean grown in the US.

## Increased Market Power and Consolidation in Seed Industry

**85. Comment**: One of the impacts of GE technology has been increased market power by firms that patent and profit from these products. As patented traits boost market power, farmers see less choice and higher prices in the marketplace. Dozens and dozens of seed industry mergers and acquisitions have followed the expansion of biotechnology in agriculture. This means independent seed companies have vanished from the landscape, with 70 acquisitions by the top eight firms occurring in the last five years alone. Three firms maintain their dominant position and collectively control more than half of the market, up from 22 percent in 1996, when the technology was introduced. Access to non-GE seed in the face of increased demand – due to herbicide-resistant weeds, high seed prices, premiums for non-GE crops, among other reasons – is more important than ever. We've seen increased demand for non-GE corn and soybeans, but supplies are often short. Many farmers don't want to continue on the GE trait and pesticide treadmill for economic, market, human health, and environmental reasons, but they need high-quality alternatives. **(9716)**

**Response:** The commenter seems to imply that non GE seeds will not be available in the face of increased demand because the major biotech companies control the seed market because they have acquired most of the independent seed companies. The commenter further implies that biotech companies will not be responsive to the demands of the market, instead only producing more profitable biotech seeds. First APHIS emphasizes that this topic is a market issue outside the scope of the EIS. Second, APHIS disagrees that the article used to support this view, a NY Times article about the increased demand for non GE ingredients in food products, makes this point (Strom, 2013).

**86. Comment**: Dow Agrosciences is the biggest beneficiary of its patented seed. Dow would like to see a return on their investment, and had expected to reap $1.5 billion in extra profit in 2013 from 2,4-D resistant corn sales alone. But USDA must act in the best interest of the public, and deregulating 2,4-D-resistant corn and soy does not have any foreseeable benefits for farmers or consumers. **(6923)**

**Response**: APHIS has articulated numerous benefits to farmers and consumers in the EIS including improved weed control, lower production costs, lower energy required for crop production, and less tillage among others. The production costs are expected to be lower under the Preferred Alternative because less tillage and hand-weeding is likely to be needed. Less tillage is expected to lead to less environmental harm under the Preferred Alternative compared to the No Action Alternative.

APHIS notes that its decision on the petition for nonregulated status is a science based determination that is constrained by the PPA and 7 CFR part 340.

**87. Comment**: It is a certainty that if these traits are approved they will be widely adopted in part because a farmer's choice of options will continue to be constrained by the way the traits, the crop germplasm they're placed in and the packaged herbicide products (that match the traits) are marketed**. (9938)**

**Response**: APHIS does not agree that it is a certainty that Enlist™ crops will be widely adopted because of constraints on farmer's choice. APHIS believes that Enlist™ soybean will be widely adopted because soybean producers want the technology. It is far from certain that Enlist™ corn will be widely adopted because the technology is less important to corn growers who already can use 2,4-D on corn and have several other effective herbicide chemistries at their disposal.

**88. Comment**: Seed industry consolidation means less innovation, fewer options for farmers. This week marks the 4 year anniversary of the DOJ/USDA hearings on corporate consolidation in agriculture. USDA has at its fingertips thousands of pages of testimony by American farmers regarding the devastating impacts on their livelihoods of corporate consolidation in agriculture, including in particular, the seed industry. Documentation of the negative impacts on farmers of the loss of hundreds of independent seed retailers and farmers' increasing inability to source non-GE seed as a consequence of the monopolistic growth of Monsanto in particular was presented at these hearings in March, 2010. Dow's response to the rise of glyphosate resistance and the corresponding loss of effectiveness of Monsanto's Roundup Ready technology has been the development and presentation of the "Enlist" seeds under review today. Monsanto and Dow have entered into cross-licensing agreements to share Dow's 2,4-D resistant traits. USDA's "preferred alternative" of deregulating Dow's 2,4-D seeds is likely to lead to a scenario in which two corporate actors (Monsanto and Dow) maintain upwards of 90% control of U.S. corn and soybean seed markets. This in turn is likely to continue to drive corporate consolidation of the seed industry and the corporate capture of germplasm that occurs when seed varieties once in the public domain are genetically engineered to contain new traits, patented and removed from the public domain. The EIS fails to identify, explore and assess the socio-economic and livelihood impacts on farmers of Dow's move to increase its market share of U.S. corn and soybean markets, of Dow and Monsanto's cross- licensing deals, and of farmers' growing inability to find and purchase non-GMO seed. **(10203)**

**Response**: Dow's move to increase its market share of the U.S. corn and soybean markets, Dow and Monsanto's cross licensing deals, and the commenter's view of farmers growing inability to find and purchase non-GE seed are market issues outside the scope of the EIS

## Human Health:

**89. Comment**: Dozens of studies in humans have reported an association between exposure to 2,4-D and non-Hodgkin's lymphoma, a cancer of the white blood cells that can be fatal. The first studies linking 2,4-D with non- Hodgkin's lymphoma were published in Sweden thirty years ago. Some of these studies also found an association with soft-tissue sarcoma, a rare and frequently fatal cancer. More recently, studies published in Canada and Italy have supported these results, as have studies performed by researchers at the National Cancer Institute. A recent study by the Dow Chemical Company of their pesticide production workers reported a 36 percent increase in non-Hodgkin's lymphoma in workers classified as exposed to 2,4-D, but the authors concluded the result was not statistically significant.

2,4-D increases lymphocyte replication in humans. One study of pesticide applicators found increasing lymphocyte proliferation of 11 to 14 percent greater than normal in the applicators in a manner that was directly related to 2,4-D absorbed dose. This finding was confirmed in a follow-up study, showing a 12 to 15 percent increase in lymphocyte proliferation, with a further indication that higher-dose exposures may cause direct damage to white blood cells, thereby increasing the risk of lymphoid cancer in humans.

Many studies have found that 2,4-D formulations are cytotoxic (i.e., damage and kill cells) and mutagenic (i.e., trigger genetic mutations). For example, in human lymphocytes—commonly known as white blood cells—2,4-D causes chromosome breakage and aberrant cells. Lymphocytes are the cells that turn cancerous in lymphoma. Other studies have reported positive results in various other standardized tests of chromosome and DNA damage, including sister chromatid exchange in chick embryos and in the bone marrow and developing sperm cells of mice, and DNA damage in hamster ovary cells. In the aggregate, these studies demonstrate that 2,4-D can damage chromosomes and cause mutations in numerous cell types, which could explain why this chemical has been linked to cancer in humans.

*2,4-D, Neuroendocrine Disruption, and Reproductive Effects.* Dozens of peer-reviewed studies show that 2,4-D exhibits hormone-disrupting activity. 2,4-D also affects the function of the neurotransmitters dopamine and serotonin. Interference with hormones and neurotransmitters can cause serious and lasting effects during fetal and infant development, including birth defects, neurological damage in offspring, and interference with reproductive function such as suppression of sperm production.

Some human studies have been done on the hormonally-related effects of 2,4-D, and these support the results of the animal studies. Male farm sprayers exposed to 2,4-D have lower sperm counts and more spermatic abnormalities compared to men who are not exposed to this chemical. In Minnesota, higher rates of birth defects have been observed in wheat-growing areas of the state with the highest use of 2,4-D and other herbicides of the same class. This increase in birth defects was most pronounced among infants who were conceived in the spring, the time of greatest herbicide use. A larger study in agricultural counties in Minnesota, Montana, North Dakota, and South Dakota found significant increases in birth malformations of the circulatory and respiratory systems, especially among infants conceived in April- June in wheat-growing counties (this is the time period and zone of greatest 2,4-D use). In the same study, infant deaths from birth defects among males were significantly elevated in high-wheat-growing counties. A recent epidemiological study found increased odds of Parkinson's disease in those with occupational exposure to 2,4-D.

*Exposure to 2,4-D.* 2,4-D blows in the wind from the point of application, so the chemical may contaminate soil and water for many miles downwind. 2,4-D is classified by the EPA as a hazardous air pollutant and by the State of California as a toxic air contaminant. 2,4-D lingers in the soil for over a month after it is applied (the half-life of 2,4-D in soil is one week, with virtual elimination defined as about five half-lives). Numerous studies have demonstrated that 2,4-D that was applied outdoors is commonly tracked into homes on shoes or pet paws, and that 2,4-D degrades very slowly when it is not exposed to direct outdoor sunlight, persisting for many months or even a year in household carpets. Residues of 2,4-D on children's hands and in their urine have been shown to correlate closely with the levels of 2,4-D in carpet dust, demonstrating that the contamination from the dust enters children's bodies. Studies in homes in Iowa within about a half-mile of agricultural fields where 2,4-D was applied detected the chemical in house dust in 95 percent of nearby homes. 2,4-D has been found as a contaminant in surface water samples in the United States, and has also been detected in groundwater, according to the United States Geological Survey. 2,4-D has also been detected in drinking water and it is a regulated contaminant in the National Primary Drinking Water Regulations. Human exposure to 2,4-D is widespread, including among children. A 2008 study, for example, found 2,4-D in 83 percent of household dust samples in North Carolina and 98 percent of homes sampled in Ohio, despite the fact that only one homeowner in this study of 135 homes reported recent use of the pesticide. **(4079)**

**Response**: The harms mentioned by the commenter are not harms resulting from the corn or soybean plants themselves. Rather, the alleged harms are attributed to increased herbicide use. EPA regulates herbicide use, USDA does not. An herbicide cannot be registered through the EPA, nor can an existing registration be amended, unless the registered use conforms to the EPA standard of "no unreasonable adverse effects on the environment" as described in FIFRA. The registration label includes strict limits on the quantities and methods allowed for the use of an herbicide to ensure that the standard of no unreasonable adverse effect is met. USDA has summarized the EPA risk assessment prepared in the registration process in section 5.4 of the FEIS.

Regarding the alleged association of exposure to 2,4-D and non-Hodgkin's lymphoma, According to EPA (US-EPA, 2014b), "the Agency on numerous occasions has concluded that the data are inadequate to support a link between 2,4-D exposure and cancer of any type (most recent assessment can be found in the Agency's response to NRDC petition, (US-EPA, 2012a)). The Agency will further evaluate research related to 2,4-D under registration review, including any new epidemiology data."

Regarding the issue of 2,4-D and human carcinogenicity, EPA reported, "The Agency has evaluated on several occasions the issue of human carcinogenicity, based on epidemiological links of 2, 4-D to NHL, as well as mutagenicity potential. EPA has consistently found that these data do not support classification of 2,4-D as a carcinogen" (US-EPA, 2014b).

Regarding 2,4-D and Parkinson's disease, EPA reported, "Epidemiological studies in the open literature linking Parkinson's disease with 2,4-D exposure will be addressed during the Registration Review of all 2,4-D formulations, taking into account the fact that 2,4-D use patterns have changed in agriculture since the timeframes where the cited data were generated and possible confounding aspects, such as potential dioxin contamination, which are no longer a factor in the modern manufacturing processes for 2,4-D" (US-EPA, 2014b).

Regarding epidemiology studies, EPA reported (US-EPA, 2014b), "The Agency has on several occasions reviewed epidemiology studies asserting a link between cancer and 2,4-D exposure. EPA concluded that the existing data did not support the link. During Registration Review, all new epidemiology information will be considered. During the registration review process, the Agency is also involved in many efforts to refine its risk assessment policies including establishing better methods for considering epidemiological research in the regulatory process; and more active participation with several epidemiological cohorts focused on agriculture and the use of pesticides. The Agency will further evaluate research related to 2,4-D under registration review."

**90. Comment***:* Humans are exposed to 2,4-D through both dermal contact and ingestion of contaminated food and water. Residues remain on crops treated with 2,4-D, and the herbicide enters surface water and groundwater, ultimately contaminating drinking water supplies. In addition, 2,4-D drifts from the point of application and becomes widely distributed, exposing populations distant from the site of application to its harmful effects. One study, for instance, found that 2,4-D residues were detectable in 83 percent of household dust samples in North Carolina and 98 percent of homes in Ohio, despite the fact that 2,4-D use was reported at just one of the 135 homes inspected. The herbicide is often tracked into homes, where it may persist for months on indoor carpets, leaving children who crawl or play on floors disproportionately vulnerable to 2,4-D exposure and accompanying risks. **(8094)**

**Response:** See response to comment #89.

**91. Comment:** Of most concern to NCGA are the unknown effects of novel chemical reactions in the agricultural areas due to the presently high use of glyphosate and the predicatble increase in 2, 4-D usage. What are effects of mixing these two herbicides in the environment? What reactions are catalized when these two herbicides mix in the presence of sunlight? Deregulating 2, 4-D resistant crops will inevitably lead to the uncontrolled mixing of these two chemical compounds in the environment. Each of these chemical compounds have known detrimental impacts on human health and environment. 2, 4-D is associated with increased cancer risks, especially for non-Hodgkin lymphoma. It is also a potent neurotoxin and hormone-disruptor. Studies report that exposure to 2,4-D is associated with an increased risk of Parkinson's disease, reduced sperm counts, and birth defects. These impacts on human health should be enough to deny the petition to deregulate these crops. Given the current usage of glyphosate it is imparrative that we first study how these two compounds interact. Otherwise we are wagering rural America's health and wellbeing on a foolish gamble that we are certain to lose. Knowing that this herbicide is a known and effective carcinogin and an endochrin disrupter should be reason enough to deny the deregulation. The development of glyphosate resistance in a little over a decade should also be reason enough to deny deregulation and look for safer and more effective long-term agricultural advancements. The unknown impacts of turning our farm fields into chemical reactors filled two compounds known to impact human and environmental health trumps the known risks. **(10164)**

**Response:** See response to comment #89

**92. Comment**: Research by EPA suggests that babies born in counties where high rates of chlorophenoxy herbicides are applied to farm fields are significantly more likely to be born with birth defects of the respiratory and circulatory systems, as well as defects of the musculoskeletal system, such as clubfoot, fused digits, and extra digits. These birth defects are 60% to 90% more likely in counties with higher 2,4-D application rates. **(8681)**

**Response:** See response to comment #89

**93. Comment:** Additionally, 2,4-D tolerant corn and soybeans could be dangerous to eat because a metabolite of 2,4-D (2,4 Dichlorophenol or DCP) is known to cause skin sores, liver damage and sometimes death in animals. Because of the risks of this byproduct, scientists from the French National Institute for Agricultural Research suggest that crops treated with 2,4-D "may not be acceptable for human consumption." A 2012 study found that individuals with 2,4-DCP present in their urine were more likely to have a diminished tolerance to food and environmental allergens. **(6923)**

**Response:** See response to comment #89

**94. Comment:** APHIS states, "APHIS has not identified any direct or indirect effects on worker safety that would result from choosing the Preferred Alternative Hazards to workers occurring through the various management practices that are used to grow corn and soy." However, the scientific literature confirms that farmers, farmworkers and their families face extraordinary and disproportionate risks from pesticides, making the expansion of pesticide use an issue of environmental justice. Application and pesticide drift result in dermal, inhalation, and oral exposures that are typically underestimated. According to a study by Arcury et al.,workers experience repeated exposures to the same pesticides evidenced by multiple pesticides routinely detected in their bodies. This study of 196 farmworkers found that 86 percent of them contained 2,4-D in their urine. Others have also reported 2,4-D detections in a majority of samples including those of pregnant workers. A 2004 study detected agricultural pesticides in the homes near to agricultural fields. Researchers from the National Cancer Institute and the National Institutes of Health found that increasing acreage of corn and soybean fields within 750 meters of homes is associated with significantly elevated odds of detecting agricultural herbicides. 95 percent of the homes sampled here contain 2,4- D. 2,4-D has also been detected in the semen of farmworkers in Canada, which could be toxic to sperm cells and can be transported to the woman and developing embryo/fetus. Phenoxyacetic acid herbicides, specifically 2,4-D, is associated with non-Hodgkin lymphoma (NHL) and a high incidence of NHL has been reported among farmers and other occupational groups working with 2,4- D. According to the National Cancer Institute, frequent use of 2,4-D, has been associated with 2- to 8-fold increases of NHL in studies conducted in Sweden, Kansas, Nebraska, Canada, and elsewhere. Farmers using 2,4-D are associated with an increased risk of NHL in 131 lymphohematopoietic cancers (LHC) in a case-control study embedded in a cohort of 139,000 members of United Farm Workers of America (UFW) diagnosed in California between 1988 and

2001. Despite industry attempts to downplay these findings and claim that 2,4-D has low toxicity, farmworkers continue to bear the brunt of these exposures and chronic health effects. APHIS has not adequately looked at the increased occupational risks posed by 2,4-D. The agency therefore cannot make a determination for DAS-40278-9 corn until occupational health is specially considered. **(9822)**

**Response:** As described in the response to comment #89, pesticide effects on farmers, farmworkers, and their families are addressed by EPA and are outside the scope of this EIS. As noted in the FEIS (section 4.1.1 Worker Safety) , Agriculture is one of the most hazardous industries for U.S. workers. As a result, in 1990, Congress directed the National Institute of Occupational Safety and Health to develop a program to address high-risk issues related to occupational workers. In consideration of the risk of pesticide exposure to field workers, EPA's Worker Protection Standard (WPS) (40 CFR Part 170) was published in 1992 to require actions to reduce the risk of pesticide poisonings and injuries among agricultural workers and pesticide handlers. The WPS offers protections to more than two and a half million agricultural workers who work with pesticides at more than 560,000 workplaces on farms, forests, nurseries, and greenhouses. The WPS contains requirements for pesticide safety training, notification of pesticide applications, use of personal protective equipment, restricted entry intervals following pesticide application, decontamination supplies, and emergency medical assistance. On February 20, 2014, the US-EPA announced proposed changes to the agricultural WPS to increase protections from pesticide exposure for agricultural workers and their families. EPA is proposing to strengthen the protections provided to agricultural workers and handlers under the WPS by improving elements of the existing regulation, such as training, notification, communication materials, use of personal protective equipment, and decontamination supplies. The proposed changes to the current WPS requirements, specifically improved training on reducing pesticide residues brought from the treated area to the home on workers and handlers' clothing and bodies and establishing a minimum age for handlers and early entry workers, other than those covered by the immediate family exemption, mitigate the potential for children to be exposed to pesticides directly and indirectly. EPA expects the revisions, once final, to prevent unreasonable adverse effects from exposure to pesticides among agricultural workers and pesticide handlers; vulnerable groups, such as minority and low-income populations, child farmworkers, and farmworker families; and the general public.

**95. Comment**: As the DEIS acknowledges, Executive Order 12898 (US-NARA, 2010) establishes policy to "prevent minority and low-income communities from being subjected to disproportionately high and adverse human health or environmental effects." DEIS p. 159. While the DEIS acknowledges that the increase in 2,4-D use under the proposed action alternative will be "up to three fold" greater than if the proposed action is not approved (DEIS p. 119), the DEIS fails to address the resultant impacts to farmworkers and farmworking communities.

According to the USDA Economic Research Service, in 2009, 79% of hired crop farmworkers were born in Mexico, and approximately 50% of all hired crop workers are undocumented immigrants. USDA Economic Research Service, Farm Labor

Background.8 “According to the [Farm Labor Survey], the real average hourly earnings of non-supervisory farm laborers has been between $10.50 and $10.80 since 2007 (in constant inflation-adjusted dollars, at 2012 prices), and stood at $10.80 in 2012. Real farmworker wages have risen at 0.8 percent per year since 1990.” *Id.* Thus, pursuant to Executive Order 12898, APHIS has a duty to discuss whether farmworking communities are disproportionately impacted by the proposed action.

There is no question that farmworkers are improperly exposed to harmful levels of pesticides during the course of their work. As discussed above, in California, even in years where over 95% of pesticide permits, pesticide labels, and personal protective equipment requirements were met, the California Department of Pesticide Regulation found thousands of violations during inspections and investigations. *See* California Pesticide Use Enforcement Statistical Profile, *supra*, p. 5. These violations substantially increase risks to farmworkers, who are directly impacted when pesticides are applied without (1) compliance with pesticide labels, (2) appropriate information regarding the pesticides applied and hazards associated with them, (3) personal protective equipment, (4) posted emergency information, (5) pesticide handler decontamination facilities, and other violations. *Id.*, p. 5.

Had APHIS appropriately studied the increased use of 2,4-D in the DEIS – instead of improperly deferring to the EPA’s non-NEPA review under FIFRA – it would have addressed related increased risks on farmworkers inherently associated with this change. By mistakenly assuming that the action alternatives would not change working conditions as compared to the no-action alternative (DEIS p. 110), APHIS has improperly ignored these impacts, in violation of Executive Order 12898 (US-NARA, 2010). APHIS’ conclusion that the proposed action would not disproportionally affect minorities or low-income populations is erroneous. In addition to violating Executive Order 12898, APHIS’ failure to address the action alternatives’ impacts on farmworker health violates NEPA’s requirement that the DEIS discuss the environmental consequences of the proposed action. *Robertson v. Methow Valley Citizens Council*, *supra*, 490 U.S. at 352. **(10158)**

**Response:** We disagree with this comment. As explained in the response to comment # 89, EPA sets the conditions for pesticide use on the label to achieve a standard of a “reasonable certainty of no harm”. In consideration of the risk of pesticide exposure to field workers, EPA’s Worker Protection Standard (WPS) (40 CFR Part 170) was published in 1992 to require actions to reduce the risk of pesticide poisonings and injuries among agricultural workers and pesticide handlers. Also, the commenter does not give an example of how APHIS action will disproportionally prevent or perpetuate any impacts to minorities or low-income populations.

APHIS disagrees with the commenters assertion that most workers on corn and soybean farms are minority farmworkers. Relatively few farmworkers are hired to work in corn and soybean fields. According to (Zahniser *et al.*, 2012), hired labor accounted for just 5 and 6% of variable production expenses for corn and soybean, respectively. In contrast, for fruit and vegetables, hired labor accounted for 48 and 35% of variable production costs respectively. For corn and soybean, most on farm work is done by the owner/operator who relies extensively on farm machinery. According to the USDA Census of Agriculture (USDA-NASS, 2009), over 95% of owner operators are white Caucasians.

**96. Comment:** While acknowledging that APHIS has a duty under Execute Order 13045 to "identify, assess, and address environmental health risks and safety risks that may disproportionately affect children," the DEIS fails to meet this mandate by ignoring the potential impacts of increased pesticide use on children. *See* DEIS p. 159. Children in areas where 2,4-D is commonly used are likely to have higher concentrations of the pesticide in their urine than adults in the same environment. *See, e.g.*, Adult and children's exposure to 2,4-D from multiple sources and pathways, M.K. Morgan, *et al*, 18 *Journal of Exposure Science and Environmental Epidemiology*, 486–494 (2008). This may be because, as pesticide residue is tracked into homes on clothing and shoes, it settles into the carpeting, exposing children – who spend more time in contact with the ground and carpeting – to higher quantities of 2,4-D. Thus, children are more likely to be exposed to additional levels of 2,4-D as usage levels increase, compared to others in the same homes. By improperly deferring any analysis of how the action alternatives' resultant pesticide use will impact children, APHIS ignored the purpose of Execute Order13045. Further, APHIS' failure to discuss the reasonably foreseeable impact of increased 2,4-D use on children violates NEPA's mandate that the DEIS discuss the environmental consequences of the proposed action. *Robertson* v *Methow Valley Citizens Council, supra,* 490 US. at 352. **(10158).**

**Response:** APHIS acknowledges that children can be exposed to pesticide residue tracked into homes on clothing and shoes. EPA considers this exposure in their Human Health Risk Assessment (US-EPA, 2013b).

**97. Comment**: In its discussion of worker safety, APHIS acknowledges that "changes in acreage, crops, or farming practices can affect the amounts and types of pesticides used and thus the risks to workers." However, the DEIS denies any direct or indirect effects on worker health and safety because deregulating the 2,4-D resistant crops "will not result in a change in management practices...[because] workers will continue to use farm equipment and agricultural chemicals." As with glyphosate, the application of which increased substantially following the deregulation of "Roundup Ready" staple crops, the application of 2,4-D is almost certain to expand. The DEIS also suggests that the impacts on worker safety will be better if the crops in question are deregulated because "under the No Action Alternative, workers are likely to be exposed to a wider range of chemicals as additional chemistries are used to manage weed resistance." APHIS, however, does not conduct a thorough analysis of whether exposure to a more diverse group of herbicide chemicals is conclusively worse for worker safety than exposure to higher levels of a more narrow set of herbicides. Again, APHIS has improperly sidestepped a key issue—the impact of a significant increase in overall application of 2,4-D. **(8094)**

**Response**: The commenter has quoted the DEIS out of context. APHIS did not conclude that deregulating 2,4-D resistant crops will not result in a change in management practices. APHIS is quite clear that under the Preferred Alternative, 2,4-D use is expected to increase (Cumulative Effects and Appendix 4). APHIS concluded that no adverse impacts are expected to workers if herbicides are used in accordance with the EPA label. The DEIS p. 88 actually reads, “Changes in acreage, crops, or farming practices can affect the amounts and types of pesticides used and thus the risks to workers. The EPA pesticide registration process, however, involves the design of use restrictions that if followed have been determined to be protective of worker health. Growers are required to use pesticides consistent with the application instructions provided on the EPA-approved pesticide labels. Worker safety precautions and use restrictions are clearly noted on pesticide registration labels. These restrictions provide instructions as to the appropriate levels of personal protection required for agricultural workers to use herbicides. These may include instructions on personal protective equipment, specific handling requirements, and field reentry procedures. Used in accordance with the EPA label, these herbicides have been determined to not present a health risk to workers (US-EPA, 2005; 2008).”

APHIS did not reach a conclusion whether exposure to a wider range of chemicals under the No Action Alternative is worse for worker health. First, human health effects from pesticide use are outside the scope of this EIS. Second, as mentioned above, APHIS concluded that if used in accordance with the EPA label, these herbicides have been determined to not present a health risk to workers.

## Dioxin/Agent Orange

**98. Comment:** As you know, it was a major component of Agent Orange, the chemical defoliant used by the U.S. military in Vietnam. If that wasn’t enough, industry tests also show that 2,4-D is contaminated with dioxins—often referred to as the most toxic substance known to science. In fact, EPA has reported that 2,4-D is the seventh largest source of dioxins in the U.S. More 2,4-D use will lead to more dioxins in the environment. They are implicated as a major cause of many serious medical conditions in both Vietnam veterans and the Vietnamese, including birth defects in the children of exposed parents. **(3106)**

**Response**: EPA, not USDA, has the authority to regulate the use of herbicides. APHIS has considered the comment and also reviewed EPA data, and it disagrees with the comment. The herbicide Agent Orange, which was used by the military during the 1960s, was a mixture of the herbicides 2,4,5-T and 2,4-D. The principle source of dioxins in agent orange resulted from the manufacture of 2,4,5-T, and not 2,4-D. In 1970, the United States Department of Agriculture (USDA) stopped the use of 2,4,5-T on all food crops except rice, and in 1985 EPA terminated all remaining uses in the U.S. The herbicide 2,4- D has been reviewed extensively in past years. Since the 1980s, the manufacturers of 2,4-D have taken steps to decrease the chances that dioxin contaminants will be formed during the production process. In periodically reviewing 2,4-D, EPA has required the manufacturers to provide data on dioxin levels in 2,4-D products to confirm that the products can be used safely (US-EPA, 2014b). The statement that 2,4-D represents the seventh largest source of dioxin refers to data from 1995 (http://www.epa.gov/oppsrrd1/REDs/24d_red.pdf) and at that time still only constituted 2.6% of dioxin emissions. Since that time, the manufacturing processes for

2,4-D have been modified, resulting in even lower amounts of dioxin in 2,4-D. (US-EPA, 2005). According to EPA, potential dioxin contamination is no longer a factor in the modern manufacturing processes for 2,4-D (US-EPA, 2014b).

**99. Comment:** Meanwhile, the latest available data show that 2,4-D is still contaminated with low levels of extremely toxic dioxins, which may or may not be the cause of 2,4-D's toxicity. EPA begins its registration review of 2,4-D next year, which will involve a fresh look at the latest science on its toxicity; this review will take account of strict new dioxin exposure standards issued by EPA earlier this year as part of its ongoing reanalysis of dioxin toxicity. USDA should refrain from any decision on 2,4-D corn, and the many-fold increase in 2,4-D use it would entail, until that review is complete. EPA should likewise refrain from registering any 2,4-D product on any 2,4-D crop pending completion of its review. **(6905-007)**

**Response:** APHIS and EPA expect to complete their respective reviews about the same time and are consulting with each other about their respective findings.

**100. Comment:** The issue of 2,4-D contaminants, such as dioxins that are present in formulations, has been ignored and is probably much more serious in terms of degradation issues than the "active ingredient." Dioxins have notoriously long half-lives, are bioaccumulative, and present broadly significant health risks developmentally and postnatally, including increased risk of heart disease and diabetes. APHIS has not sufficiently taken into account the possibility of increased dioxin contamination to fields using 2,4-D and the threat to environmental health. **(9822)**

**Response:** See response to comment #98.

**101. Comment:** In supplementary material to the Environmental Assessment for 2,4-D tolerant corn provided by Dow, the company lists additional data requested by the EPA during the reregistration of 2,4-D. As of July 2011, all data gaps had been fulfilled except for the dioxin profiles. The USDA's EIS did not include any updates on this data, ignoring many of the comments that asked for this information during the EIS scoping comment period. Dioxin is an extremely hazardous chemical that should not be overlooked. USDA should not allow the use of 2,4-D resistant corn until the EPA reviews the dioxin data and the agency's reregistration analysis is complete. **(6923)**

**Response:** see response to comment #98 and comment #99

## Food Safety

**102. Comment**: These crops are clearly different from their conventional counterparts. For example when the FDA assessed the AAD-1 protein expressed by maize in question "as safe as conventional corn varieties…and not materially different" from other maize, it also reported statistically significant differences in amino and fatty acids, vitamins and minerals. Brazilian researchers have also found significant differences in the molecular composition of GM crops compared to conventional varieties. Agapito-

Tenfen found 32 differences in proteins involving molecular functions attributed to energy metabolism, metabolism of plant response, metabolism of genetic information processing, and metabolism of stress. The study also found that these differences were highly dependent on environmental conditions so were difficult to predict.

Such differences have not been studied in the determination of their safety, nor has the identification of these differences triggered investigation into other unexpected differences caused by the GM event. This is not scientific, so is not a sound determination of safety, and the crops should not enter the food chain or wider environment until such study genuinely determines safety. **(7680)**

**Response:** FDA, not APHIS, regulates food safety of biotech crops. APHIS agrees that the review by FDA regarding the food safety of Enlist™ corn and soybean reached the conclusion that Enlist™ corn or soybean is not materially different in any respect relevant to food or feed safety from corn varieties currently on the market and that the genetically engineered corn or soybean does not raise issues that would require premarket review or approval by FDA (US-FDA, 2011b; 2011a). FDA did not interpret the small variations in amino acids, fatty acids, vitamins, or minerals noted by the commenter as relevant to the food or feed safety of the corn and soybean varieties.

**103. Comment**: The Food and Drug Administration (FDA) considers the AAD-1 protein "as safe as conventional corn varieties…and not materially different" from corn currently grown and marketed in the United States. Yet, the FDA's Biotechnology Consultation Note for 2,4-D- resistant corn lists several amino acids, fatty acids, vitamins and minerals that differed from conventional corn in the compositional analysis and were statistically significant. Some of these important biological compounds include alanine, cysteine, glutamic acid, methionine, phenylalanine, oleic acid, vitamin B1, vitamin C, niacin, magnesium, manganese, phosphorus and zinc. FDA has awarded the "generally recognized as safe" status to almost all—95 percent—foods and traits in food since 1998, so this distinction is relatively meaningless. A description of differences without data showing that these differences are "safe" is inadequate and unacceptable. More research must be done to show that these nutritional differences do not result in any functional differences that could affect human or animal health when this corn is present in food or animal feed.

Additionally, more 2,4-D use will likely result in an increase of the pesticide's residues on corn for food and feed and if 2,4-D follows in the same footsteps as glyphosate, tolerance levels may be increased to keep up with higher residue levels. The USDA must consider the effects that higher 2,4-D residues in food would have on human health. **(6923)**

**Response**: As noted in the response to comment #102, FDA did not interpret the small variations in amino acids, fatty acids, vitamins, or minerals, or proteins noted by the commenter as relevant to the food or feed safety of the corn and soybean varieties. According to EPA's website (US-EPA, 2014a), "EPA is responsible for setting tolerance levels for pesticides left on foods. EPA establishes tolerances for each pesticide based on the potential risks to human health posed by that pesticide. Some risk assessments are based on the assumption that residues will always be present in food at the maximum level permitted by the tolerance. Other risk assessments use actual or anticipated residue data, to reflect real-world consumer exposure as closely as possible." In this case, the relevant risk assessment for setting the tolerance is the Food and Drinking Water Exposure and Risk Assessment. According to this assessment (US-EPA, 2013a), "2,4-D tolerances have been established in numerous plant commodities, crop groups, processed products, livestock commodities, fish, and shellfish at 40 CFR §180.142. No new or revised tolerances are required to support the proposed new use on 2,4-D tolerant field corn and soybean". At this time, an increase in the tolerance level of 2,4-D on Enlist™ corn and soybean is not reasonably foreseeable.

**104. Comment**: Additionally, since more 2,4-D will be used it is reasonable to assume residue levels in food will also increase. The U.S. response to this situation with glyphosate has been to increase the legally permissible residue levels in food. A path that virtually guarantees a similar response to 2,4-D is both worrying in itself and a means to store up health problems for the future that will be costly in many ways. It is simply unacceptable for the USDA to absolve itself of responsibility for these critical issues by claiming they are not plant pest risks. If APHIS cannot address these concerns, we wonder who will do so and when they will they do it. **(7706)**

**Response**: see response to comment #103.

**105. Comment:** When commenting on the EAs for Enlist corn and soybeans (CFS Science Soy at 84 – 94, CFS Enlist Corn II Comments at 29 - 34), CFS alerted APHIS to the need to consider potentially toxic metabolites of 2,4-D as part of its assessments, but APHIS has not done so. In fact, APHIS makes an explicit assumption that there are no differences in composition between Enlist corn and soybeans and non-2,4-D-resistant counterparts:

In order to determine impacts of Enlist corn and soybeans, APHIS first must describe how Enlist corn and soybeans differ in phenotypic characteristics as a result of the specific genetic engineering events. The first step in doing so is to determine expression patterns of the transgenes, by finding out where, when, and how much of the gene products are made in the Enlist corn and soybean plants in environments in which they are likely to be grown. In this case, the engineered gene products are enzymes that break down, or metabolize, 2,4-D and some related herbicides. In it's Petitions, Dow provides APHIS with some transgene expression data. They measured AAD-1 and AAD-12 protein in a few plant parts and stages of development of Enlist corn and soybeans grown with different combinations of the herbicides that the introduced enzymes allow them to withstand (see DAS Petitions, "Characterization of Introduced Proteins").

APHIS uses Dow's description of when, where and how much of the transgenic protein is present in Enlist corn and soybean plants, along with analyses of protein sequence comparisons to known toxins and allergens, and *in vitro* studies of AAD-1 and AAD-12 protein digestion (EIS at 111), to determine whether ingestion of the transgenic proteins themselves was likely to harm non-target animals. For example, for Enlist soybeans:

DAS evaluated the potential allergenicity and toxicity of the AAD-12 protein following the weight-of-evidence approach (DAS, 2010a). The AAD-12 protein does not share any meaningful amino acid similarities with known allergens. The AAD-12 protein is degraded rapidly and completely in simulated gastric fluids, and the protein is not present in a glycosylated state (DAS, 2010a). The protein does not share any amino acid sequence similarities with known toxins (DAS, 2010a). The results presented by DAS suggest that the AAD-1 protein is unlikely to be a toxin in animal diets. Based on a review of this information and the assumption that these studies serve as surrogates for direct testing, APHIS has found no evidence that the presence of the *aad-12* gene or the expression of the AAD-12 protein would have any impact on animals, including animals beneficial to agriculture (USDA-APHIS, 2012a). (EIS at 111 – 112)

The assumption that Dow's *in silico* (computer simulated) and *in vitro* studies of AAD-1 and AAD-12 proteins can predict toxicity of these proteins, as they exist within Enlist corn and soybean plants, is unfounded. Proteins made in plants can have different properties than counterpart proteins in bacteria that were used in the simulated digestion studies, and computer analyses of coding sequences do not always identify toxins and allergens accurately (Freese and Schubert 2004). But the biggest problem with APHIS' assumption is that Dow's analyses are based on toxicity to mammals and, by extension, to humans; whereas the non-target organisms that could be impacted by approval span the taxonomic spectrum, from beneficial soil annelids (i.e. earthworms) to insect pollinators and endangered birds. Human and mammalian parameters of toxicity are simply not applicable over this range of organisms.

CFS stressed this point in our comments about analysis of harms to pollinators (CFS Science Corn II at 35 - 41, CFS Science Soy at 93 – 94). Composition of pollen, nectar and guttation liquid was not determined to assess differences resulting from the Enlist events, for example. The inadequacy for pollinators of toxicity assessments based on mammals was also stressed in a recent EPA white paper on pollinator risk assessments (EPA SAP 2012). Nor were impacts on honey bees studied by Dow in its field trials. Therefore, there are no relevant data for making an assessment of impacts of approval to honey bees or other pollinators.

In addition, APHIS must continue on in its analyses, past the characteristics of the novel proteins themselves, to determine how the functioning of the AAD enzymes changes the phenotypic characteristics of corn and soybean plants, and whether the changes could harm non-target species. As with the levels of AAD proteins, these phenotypic differences in metabolism should be described and assessed in the presence of the herbicides that will be used with Enlist corn and soybeans.

Dow's whole purpose in engineering corn and soybeans with these particular transgenes is to have the genes expressed throughout the plants at high enough levels that the resulting proteins will be *active* in converting 2,4-D to non-phytotoxic metabolites. The rate and extent of conversion of 2,4-D to metabolites, and thus the level of 2,4-D and metabolites, is the most relevant phenotypic difference to consider after looking at the properties of the novel protein itself, and this is not considered by APHIS in their assessments.

As CFS has noted (CFS Science Corn II at 29 – 34), CFS Science Soy at 84 – 92), Dow's studies of metabolites in Enlist corn and soybeans after applications of 2,4-D show that the activity of the AAD-1 and AAD-12 enzymes metabolizes 2,4-D into 2,4-DCP, that then is changed by other enzymes in the plant into conjugated forms of DCP (mainly DCP with specific sugars attached). In non-engineered corn and soybeans, little 2,4-DCP is produced after 2,4-D applications, nor are conjugated forms found at appreciable levels. 2,4-DCP has been shown to be toxic to some organisms, and conjugated forms have been shown to release 2,4-DCP during digestion, raising the specter that conjugated forms could be a delayed-release poison. Dow did not perform studies to test toxicity of these metabolites to non-target organisms, other than simply observing that insects were found in fields of Enlist corn and soybeans at levels comparable to nonengineered corn and soybeans (DAS Petition). These observations do not constitute an appropriate study of toxicity, nor do they address the range of organisms of interest. No observations of any kind were made of pollinators, beneficial soil organisms, or predators of crop pests, for example. Nevertheless, APHIS accepts these observations as evidence that no harm to animals of ingesting Enlist corn and soybeans will occur (e.g., 44406-6 soybean PPRA, at 10: "Field observations of DAS-444Ø6-6 (DAS and MS Tech 2011, section 7) revealed no negative effects on non-target organisms, suggesting that the production of the ADD-12, PAT and EPSPS proteins in the plant tissues are not toxic to organisms.").

Therefore, to summarize, APHIS does not describe or consider important aspects of the known and potential differences in phenotypes of Enlist corn and soybeans that could harm non-target organisms, relative to the unmodified recipient organisms, in the environmental conditions that Enlist corn and soybeans are likely to encounter. APHIS only considers toxicity of the protein products of the AAD-1 and AAD-12 transgenes (the earliest phenotypic character), rather than following through to consider how these new enzymes would change plant metabolism in such a way that the plants' phenotypes would differ in the most likely environment for Enlist crops, where 2,4-D will be present. In the likely and foreseeable presence of 2,4-D, potentially toxic metabolites accumulate in the Enlist corn and soybeans but not in the recipient organisms. APHIS does not consider impacts of these potential toxins as part of the approval process or other assessments. **(8081)**

**Response:** With regard to the potential toxicity of 2,4-D metabolites, EPA considers this issue in its risk assessments (US-EPA, 2013c). The potential toxicity of 2,4-D metabolites is outside the scope of this EIS**.**

APHIS disagrees with the assertion that Dow'simulated digestion studies are insufficient because they used proteins made in bacteria which can be different than proteins made in plants. While it is true that proteins produced in plants may have sugar modifications (glycosylation) attached to the protein, Dow tested whether AAD-

1 and AAD-12 are glycosylated in plants and determined they were not based on comparison of molecular weight, immunoreactivity, N-terminal sequence analysis and MALDI-TOF mass spectrometry (DAS, 2010a; 2010b). Many allergens have been reported to be expressed at high levels in plants, be resistant to digestive enzymes and heat and be glycosylated. Both AAD-1 and AAD-12 proteins are expressed at low levels, in vitro digestive fate and heat stability studies show that these proteins are rapidly degraded in simulated gastric fluid, are not heat stable, and neither protein appears to be glycosylated in plants. These results indicate that the two proteins are unlikely to be allergens. APHIS also disagrees with the assertion that *in silico* analysis of the proteins for potential toxins is not enough because it is not always possible to identify toxins and allergens. All known toxins and allergens, including those toxic to any organism, can be identified this way and unless there is a valid risk hypothesis to suggest the protein may be a toxin when its sequence does not match a known toxin, APHIS does consider it reasonable to request additional experimentation.

The commenter further raises the point that Dow's evidence does not rule out the possibility that the AAD-1 and AAD-12 protein or plant metabolites that result from its expression in plants may be toxic to earthworms, pollinators, and birds. While the risk of harm cannot be completely ruled out, the risk of harm to these organisms is considered to be low for several reasons. First, the AAD-1 and AAD-12 were isolated from naturally occurring widely prevalent soil bacteria, *Sphingobium herbicidovorans* and *Delftia acidovorans*, respectively. Thus earthworms, birds, and bees are naturally exposed to the two AAD proteins. Second, the *in silico* studies do include toxins to any organism, not just humans and mammals, and do not reveal a match between AAD proteins and any known toxin. Third, Dow has determined that the AAD proteins are extremely substrate specific where the preferred substrates are halogen substituted phenoxy ring compounds (Griffin *et al.*, 2013). They tested a number of endogenous plant compounds as potential substrates for both the AAD-1 and AAD-12 enzymes (US-FDA, 2011b; 2011c; Griffin *et al.*, 2013). Potential substrates were determined based on chemical structure, similar physiological function to known substrates, and abundance within primary/secondary metabolic pathways of plants. The substrates tested were separated into three groups; natural plant hormones (indole acetic acid, abscisic acid, gibberellin, and aminocyclopropane-1- carboxylate), phenylpropanoid intermediates (cinnamate, coumarate, and sinapate), and L-amino acids. 2,4-dichlorophenoxyacetic acid (2,4-D), the positive control substrate, showed a high level of activity in the enzyme assay. Under the same reaction conditions, the compounds tested were not oxidized upon incubation with AAD-12, resulting in values at or below the background limit of detection (<3% positive control rate) (Griffin *et al.*, 2013). Based on this survey of potential substrates, there is no indication that AAD-1 or ADD-12 has activity on endogenous plant substrates. Fourth, no significant differences were observed in the major metabolites between the engineered corn and soybean and untransformed lines (DAS, 2010a; 2010b). Thus the likelihood is small that an endogenous plant compound would be metabolized by these enzymes, even less likely that it would accumulate in the plant, and even less likely that it would be toxic to a non-target organism.

**106. Comment:** Again, APHIS relies on Dow's presentation of "food and feed safety" of the AAD-1 and AAD- 12 proteins to conclude that exposure and consumption of Enlist corn and soybeans would have no effect on threatened or endangered animal species, or those proposed for listing (Enlist corn: EIS, at 153 – 154; Enlist soybeans: EIS, at 156 – 156). As discussed above, nutritional requirements and toxicity differ between species, so that extrapolation from mammalian requirements is not valid for assessing risk to other animal taxa. For example, insects may eat nectar or pollen that was not studied for differences in nutrient composition. Birds may eat insects that fed on corn or soybean leaves, and the insects were not studied to see if they differ nutritionally. In addition, APHIS did not look at risks from potentially toxic metabolites in relevant Enlist corn- or soybean-derived materials used by endangered species that result from activity of the introduced enzymes in the presence of 2,4-D. **(8081)**

**Response**: APHIS disagrees with the comment. It is simply not possible or advisable to study every possible combination of animal plant interaction. Unless there is a valid risk hypothesis to explore, APHIS does not require additional data. For example, Dow examined the nutrient composition of forage and grain and observed no significant differences in nutrient composition. The commenter considers this measure inadequate because they did not examine the nutrient composition of pollen and bees may be exposed to the plant through the pollen and not the leaf or seed. APHIS disagrees. The commenter did not present a reason to believe that the nutrient composition of pollen may differ from the forage and seed in a significant way-only that such a difference is a formal possibility. APHIS similarly disagrees that nutritional studies should be done on the insects that feed on corn and are eaten by birds in the absence of a plausible risk hypothesis. APHIS similarly disagrees that threatened and endangered species should be used for experimentation as the commenter seems to imply that results are not generalizable between species.

## Biological Resources

## Environmental Impacts from Off-Target Movement of Herbicides

**107. Comment**: Under NEPA's "hard look" doctrine (40 C.F.R. § 1502.1), "[t]he adequacy of an EIS depends upon whether it was prepared in observance of the procedure required by law." *State of California v. Block*, 690 F.2d 753, 761 (9th Cir. 1982), citing 5 U.S.C. § 706(2)(D) and *Lathan v. Brinegar*, 506 F.2d 677, 693 (9th Cir. 1974) (*en banc*). "Under this standard of review, [courts] employ a 'rule of reason' that inquires whether an EIS contains a 'reasonably thorough discussion of the significant aspects of the probable environmental consequences'" of the project in question. *Id.*, quoting *Trout Unlimited, Inc. v. Morton*, 509 F.2d 1276, 1283 (9th Cir. 1974). "In short, [courts] must ensure that the agency has taken a 'hard look' at the environmental consequences of its proposed action." *Blue Mountains Biodiversity Project v. Blackwood* ("*Blue Mountains*"), 161 F.3d 1208, 1211 (9th Cir. 1998), citing *Oregon Natural Resources Council v. Lowe*, 109 F.3d 521, 526 (9th Cir. 1997). Here, APHIS failed to take a hard look at the numerous impacts related to the probable environmental consequences of increased pesticide usage under all of the action alternatives.

NEPA requires APHIS to consider the likely effects of its decision, including the foreseeable consequences of increased pesticide usage. The Supreme Court ruled in *Monsanto Co. v. Geertson Seed Farms* ("*Monsanto*"), 561 U.S. 139 (2010), that the USDA did not adequately consider how deregulation of GE crops could result in gene transmission and pesticide-resistant superweeds. Similarly, in *Center for Food Safety v. Vilsack*, No. C08-00848 JSW, 2009 WL 3047227 (N.D. Cal., Sept. 21, 2009), the United States district court for the Northern District of California found that the USDA's decision to deregulate sugar beets was inadequate under NEPA.

The CEQ's NEPA regulations provide the means to evaluate reasonably foreseeable significant adverse effects on the human environment, even with incomplete information. 40 C.F.R. §1502.22. However, in spite of its recognition that "the plants were engineered to be resistant to the application of certain herbicides," APHIS declines to examine the increased use of these herbicides as a direct or indirect impact of the proposed action. DEIS p. 59. "Approving the petitions would allow these varieties to be planted," APHIS explains unconvincingly, "but it does not allow for the use of the Enlist Duo™ herbicide on the plants." DEIS pp. 113, 114. While APHIS purports to examine the use of Enlist Duo™ in its cumulative impact section, discussed below, that analysis also fails to examine most reasonably foreseeable impacts of its use.

APHIS cannot claim that it lacks the authority to *analyze* these impacts. Following the Supreme Court's decision in *Monsanto*, APHIS issued an FEIS that studied whether increased use of the pesticide glyphosate has an adverse impact on other plants and animals. In that Glyphosate-Tolerant Alfalfa Events J101 and J163: Request for Nonregulated Status FEIS (December 2010) ("Alfalfa FEIS"), APHIS addressed the impacts of GE alfalfa on plants and animals, including the impacts that increased pesticide usage would have. As the Alfalfa FEIS notes, "[b]ecause the subject of this EIS is an herbicide-tolerant crop, GT alfalfa, some additional detail is warranted on the herbicides that are used on alfalfa." Alfalfa FEIS p. 73. The Alfalfa FEIS also addressed how field workers will be exposed to pesticides. *Id*. at pp. 74-75.

The Alfalfa FEIS evaluates overall impacts to "Plants and Animals from Herbicides," including the "Chemical Fate and Transport of Glyphosate in the Environment" and "Toxicology and Environmental Risk" to birds, mammals, amphibians, microorganisms and soil invertebrates, terrestrial invertebrates, aquatic invertebrates, fish, and plants. Alfalfa FEIS pp. 139-142.

Pesticide use is also considered as an impact to public health and safety, including an "independently conducted [] screening-level human health risk assessment for the general population." *Id*. at pp. 179-184. If APHIS was capable of studying the impacts that increased applications of pesticides have in the context of the Alfalfa FEIS, it follows that it has the ability to do so here.

APHIS acknowledges that there will be increased pesticide usage, but its DEIS contains only minimal analysis of the impacts of increased pesticide use on the environment. In fact, APHIS has "limited its analysis of herbicide use to the cumulative impacts that occur from the selection of herbicide resistant weeds and the changes in management practices that result." DEIS p. vi. Yet, if "APHIS adopts the Preferred Alternative, APHIS expects that 2,4-D use will further increase by another two fold to six fold" over already expected increases in use. DEIS p.ix. In spite of this drastic increase in usage, no mention is made of pesticide residue in APHIS' discussion of human health topics. DEIS p. 87. APHIS cannot make an informed decision, as required by NEPA, without a reasonable approximation of what the impacts of such increased pesticide usage would be.

Consigning the DEIS's minimal analysis of pesticide impacts to the cumulative impacts section ignores the significant effect that deregulation alone could have on the increased use of pesticides. There is evidence that pesticides will be used outside of label restrictions and manufacturers' recommendations, especially where growers know that crops have been designed with specific tolerances in mind. For instance, Ignite, which is designed for LibertyLink cotton varieties, has been used instead on varieties with WideStrike, in order to address problems with glyphosate-resistant Palmer amaranth weeds. *See Growers swing at pigweed with Ignite on WideStrike*, Pam Golden, Farm Progress (January 2010), *available at* http://farmprogress.com/library.aspx/growers-swing-pigweed-using-ignite-widestrike-41/48/189. Therefore, increased pesticide usage should be addressed as part of the revised DEIS's analysis of environmental impacts. **(10158)**

**Response:** We disagree with the commenter's assertion that APHIS failed to take a "hard look" at environmental consequences and with its characterization of the requirements of NEPA or relevant case law under the circumstances presented here. APHIS gave a thorough discussion of these topics throughout the DEIS and relied upon its experts to utilize their scientific judgment and technical analysis related to these issues. APHIS disagrees with commenter's interpretation of Geertson.

EPA regulates the use of herbicides under FIFRA and is making a separate decision which may or may not allow Enlist Duo™ use on these plants. EPA sets the conditions for pesticide use on the label to achieve a standard of a "reasonable certainty of no harm." Impacts of pesticide residue on human health and non-target organisms are outside the scope of this EIS. The current labels for 2,4-D, Quizalofop, glufosinate, and glyphosate include label use restrictions intended to protect humans, including protective equipment to be worn during mixing, loading, applications and handling, equipment specifications to control pesticide application, and reentry periods establishing a safe duration between pesticide application and exposure to the pesticide in the field. Furthermore, the environmental risks of pesticide use on wildlife and wildlife habitat are assessed by EPA in the pesticide registration process.

**108. Comment**: Finally, we note our concern that APHIS has declined to analyze or consider the cumulative adverse impacts on natural and biological resources, including non-herbicide-resistant crops, that will result from the widespread application of the 2,4-D chemical accompanying the adoption of these seed varieties. APHIS takes the position in the draft EIS that because chemical regulation is outside the scope of the agency's regulatory authority, it would be inappropriate to consider those impacts as part of this docket. We respecfully disagree. The National Environmental Policy Act (NEPA) does not direct the acting agency to examine only those impacts that fall within the scope of the agency's regulatory authority, but rather to examine any serious environmental impacts that might reasonably result from an agency's action. APHIS already has acknowledged in the draft_ EIS that it is appropriate to examine the cumulative impacts of 2,4-D application in the context of 2,4-D resistant weeds. While we appreciate that the U.S. Environmental Protection Agency (EPA) will be conducting its own review of the 2,4-D chemical, that does not and should excuse APHIS from completing a full NEPA analysis of all environmental impacts stemming from this action, including the adverse impacts on natural and biological resources resulting from widespread application of 2,4-D. We request that APHIS include such an analysis in the final EIS and consider those impacts in any final decision in this docket **(8007).**

**Response**: This comment is outside the scope of this EIS. The Coordinated Framework tasks the EPA, under FIFRA, with regulating herbicide use. EPA thoroughly considers the environmental impacts of herbicide use in its Environmental Risk Assessment (US-EPA, 2013c) and USDA is aware of their conclusions. APHIS does not agree that it is necessary to duplicate the efforts of its sister agency in assessing the risks of pesticide use to natural and biological resources.

**109. Comment:** In birds, 2,4-D exposure reduced hatching success and caused birth defects. It also indirectly affects birds by destroying their habitat and food source. The herbicide also has negative effects on a range of beneficial insects. It reduces offspring numbers in honey bees, kills predatory beetles and ladybug larvae. 2,4-dicholorphenol, a breakdown product of 2,4-D, is extremely toxic to earthworms, 15 times more toxic than 2,4-D itself. 2,4-D is extremely toxic to fish and can bio-accumulate inside fish. **(8524)**

**Response:** This comment is outside the scope of this EIS. The Coordinated Framework tasks the EPA, under FIFRA, with regulating herbicide use. EPA evaluated impacts to birds in its Environmental Risk Assessment (US-EPA, 2013c). In its proposed registration(US-EPA, 2014b), a mitigation step has been incorporated into the pesticide label to require a 30 foot spray setback from areas likely to be habitat for birds in order to further reduce off-site exposure for birds.

**110. Comment:** While EPA does indeed have jurisdiction over herbicide applications and APHIS does not, it is inappropriate for APHIS to make a final determination on an action that would impact herbicide use under the purview of EPA without EPA first finalizing its authority over said herbicide use. Currently, 2,4-D and its various forms, including the new choline salt, are undergoing registration review by EPA. According to EPA, this registration review, which will review human and ecological toxicological data, is not expected to be completed before 2017. Consequently, since APHIS acknowledges that cumulative impact (of 2,4-D corn and soybean) results from the “combined action of USDA on the subject of petitions and of the EPA’s action to register 2,4-D for use on EnlistTM corn and soybean,”APHIS must therefore await EPA’s registration review of 2,4-D before APHIS can move on a decision that will inevitably impact decisions made by EPA. While EPA review findings should be integrated into APHIS’s evaluation of whether to deregulate 2,4 D resistant crops, APHIS must itself assess the impact of herbicide use on agricultural health, including impacts on non-GE conventional and organic production, the effect of resistant weeds on the long-term economics of agriculture, and the range of alternative management strategies available that may offer better protection from the onset of resistance and environmental degradation. Thus, while APHIS has a duty to consider the full spectrum of sound science in making its determination, including EPA’s review, EPA’s duty to perform a pesticide registration review cannot be used as a substitute to help APHIS satisfy its statutory duty. **(9822)**

**Response:** APHIS and EPA expect to complete their respective reviews about the same time and are consulting with each other about their respective findings.

**111. Comment**: There is good evidence that EPA’s label restrictions have not “….ensure[d] the safety standards for human health and the environment associated with the use of…” herbicides with previously approved herbicide resistant crops. For example, glyphosate applications on glyphosate resistant corn and soybeans, presumably used according to label instructions, has essentially eradicated common milkweed from fields in the Midwest (CFS Science Soy at 79 - 80). Common milkweed in corn and soybean fields is the most important food plant for monarch butterfly larvae in North America, producing almost 80% of the butterflies that overwinter in Mexico (Pleasants and Oberhauser 2012). Monarch populations have plummeted in recent years, with the lowest overwintering population ever recorded this year (Rendón-Salinas & Tavera- Alonso 2014), continuing an alarming 20-year decline of more than 90% (Brower et al. 2011, 2012), and raising concern that the entire migration is in jeopardy. Scientists have linked this dramatic decline in monarchs in large part to loss of breeding habitat from milkweed eradication by glyphosate use on glyphosate-resistant crops (Pleasants and Oberhauser 2012). EPA’s label regulations failed to prevent this important harm to the environment, even though monarch biologists predicted the result soon after glyphosate-resistant crops were approved (e.g., Simpson 1999, Hartzler and Buhler 2000, Brower 2001). Now, in the EIS, APHIS has failed to assess impacts of approving Enlist corn and soybeans on monarchs, even after learning of harm from previous herbicide-resistant corn and soybean approval decisions, and seeing the evidence that EPA’s label restrictions were not protective. APHIS must consider how approval of Enlist corn and soybeans will impact milkweeds and monarchs, including associated use of herbicides, rather than improperly deferring responsibility for assessment to EPA (discussed in more detail below). **(8081)**

**Response**: The harm raised by the commenter is an impact related to herbicide use regulated by EPA and is outside the scope of this EIS. The commenter asserts that the eradication of milkweed in corn and soybean fields and subsequent decline of monarch populations represents a case where EPA’s label restrictions have not ensured the safety standards for human health and the environment. APHIS disagrees with the commenter because in this case milkweed was the intended target of the herbicide application as it has traditionally been a problem weed in corn and soybean fields (Cramer and Burnside, 1981; Isleib, 2012).

**112. Comment**: Also, in spite of EPA's regulation, off-target herbicide movement, including drift of glyphosate applied on glyphosate-resistant crops, has resulted in many incidents where non-target organisms were harmed (US-EPA 2009). Glyphosate use has increased dramatically in concert with widespread adoption of glyphosate resistant crops (CFS Science Soy at 21 - 26). Even though glyphosate is not volatile, it nevertheless has become one of the most common herbicides detected in air and rain samples as fine droplets become airborne (Chang et al. 2011, Majewski et al. 2014). Glyphosate and its metabolites are also frequently measured in runoff and surface water (Battaglin et al. 2009, Coupe et al. 2012), glyphosate-resistant soybean samples (Bøhn et al. 2013), and in urine from both rural and urban people (Curwin et al. 2007a, 2007b). In other words, glyphosate is now practically ubiquitous in the environment. In some cases, glyphosate is measured at levels that can harm non-target organisms, such as amphibians (Relyea 2011) and plants (US-EPA 2009). Much of this glyphosate is likely to have originated in labeled applications to glyphosate-resistant crops (Coupe et al. 2012, Majewski et al. 2014). Many people find this level of off-target movement, including drift, to be unacceptable (for example, growers whose crops have been injured: CFS Science Soy at 43 – 44). APHIS does not provide evidence that off-site movement of 2,4-D used with Enlist corn and soybeans will be mitigated by EPA's regulations any more effectively, and its assumption to the contrary is belied by past crop experiences and sound science. In fact, 2,4-D's volatility makes off-site movement even more prevalent and APHIS's reliance on EPA further misplaced. **(8081)**

**Response**: This comment is outside the scope of this EIS. EPA and not APHIS regulates pesticide use.

**113. Comment**: 2,4-D potentially harms key aquatic species. Additionally, benthic macroinvertebrates, like mayflies, leeches and crayfish, are used as indicators of stream health and their relative diversity can reveal disturbances in water chemistry that may affect their population. They play a critical role in the aquatic food web, and if their populations diminish due to 2,4-D drift, the effects will be seen at the top and bottom of the aquatic food chain. Because they consume algae and other plant life, these materials could accumulate if the population of macroinvertebrates goes down. Likewise, without these populations to feed on, fish and other larger aquatic organisms would have trouble finding food **(6923).**

**Response**: EPA evaluated the toxicity risks on aquatic species and determined there would be no direct risks from the proposed applications of 2,4-D choline salt to herbicide tolerant corn and soybeans for freshwater fish, estuarine fish, marine fish, freshwater invertebrates, estuarine invertebrates, marine invertebrates, aquatic plants, and terrestrial insects (US-EPA, 2013c)

**114. Comment**: APHIS' assumption that herbicide use on Enlist corn and soybeans will always conform to EPA registered uses as described in Appendix 7 and 8, where APHIS describes what label it assumes EPA will require, is also unfounded, because it is contrary to experience with previously approved herbicide-resistant crops. There are well known examples of off-label applications of herbicides to resistant crops in certain circumstances where growers find benefits (CFS Science Corn II at 36: use of glufosinate on WideStrike cotton), and APHIS has not analyzed the conditions under which off-label use is likely to occur with Enlist corn and soybeans in order to assess risks. Also, herbicides are sometimes applied when environmental conditions are not as required on the label (AAPCO 2002). **(8081)**

**Response**: APHIS acknowledges that some herbicide use may be off label. Nevertheless, it is unlawful to apply pesticides inconsistent with label directions. Civil penalties range up to $5000 per offense and criminal penalties may include fines up to $25,000 and up to one year in prison (US-EPA, 2000). The example cited by the commenter about the use of glufosinate on Widestrike cotton is an unsupported use but not an example of off label use (Golden, 2010). Glufosinate is registered for use on cotton (Roberson, 2011). The use of glufosinate on widestrike cotton was not supported by Dow, the developer of the cotton variety, or Bayer, the manufacturer of the herbicide, because the resistance to glufosinate in this line is limited and crop damage can result. APHIS has no way of knowing how often and in what circumstances herbicides are applied when environmental conditions are not as required on the label. APHIS discussed known cases of off-target movement of 2,4-D in Appendix 7.

**115. Comment:** Although it claims that direct and indirect effects of 2,4-D use on Enlist corn and soybeans are outside of the scope of the EIS, APHIS nevertheless considers impacts of herbicide use with Enlist corn and soybeans when assessing socioeconomic impacts of increased weed resistance to those herbicides – a harm that only will occur if the herbicides are registered and used on Enlist crops: Limiting the scope of its EIS to cumulative impacts from 2,4-D selection of resistant weeds and resulting agricultural practices when there are many other direct, indirect and cumulative impacts of herbicide use with Enlist corn and soybeans, including to non-target organisms, is arbitrary and contrary to sound science. Impacts of the APHIS approval of Enlist corn and soybeans must be assessed by APHIS under realistic scenarios, considering all reasonably foreseeable factors. Neither APHIS nor Dow provides any reason that a farmer would buy and plant Enlist crops unless he or she planned to use 2,4-D and glyphosate on those fields, since the engineered traits confer no advantage in environments where the herbicides are absent. **(8081)**

**Response** EPA considers the direct and indirect impacts of herbicide use in its risk assessments including the environmental fate and toxicity of herbicides. In the past, EPA has not evaluated the socioeconomic impacts from the selection of herbicide resistant weeds as a result of herbicide use. Although it is not required to do so, APHIS has included the socioeconomic impacts of herbicide resistant weeds from herbicide use in the cumulative impact section of the EIS. APHIS does not address the direct and indirect impacts of herbicides on human health and the environment because EPA risk assessments include that analysis. During its registration of Enlist Duo™, EPA now also considers the emergence of herbicide resistant weeds and is requiring that Dow develop a stewardship program that will promote resistance management efforts (US-EPA, 2014b).

**116. Comment**: Impacts of glufosinate use on Enlist soybeans must also be analyzed by APHIS. Glufosinate is a potent broad-spectrum herbicide, toxic to non-target crops and wild plants at low levels via drift and runoff of water and soil (Carpenter and Boutin 2010, EPA EFED Glufosinate 2013). Therefore glufosinate use on Enlist soybeans will impact non-target crops and wild plants, including threatened and endangered plants, with consequences for biodiversity. In addition, glufosinate is directly toxic to some animals at environmentally relevant concentrations. Beneficial insects may be particularly at risk from glufosinate use on Enlist soybeans, including predatory mites and spiders, and lepidopteran pollinators (discussed below). Mammals present in the agroecosystem may experience chronic toxicity. Pest and pathogen levels may be altered. Also, threatened and endangered animals may be put at greater risk by glufosinate use on Enlist soybeans. These are significant adverse impacts that APHIS must assess and meaningfully consider in its assessments. In addition, APHIS fails to analyze impacts of quizalofop use on Enlist corn, even though Enlist corn is engineered to resist this herbicide via the same enzyme that confers resistance to 2,4-D. **(8081)**

**Response**: As stated in the DEIS and responses above, herbicide impacts on non-target species are considered by EPA in its risk assessments (US-EPA, 2013c) and are outside the scope of this EIS. Glufosinate impacts are also outside the scope of this EIS because glufosinate resistant corn and soybean are already available. Thus a grower's decision to use glufosinate resistant corn and soybean is independent of the Agency action to approve Enlist™ corn or soybean. Furthermore as noted in Appendix 4, glufosinate and quizalofop use under the No action Alternative is expected to be greater than under the Preferred Alternative.

**117. Comment**: CFS commented on potential pest and pathogen impacts of herbicides used with Enlist soybeans to crops and non-target organisms (CFS Science Soy at 44), concluding that drift of 2,4-D can cause symptoms similar to injury from pests and pathogens, and herbicides can suppress or stimulate pests and pathogens, as well. In addition, glufosinate has been shown to affect various plant pathogens, both after applications to resistant crops, and in culture (reviewed in Sanyal and Shrestha 2008). Some effects of glufosinate on pathogens may be beneficial for agriculture, and some may be harmful. In glufosinate-resistant rice, glufosinate has been shown to trigger transcription of pathogenesis related genes and other defense systems that act in concert with direct suppression to protect the GE rice from blast and brown leaf spot diseases (Ahn 2008). In contrast, glufosinate may be harmful to agriculture by suppression of pathogens of weeds and pests, allowing those weeds and pests to cause more damage. Therefore, APHIS must consider the changes in pests and pathogens of non-target plants as a result of increased herbicide use and different patterns of herbicide use resulting from approval of Enlist corn and soybeans, and it does not do so in the EIS. **(8081)**

**Response**: see response to comment #116.

**118. Comment:** Enlist soybeans are the first broadleaved plant that will be sprayed directly with 2,4-D, and also the only genetically engineered crop that harbors symbiotic nitrogen-fixing bacteria. Therefore, it is crucial that APHIS analyzes and assesses risks to rhizobium and the nitrogen fixation process in Enlist soybeans under realistic field conditions that include herbicides that Enlist soybeans have been engineered to withstand. APHIS does not analyze or assess impacts of 2,4- D as used on Enlist soybeans in any specific way, nor does Dow provide any specific data or observations on nitrogen fixation in Enlist soybeans with or without associated 2,4-D use. Enlist soybeans are also glufosinate resistant. Some studies have shown negative effects of glufosinate on beneficial microbes. Pampulha et al. (2007) treated soil in laboratory microcosms with the glufosinate formulation "Liberty" at different concentrations and durations, and then determined the types, numbers and functional activity of culturable microorganisms – bacteria, fungi, and actinomycetes; cellulolytic fungi, nitrite oxidizing bacteria, and dehydrogenase activity. They found a complex pattern of changes in number and activity of microbes. However, the most dramatic change in response to glufosinate was a large decrease in dehydrogenase activity over time, which they say is a good indicator of general microbial activity. They conclude that glufosinate use "may have injurious effects on soil microorganisms and their activities." APHIS does make a general statement that "[s]everal reviews of the investigations into the impact of GE plants on microbial soil communities found that most of the studies examining distinctive microbial traits concluded that there was either minor or no detectable non-target effects…" (EIS, at 99). In fact, glyphosate use on glyphosate-resistant soybeans has been shown to impair nitrogen-fixing bacteria in some circumstances (Zablotwicz and Reddy 2007, Kremer and Means 2009, Zobiole et al. 2010, Bohm et al. 2009). And, more importantly, none of these reviews include studies of use of 2,4-D on GE, resistant soybeans, or use of 2,4-D on any GE crop. If approval of Enlist soybeans does lead to a reduction in nitrogen fixation in soybeans, then soybean growers may need to add more nitrogen fertilizer to their fields, with increased socioeconomic costs and environmental impacts. Impacts on nitrogen fixation need to be ascertained before concluding, as APHIS does, that agronomic inputs will not be changed by a deregulation decision (EIS, p. 121). **(8081)**

**Response:** APHIS does not agree that Dow did not provide any data or observations on nitrogen fixation. Dow indirectly measured nitrogen fixation by evaluating yield of soybeans that were sprayed or were not sprayed with 2,4-D. Because nitrogen is essential for soybean production, if 2,4-D were to inhibit nitrogen fixation there would be a significant decrease in yield between sprayed and non-sprayed plants. As Dow, did not observe a significant difference in yield between the two treatments ((DAS, 2010b), Table 14 and Table 15), it is reasonable to conclude that 2,4-D spray treatments do not impact nitrogen fixation to the point that additional nitrogen fertilizer treatments would be necessary.

**119. Comment**: Impacts of the approval of Enlist corn and soybean interactions with beneficial fungi also are not specifically considered by APHIS. Both corn and soybeans benefit from being infected by mycorrhizal fungi that live in their roots. These fungi facilitate movement of nutrients from the soil, protect against pathogens, and moderate effects of drought (Harrier and Watson 2003, Cheeke et al. 2013: Chapter 7). A wide range of agronomic practices influences the numbers and kinds of mycorrhizal fungi. Studies have even shown that corn varieties genetically engineered with insect-resistant Bt traits inhibit mycorrhizae in certain conditions (Cheeke et al. 2013: Chapter 8), possibly due to changes in rood exudates. APHIS must assess impacts of its proposed approval of Enlist corn and soybeans on mycorrhizal fungi under realistic field conditions covering a range of stresses that these fungi are known to ameliorate, and that include applications of the herbicides Enlist soybeans have been engineered to withstand. **(8081)**

**Response:** 2,4-D has been reported to have opposite effects on soil mycorrhiza. In one case it had adverse impacts (Gupta *et al.*, 2011), in another it was beneficial (Devi *et al.*, 2008). Gupta suggests that the effect of 2,4-D was indirect and due to the influence of the herbicide on plant metabolism and growth (Gupta *et al.*, 2011). EPA does not require an evaluation of herbicides on mycorrhiza. As APHIS has no authority over pesticide use, it is EPA's decision whether such data should be required to complete their environmental assessment.

**120. Comment:** Predators of crop pests may be harmed by use of herbicides on Enlist corn and soybeans, and this was not analyzed by APHIS in the EIS. For example, glufosinate is toxic via a metabolic pathway found in animals and microorganisms, as well as plants, and some animals are injured or killed by herbicidal doses (EPA EFED Glufosinate 2013). Arachnids such as mites and spiders are particularly sensitive to glufosinate. Although some mite species are serious agricultural pests of many crops, including corn, the use of pesticides for their control is not generally an effective strategy. Pesticides fail because many pest mites have developed resistance; while predatory mites, spiders and other insects that are important for keeping pest mite populations low are susceptible. Therefore, Integrated Pest Management systems are recommended, where healthy predator populations are encouraged (Peairs 2010). Glufosinate can harm predatory mites. Experiments on the direct toxicity of various pesticides to a predator mite found in Virginia vineyards showed glufosinate to be particularly toxic, causing 100% mortality within a day (Metzger and Pfeiffer 2002). Although the dose used was greater than that for resistant corn, lower doses were not tested. Further experiments on glufosinate and beneficial arthropods were carried out in conjunction with a risk assessment by the European Food Safety Authority (EFSA 2005), and included glufosinate applications as used on corn: The European Food Safey Authority (EFSA 2005) evaluated a series of extended laboratory and semi-field studies on beneficial insects including the parasitoid wasp (*Aphidius rhopalosiphi*), predatory mite (*Typhlodromus pyri*), wolf spider (*Pardosa* ssp.), green lacewing (*Chrysoperla carnea*), ground beetle (*Poecilus cupreus*), and rove beetle (*Aleochara bilineata*). "Severe" effects were observed with a potential for population recovery in one season when glufosinate was applied at rates consistent with use on glufosinate-resistant corn (two application at 0.8 kgai/ha) (EPA EFED Glufosinate 2013 at 95) Although there was "potential for population recovery in one season", the risks to beneficial insects were considered to be high enough to warrant mitigation: As described in the EFSA (2005) report, the EFSA Peer Review Coordination (EPCO) expert meeting (April 2004, ecotoxicology) recommended mitigation measures for risk to nontarget arthropoods, such as a 5-m buffer zone when glufosinate is applied to corn or potatoes. (EPA EFED Glufosinate 2013 at 95). Data from EPA also indicates that large buffers may be required to protect non-target terrestrial plants from injury (EPA EFED Glufosinate 2013 at 98), and thus reduce harm to non-target predatory mites and spiders, and other beneficial arthropods. **(8081)**

**Response:** Herbicide impacts on terrestrial invertebrates are assessed by EPA and are outside the scope of this EIS. As noted in the response to comment #116, glufosinate impacts are outside the scope of this EIS. APHIS predicts that glufosinate use under the No Action Alternative will increase more than under the Action Alternatives (Appendix 4).

**121. Comment:** Some mammals are considered beneficial to agriculture, including corn and soybeans. For example, some rodents eat weed seeds, reducing the weed seed bank (EFSA 2005), or become food for predators that control pest species. Other mammals are predators of corn and soybean pests. APHIS does not analyze risks to beneficial mammals from the use of 2,4-D with Enlist corn and soybeans, even though APHIS includes information from EPA in Appendix 8. Both acute and chronic risks to mammals have been identified by EPA in screening level risk assessments for the 2,4-D use patterns being planned for Enlist corn and soybeans (EIS at 8-10 appendix). EPA also identified indirect risks to mammals from modification of their habitat by 2,4-D use with Enlist crops (EIS at 8-10). CFS has commented on risks from 2,4-D use to mammals and other animals, as well (CFS Science Soy at 83). Center for Food Safety – Science Comments II – Enlist corn & soybean draft EIS 11 Glufosinate use on Enlist corn and soybeans is likely to exceed levels of concern for chronic risk to mammals that eat insects, and plant parts other than strictly fruits, seeds and grains (EPA EFED Glufosinate 2013 at 70), as summarized: The screening level assessment with preliminary refinements concludes that the use of glufosinate in accordance with registered labels results in chronic risk to mammals that exceeds the Agency's chronic risk Level of Concern (LOC). Adverse effects in mammals following chronic exposure to glufosinate in laboratory studies include reductions in growth and in offspring fitness and viability; these effects are seen across generations and in multiple species (EPA EFED Glufosinate 2013 at 5). Chronic effects of glufosinate at the expected exposure levels in laboratory studies "include reductions in parental and offspring growth and offspring viability. These effects have been observed in multiple studies and have been shown to extend to the second generation (no subsequent generations were tested)." (EPA EFED Glufosinate 2013 at 92) Formulated products are more acutely toxic to mammals than the active ingredient alone by an order of magnitude (EPA EFED Glufosinate 2013 at 91), and formulations may also cause chronic toxicity at lower levels. EFSA identified a high risk to mammals from glufosinate use in glufosinate-resistant corn based on chronic toxicity, and considered it to be "critical area of concern" (EFSA 2005). **(8081)**

**Response:** Herbicide impacts on mammals are assessed by EPA and are outside the scope of this EIS. As noted in the response to comment #116, glufosinate impacts are outside the scope of this EIS. APHIS predicts that glufosinate use under the No Action Alternative will increase more than under the Action Alternatives (Appendix 4).

**122. Comment**: Pollinators are beneficial to agriculture. Even though corn is wind-pollinated, and soybeans are mainly self-pollinating, pollinators necessary for other crops and wild plants are known to collect pollen from corn and nectar from soybeans (Krupke et al. 2012), and pollinators use the other plant species found within and around corn and soybean for food and other habitat requirements. Thus APHIS must assess the impacts on pollinators of herbicide use with Enlist corn and soybeans, but they did not do so in the EIS. CFS discussed impacts on pollinators of 2,4-D use with Enlist corn and soybeans are at length (CFS Science Corn II at 35 – 41, and below in relation to nectar plants used by monarchs. Glufosinate use with Enlist soybeans may have direct effects on lepidopteran (butterfly and moth) pollinators when larvae eat glufosinate-containing pollen, nectar or leaves, either after direct over-spray or from drift. Laboratory experiments with the skipper butterfly *Calpodes ethlias* showed that larvae fed glufosinate-coated leaves were injured or killed by inhibition of glutamine synthase, at doses "comparable to the amount that might realistically be acquired by feeding on GLA [glufosinate]-treated crops." These studies were done with the active ingredient, not a full formulation, and so may have underestimated field toxicity (Kutlesa and Caveney 2001). Nectar of glufosinate-treated Enlist soybeans may accumulate significant levels of glufosinate. Although primarily a contact herbicide, glufosinate does translocate via phloem to a limited degree, depending on the plant species (Carpenter and Boutin 2010). In experiments comparing glufosinate translocation in GE resistant canola versus a susceptible variety (Beriault et al. 1999), glufosinate translocated more readily in resistant plants. However, in both resistant and susceptible canola, glufosinate moved in the phloem to developing anthers without causing injury to tissues along the way. If glufosinate is retained in leaves of resistant soybeans, it may translocate to nectar later, even if the applications occur well before flower formation. APHIS should examine data on glufosinate levels in flowers of Enlist soybeans after labeled applications to assess risks to beneficial pollinators. Pollinators may also be affected by changes in habitat from glufosinate toxicity to plants. Numbers and kinds of plants can change dramatically in response to herbicide applications, with impacts that ripple through ecosystems (as discussed in previous CFS comments, and in relation to monarchs, below). In addition, pollinators that depend on specific host plants may be affected if those plants are more sensitive to glufosinate (Pleasants and Oberhauser 2012). Large buffers may be required to protect non-target terrestrial plants from injury (EPA EFED Glufosinate 2013 at 98), and thus reduce harm to pollinators. APHIS also does not consider impacts of quizalofop use on corn to pollinators in the EIS. **(8081)**

**Response:** Herbicide impacts on bees are assessed by EPA and are outside the scope of this EIS. As noted in the response to comment #116, glufosinate impacts are outside the scope of this EIS. APHIS predicts that glufosinate use under the No Action Alternative will increase more than under the Action Alternatives (Appendix 4). APHIS predicts that quizalofop use under the No Action Alternative will remain unchanged and will decrease under the Action Alternatives (Appendix 4).

**123. Comment:** The recent decline of monarchs (*Danaus plexippus*) is a clear example of harm to a non-target organism from past APHIS approval of herbicide-resistant corn and soybeans, as CFS commented (CFS Science Soy at 79 -80), yet APHIS does not analyze impacts to monarchs of approving Enlist corn and soybeans in the EIS.

Monarch numbers in North America are at their lowest since records have been kept, and biologists are concerned that the monarch migration is in jeopardy (Brower et al. 2011, 2012). At their most recent peak in 1997, there were almost a billion monarch butterflies overwintering in oyamel fir trees in the central mountains of Mexico (Slayback et al. 2007). This year, counts indicate an overwintering monarch population of fewer about 33 million, by far the lowest ever measured (WWF-Mexico 2014), continuing an alarming 20-year decline of more than 90% (Brower et al. 2011, 2012).

Although there are many factors at play, scientists have shown that a critical driver of the recent steep decline in monarch butterfly numbers is loss of larval host plants in their main breeding habitat, the Midwest corn belt of the US, as CFS commented previously (CFS Science Soy at 79- 80, Pleasants and Oberhauser 2012).Monarchs lay eggs exclusively on plants in the milkweed family, and the larvae that hatch from these eggs must consume milkweed leaves to complete the butterfly's lifecycle (Malcolm et al. 1993). Common milkweed has been largely eradicated from corn and soybean fields where it used to be common (Hartzler 2010, Pleasants and Oberhauser 2012), depriving monarchs of the plant they require for reproduction.

Common milkweed (*Asclepias syriaca*) is a perennial plant with shoots that die back in the winter, but re-sprout from buds on spreading roots in the spring to form expanding colonies (Bhowmik 1994). Common milkweed also regrows when the plants are mowed, chopped by tillers, or treated with many kinds of herbicides that only kill aboveground plant parts, or are applied before milkweed shoots emerge in late spring (Bhowmik 1994). Thus, until recently, common milkweed has been found within and around corn and soybean fields in sufficient numbers to support a large population of monarch butterflies. In fact, in the late 1990s when monarch numbers were still high, almost half of the monarchs in Mexican winter roosts had developed on common milkweed plants in the Midwest corn belt, making this the most important habitat for maintaining the monarch population as a whole (Wassenaar and Hobson 1998).

Recently, though, the widespread adoption of genetically engineered, glyphosate-resistant corn and soybeans has triggered a precipitous decline of common milkweed, and thus of monarchs (Pleasants and Oberhauser 2012). Glyphosate is one of the extremely few herbicides that efficiently kills milkweed (Waldecker and Wise 1985, Bhowmik 1994). Glyphosate moves throughout the plant – from sprayed leaves into roots, developing shoots and flowers – where it thwarts milkweed's reproductive strategies.

Glyphosate is particularly lethal to milkweed when used in conjunction with glyphosate-resistant corn and soybeans (patterns of glyphosate use on resistant crops are described in detail in CFS Science Soy at 6, 14 – 15, 21- 24). It is applied more frequently, at higher rates, and later in the season (during milkweed's most vulnerable flowering stage of growth) than when used with traditional crops. The increasingly common practice of growing glyphosate-resistant corn and soybeans every year means that milkweed is exposed to glyphosate every year without respite, and has no opportunity to recover. In fact, in the 15 years since glyphosate-resistant soybeans, and then corn, were approved by APHIS, common milkweed has been essentially eliminated from corn and soybean fields in the major breeding area for monarch butterflies (Hartzler 2010).

This loss of habitat for monarch butterflies, because of eradication of the only host plant that grows within corn and soybean fields in the Midwest, has been devastating. Fewer corn and soybean fields have milkweed plants, and where they do occur, the plants are more sparsely distributed. In a 1999 survey of Iowa, common milkweed was found in half of corn and soybean fields, and this milkweed occupied an aggregate area of almost 27,000 acres (Hartzler and Buhler 2000). A decade later in 2009, a second survey found that only 8% of corn and soybean fields had any milkweed plants at all, with an aggregate area of just 945 acres – a 96.5% decline (Hartzler 2010). By 2012, it is estimated that just over 1% of common milkweed remained in corn and soybean fields in Iowa compared to 1999, just a few hundred combined acres (extrapolated from Pleasants and Oberhauser 2012). It is clear that other Midwestern states have experienced similarly devastating milkweed losses, based on comparable land-use patterns and other evidence.

Rapid, large-scale changes in glyphosate use (e.g. Benbrook 2009, as cited in CFS Science Soy) are responsible for milkweed loss. Common milkweed in corn and soybean fields has been unable to survive the change in glyphosate use that accompanied approval of glyphosate-resistant corn and soybeans (Pleasants and Oberhauser 2012).

Milkweeds do still remain outside of agricultural fields in the Midwest, but there aren't enough of them to support a viable monarch population. The combined area of roadsides, Conservation Reserve Program (CRP) land, and pastures is only about 25% of corn and soybean acreage in Iowa, which is representative of the Corn Belt as a whole (Pleasants and Oberhauser 2012). In addition, monarchs produce almost four times more progeny per milkweed plant in corn and soybean fields than in non-agricultural areas (Monarch Larval Monitoring Project, as described in Pleasants and Oberhauser 2012), so agricultural milkweed is more valuable as habitat. Thus, even if non-crop lands have a higher density of milkweeds, they cannot begin to compensate for agricultural habitat lost to glyphosate use on glyphosate-resistant corn and soybeans. **(8081)**

**Response**: Direct and indirect herbicide impacts on the Monarch butterfly are assessed by EPA and are outside the scope of this EIS.

APHIS acknowledges the comment that glyphosate use on glyphosate resistant crops has had indirect impacts on the Monarch butterfly population through the eradication of milkweed from soybean and cornfields. Milkweed is a target organism in agricultural fields because it is a problem weed that reduces yield in field crops(Pleasants and Oberhauser, 2013) and can be toxic to cattle when found in pastures (Isleib, 2012). Prior to the introduction of glyphosate tolerant crops, milkweed infestations in agricultural fields were on the increase (Pleasants and Oberhauser, 2013). As noted by the commenter, milkweed has been largely eradicated from corn and soybean fields through glyphosate use.

Under the Preferred Alternative, glyphosate use is not expected to change relative to the No Action Alternative. As a result, milkweed is likely to remain eradicated from corn and soybean fields and thus no further impacts to the Monarch butterfly population are expected under the Preferred Alternative.

**124. Comment**: As confirmed by APHIS in the EIS, Enlist corn and soybeans will be sprayed post-emergence with a pre-mix formulation of glyphosate and 2,4-D. In addition, they may be sprayed with glufosinate or quizalafop. Farmers may also apply the individual herbicides sequentially. Enlist corn and soybeans will therefore not only continue to be sprayed post-emergence with glyphosate, but also with other herbicides, when common milkweed is in its most vulnerable reproductive stages (Bhowmik 1994). Even those herbicides that are weaker on perennial weeds such as milkweed (e.g. glufosinate) can be expected to cause considerable damage to aboveground plant parts. In addition, Enlist corn and soybeans are engineered to be extremely resistant to the herbicides in question, enabling application of rates higher than have ever been used before without injuring the crop. Herbicides that cause limited damage to weeds when applied at lower rates are often much more damaging at higher rates. The combination of additional active ingredients applied post-emergence, and use of higher rates, can only accelerate the demise of common milkweed in corn and soybean fields while preventing its reestablishment, especially in view of the fact that glyphosate will continue to be used at rates similar to those used at present on crops resistant to glyphosate alone.2,4-D is a in the synthetic auxin class of herbicides. Synthetic auxins are generally effective on perennial broadleaf weeds because, like glyphosate, they are translocated to the root. 2,4-D and dicamba are the auxin herbicides most frequently recommended for control of common milkweed, though neither is as consistently effective as glyphosate. The Ohio State University extension service recommends a high rate of glyphosate (2.25 lbs. a.e./acre) as the first option for control of common milkweed in non-crop or fallow field situations, but also notes that a lower rate of glyphosate (1.5 lbs ae/acre) combined with 2,4-D "can provide good control as well." Likewise for corn, a post-emergence application of glyphosate is recommended if the corn is Roundup Ready. For non-Roundup Ready corn, dicamba is the top choice – alone or combined with one of several other herbicides (Ohio State Extension, as cited in Isleib 2012). North Dakota State University has conducted tests evaluating the efficacy of various herbicides on common milkweed (Martin and Burnside 1984, Cramer and Burnside 1981). A high rate of glyphosate (3 lbs./acre) provided the best milkweed control when evaluated the following spring. Higher than normal rates of 2,4-D (2 lbs./acre) provided lesser but still considerable levels of control, reducing milkweed stands by roughly half. Other studies on herbicidal control of common milkweed reveal quite variable results for 2,4-D (Cramer & Burnside 1981, Bhowmik 1982). In greenhouse experiments conducted by Cramer and Burnside (1981), 2,4-D provided modest suppression of common milkweed regrowth when evaluated five weeks after application, suppression almost equal to that of glyphosate (Cramer and Burnside, Table 1). Mixtures of glyphosate and 2,4-D were one of the most effective herbicide combinations (Table 1).Field studies designed to assess the long-term efficacy of various herbicides on common milkweed generally show that 2,4-D did not provide much control in the year or two following a single application (Bhowmik 1982). However, these experiments generally involved low rates of 2,4-D and/or application in the fall when milkweed was past its reproductive phase (postflowering), and so presumably less susceptible to herbicidal control. Cramer and Burnside (1981) were unable to explain the variable efficacy exhibited by 2,4-D (or that of other herbicides) in the experiments they conducted, noting merely that herbicidal control of common milkweed "is variable … and appears to be dependent on growth stage, growth rate, time of herbicide application, climatic variables, and other factors." The discussion above shows that 2,4-D suppresses common milkweed. Although not consistently as effective as glyphosate, particularly for longer-term control, its efficacy is regarded as sufficient to merit recommendations for its use on common milkweed by experienced agronomists at several universities. Enlist corn and soybeans will greatly exacerbate the negative impacts of 2,4-D on common milkweed for several reasons: higher rates will be used; most applications will occur during milkweed's most vulnerable reproductive phase; most applications will be in combination with glyphosate; much more cropland will be sprayed; and the frequency of use will increase both within season and over years (CFS Science Soy at 78). Combined use of two herbicides known for their efficacy in killing milkweed can only hasten its eradication from crop fields and maintain its absence, with devastating consequences for monarch butterflies. APHIS does not consider these impacts of Enlist corn and soybean approval on monarchs in its EIS. **(8081)**

**Response:** APHIS predicts that glyphosate use will remain unchanged under both the No Action and Action Alternatives (Appendix 4). Given the fact that glyphosate use has already eradicated 99% of the milkweed from corn and soybean fields (comment #123), APHIS doubts whether Enlist Duo™ can have any incremental effect. The solution to the Monarch Butterfly issue, while an important conservation issue, is outside the scope of this EIS.

**125. Comment:** Although monarch larvae are selective about food plants, only thriving on milkweeds, the adult butterflies derive nutrients from a wide variety of nectar-producing flowers (Tooker et al. 2002). They depend on flowers that are in bloom in their breeding habitat during the spring and summer, and then along migration routes to winter roosts (Brower and Pyle 2004). Monarchs that are breeding during spring and summer use energy derived from nectar for flying, laying eggs, mating, and other activities. In addition, the generation that migrates in the fall converts nectar sugars into storage lipids to fuel their metabolism during winter, and perhaps also for northern migration the following spring (Brower et al. 2006). Herbicides are toxic to plants, by definition, and their use in agricultural landscapes has resulted in changes in flowering plant populations within and around crop fields, with impacts felt throughout ecosystems. It has been shown that "[b]etween 5% (commonly) and 25% (occasionally) of the applied herbicide dose is expected to reach the vegetation in field margins and boundaries (e.g. hedgerows, woodlots, etc.) (Holterman et al., 1997;

Weisser et al, 2002).” (Boutin et al. 2014). There have been no surveys of wildflowers in agricultural landscapes before and after commercialization of previously approved herbicide-resistant crops, as important as such information is for assessing environmental impacts. However, glyphosate from use on herbicide resistant crops may have already reduced abundance and diversity of nectar plants in and around agricultural fields, from direct applications as well as spray drift (e.g. Gove et al. 2007, Blackburn and Boutin 2003). Approval of Enlist corn and soybeans that are associated with use of highly active, volatile 2,4-D with an even greater potential for causing drift injury, in addition to glyphosate, is likely to have severe impacts on nectar resources used by monarchs and other pollinators (Brower et al. 2006). Hugely increased spray drift, volatilization and runoff from the much greater use of herbicides with Enlist corn and soybeans are likely to alter the very habitats important for biodiversity in agroecosystems, such as hedgerows, riparian areas, unmanaged field margins, and other areas where wild organisms live near fields (Freemark and Boutin 1995, Boutin and Jobin 1998, Olszyk et al. 2004). These areas harbor nectar plants for adult monarchs as well as milkweeds for larvae. Based on experiences with 2,4-D sensitive crops, for example, natural areas miles from agricultural applications of these herbicides will be at increased risk from the use of greater amounts on herbicide resistant crops, since these herbicides can volatilize under certain conditions (CFS Science Soy at and also come down in rain (Hill et al. 2002). Also, as CFS has commented, herbicides used on resistant crops are applied over a longer span of the growing season, and thus overlap a wider range of developmental stages of nearby plants, hitting them when they may be more sensitive to injury. **(8081)**

**Response**: Impacts to non-target organisms from offsite pesticide movement is assessed by EPA and is outside the scope of this EIS. Offsite pesticide movement is discussed in Appendix 7. APHIS disagrees with the commenter’s assertion that spray drift, volatilization, and runoff will be hugely increased under the Preferred Alternative (see response to comment #65 and comment #75).

**126. Comment:** Particular species of plants are more or less sensitive to specific herbicides (Olszyk et al. 2013, Boutin et al. 2004), and at different growth stages (Carpenter and Boutin 2010, Boutin et al. 2014), so that exposure can change plant population dynamics in affected areas. 2,4-D and other auxin-like herbicides such as dicamba are particularly potent poisons for many species of plants (Rasmussen 2001, US-EPA 2009), especially dicotyledons (broadleaf plants) that are sensitive to very low drift levels. Even monocots such as members of the grass and lily families can be killed by higher doses of 2,4-D or dicamba, and suffer sub-lethal injuries from drift levels at certain times in their life cycles (US-EPA 2009; Nice et al. 2004).Plants – both crop and wild species –are often very sensitive to herbicide injury as flowers and pollen are forming (Olszyk et al. 2004). This has been clearly shown with dicamba and injury to tomato plants (Kruger *et al.* 2012) and soybeans (Griffin et al. 2013), and with glyphosate injury to rice flowers (Wagner 2011). Drift levels of dicamba have also been shown to affect asexual reproduction in potatoes (Olszyk et al. 2010), and seed production in peas (Olszyk et al. 2009), sometimes without accompanying vegetative injury. Glyphosate drift to potato plants has been responsible for causing potato shoots arising from seed potatoes in the next generation to grow abnormally or not at all

(Worthington 1985), without always affecting the growth of the potato plants that were actually hit with the herbicide (Potato Council 2008). There are many other examples of differential sensitivity to particular herbicides (Boutin et al. 2014). Injury affecting flowers and vegetative propagules but not the rest of the plant can easily go undetected, nevertheless having a large impact on reproduction and thus subsequent generations. Differential sensitivity to herbicides can lead to changes in species composition of plant communities. For example, as noted in CFS comments (CFS Science Soy at 81), 2,4-D movement away from crop fields in mid-spring may kill sensitive dicotyledonous wildflowers at seedling stages, cause male sterility in less sensitive grasses about to flower, and have little effect on younger grasses or still-dormant perennials (Olszyk et al. 2004). These impacts can cause long-term changes in the mix of plant species, favoring annual weeds and grasses over native plants and perennial forbs (broadleaved plants), for example (Boutin and Jobin 1998, Boutin et al. 2008). And if there are herbicide resistant plants in these habitats, they will of course be better able to withstand drift and may become more abundant (Watrud et al. 2011, CFS 2013a).Pollinators are at particular risk from changes in plant populations and flowering behavior. Recently published comparisons of flowering plants in natural areas around fields that have been exposed to herbicides on a regular basis vs. near fields managed without herbicides show striking differences in abundance and kinds of plants in flower, and also in when these plants flower (Boutin et al. 2014). Hedgerows next to organic farms had more species, and many of them flowered earlier in the season and for a longer time span. These field observations confirmed greenhouse studies that showed significant delays in flowering of several species after exposure to herbicides (Boutin et al. 2014).Such changes in which plants flower, and when, could affect monarchs as they breed and migrate, disrupting coordination between the butterflies and needed resources: organic farming promoted not only plant diversity but also plant flowering capacity whereas conventional farming inhibited flower production of the fewer plants found in adjacent hedgerows and resulted in a shift in flowering. This in turn may cause disharmony with pollinator activities as pollinators can be very sensitive to flowering events (Santandreu and Lloret, 1999). Effects on timing of flowering can have consequences on pollinating insects as they may be less able to survive in non-crop habitats during periods when crop plants are unavailable for pollination (Carvalheiro et al., 2010). Alternatively, delays in flowering time may expose flowers to unfavourable weather conditions (e.g. frost or drought). Herbicide effects appear to constitute yet another stressor affecting plant – insect interactions, adding to other stressors including land-use modifications at the landscape scale (Kremmen et al., 2007) that are increasingly impacting agro-ecosystems. (Boutin et al. 2014) **(8081)**

**Response:** This comment is out of the scope of the EIS. EPA, not APHIS, determines how herbicides are applied to herbicide resistant crops. In their proposed registration of Enlist Duo™ herbicide, EPA includes mitigations to minimize drift injury to non target plants (see response to comment #65) (US-EPA, 2014b).

**127. Comment:** Herbicides such as 2,4-D that selectively kill dicots may be particularly injurious to butterflies, often considered an indicator of ecosystem health. If these herbicides are applied frequently and over a broad area – as will happen with herbicide use on Enlist corn and soybeans– negative impacts on butterflies are likely to be increased. A study by Longley and Sotherton (1997) of pesticide effects on butterflies in agricultural areas of England makes this point: The frequency and number of pesticide applications, the spatial scale of treatment and the degree of field boundary contamination during each spray occasion will determine the extent of damage to butterfly habitats and populations, and the rate at which populations will return to their original densities. (Longley and Sotherton 1997). Researchers implemented experimental mitigation measures to determine whether changes in pesticide use would result in more butterflies in the landscape. One of these measure involved limiting the use of "persistent broadleaf herbicides" near field edges, and instead using herbicides that were more specifically targeted against grasses: The outer section of a tractor-mounted spray boom (approximately 6 m) is switched off when spraying the outer edge of a crop, avoiding the use of certain chemicals (persistent broadleaf herbicides and all insecticides other than those used for controlling the spread of Barley Yellow Dwarf Virus). Whilst the rest of the field is sprayed with the usual compliment of pesticides, more selective chemicals (e.g. graminicides rather than broadspectrum herbicides) are sprayed on the edges (Boatman and Sotherton, 1988). (Longley and Sotherton 1997, p. 8). They found that there were indeed more butterflies after taking these measures, and also that there were more dicots, the main source of nectar, as well as more biodiversity in general: In addition, as a result of selective herbicide use, Conservation Headlands are rich in broadleaved plants, thereby increasing the availability of nectar resources for butterfly species. (Longley and Sotherton 1997, p. 8) The unsprayed headlands have also been shown to benefit the survival of rare weeds (Schumacher, 1987; Wilson, 1994), small mammals (Tew, 1988), beneficial invertebrates (Chiverton and Sotherton, 1991; Cowgill et al., 1993) and gamebird chicks (Rands, 1985; Rands, 1986). However, to be of long-term value for butterfly conservation, unsprayed headlands need to be maintained over consecutive years to allow the survival of those species which are univoltine and have poor powers of dispersal. (Longley and Sotherton 1997, p. 9) In conclusion, these researchers emphasize the need for research on impacts of pesticide use over time: In addition to short-term studies, covering single cropping seasons, information is also needed on the effects of different spray and cropping regimes over several seasons on butterfly communities in exposed areas. Only then will it be possible to make reliable predictions and recommendations for butterfly conservation on arable farmland. (Longley and Sotherton 1997, p. 12) Implications of this butterfly study in England are clear for use of 2,4-D with Enlist corn and soybeans: 2,4-D is an herbicide that selectively kills broadleaved plants (dicots), the main nectar source for adult butterflies, even those species whose larvae feed on grasses. 2,4-D is also likely to be used more often during a season, more extensively in an area, and from year to year with Enlist corn and soybeans than it is currently used in agriculture. This is exactly the opposite use pattern than that recommended for mitigation of pesticide impacts on butterflies, that were also shown to be protective of biodiversity in general. A new experimental study designed to test impacts of dicamba drift, an auxin-class herbicide and thus relevant to 2,4-D, on plant and arthropod communities in agricultural "edge" habitats highlights the importance of long- term studies of herbicide impacts over a range of environments (Egan et al. 2014). These researchers applied a range of doses of dicamba, meant to simulate different levels of drift, to field margins and to plots within old fields to determine whether plant and arthropod communities changed in response. In each habitat, they sprayed dicamba one time each year for two consecutive years, and performed plant censuses throughout the growing seasons, both before and after dicamba applications. In addition to monitoring the kinds and numbers of plants, number of flowers produced by each species was also recorded. For field margins, they also did a census of arthropods at different times during the growing season. Egan and colleagues found that low drift levels of dicamba did in fact affect plant and arthropod communities, but in complex ways, depending on plant successional status of the community to begin with, and environmental conditions such as water stress when herbicides were applied. However, impacts were seen at about 1% of the field application rate – a lower level than other studies have reported, and within the range expected to occur frequently from herbicide applications associated with herbicide-resistant crops. They advise: In light of this variation across sites and environments, it is not possible to derive general predictions about how plants and arthropods will respond to non-target dicamba exposure. Further research is needed to better understand the species, communities, and habitat types that are most sensitive to dicamba drift and the environmental conditions during exposure that can moderate susceptibility. In the absence of predictive understanding, a precautionary emphasis on limiting non-target herbicide exposures is well-warranted. (Egan et al. 2014) Similar cautions apply to 2,4-D use with Enlist corn and soybeans. By far the best way to limit herbicide exposure of important nectaring habitat for monarchs is to restrict post-emergence use of such herbicides. **(8081)**

**Response:** This comment is out of the scope of the EIS. EPA and not APHIS determines how herbicides are applied to herbicide resistant crops. In their proposed registration of Enlist Duo™ herbicide, EPA includes mitigations to minimize drift injury to non target plants (see response to comment #65) (US-EPA, 2014b).

**128. Comment:** IEPA guidelines for protecting non-target plants from drift injury are based on toxicity tests that include too few species, tested at only a few points in their vegetative development, and therefore underestimate the range of sensitivities in communities of wild species throughout their lifecycles (Pfleeger et al. 2012, White and Boutin 2007, Olszyk et al. 2013, Boutin et al. 2014). These deficiencies in assessment of herbicide impacts will put the monarch's nectaring habitat at further risk should Enlist corn and soybeans be approved by APHIS. **(8081)**

**Response:** This comment is out of scope of the EIS. EPA, and not APHIS, sets EPA guidelines for its herbicide toxicity tests.

**129. Comment:** Herbicides may directly harm exposed insects, such as monarchs. Some herbicides have been shown to leave residues that cause lepidopteran larvae to stop feeding on herbicide- exposed plants, and also some herbicides directly inhibit enzymes within the exposed insects (as discussed in Russell and Shultz 2009, and in Bohnenblust et al. 2013). For example, glufosinate may have direct effects on lepidopteran pollinators when larvae eat glufosinate-containing pollen, nectar or leaves, either after direct over-spray or from drift. Laboratory experiments with the skipper butterfly *Calpodes ethlias* showed that larvae fed glufosinate-coated leaves were injured or killed by inhibition of glutamine synthase, at doses "comparable to the amount that might realistically be acquired by feeding on GLA [glufosinate]- treated crops." These studies were done with the active ingredient, not a full formulation, and so may have underestimated field toxicity (Kutlesa and Caveney 2001). Glufosinate is one of the herbicides that will be used with Enlist soybeans. **(8081)**

**Response**: This comment is out of scope of the EIS. EPA assesses the direct harm of herbicides on non target insects. As noted in comment #26, glufosinate resistant corn and soybean varieties are presently on the market so glufosinate use on these crops is independent of the present action. APHIS expects the use of glufosinate to be greater under the No Action Alternative than the Action Alternatives as described in Appendix 4.

**130. Comment:** As discussed in CFS Science Soy and the second set of science comments on this draft EIS, the massive increase in 2,4-D applications will take a heavy toll on the environment as well. APHIS begins by placing herbicide use impacts "outside the scope of this EIS" (EIS at v). However, it is obviously impossible to assess an herbicide-resistant crop without considering the very purpose for which it was developed. APHIS purports to address the combined impact of deregulating Enlist crops and EPA approval of Enlist Duo (2,4-D-choline + glyphosate) in the cumulative impacts section of the EIS (Section 5). However, APHIS's treatment of 2,4-D in this section is almost entirely limited to its supposed effect of reducing soil erosion and associated harms (though as argued above increased soil erosion is more likely). There is no corresponding assessment of the direct human health and environmental harms that would ensue from this massively increased use of 2,4-D, a clear example of bias. In contrast, Section 4 of the EIS addresses an imaginary and entirely unrealistic scenario in which APHIS deregulates Enlist crops but EPA does not approve 2,4-D choline for use on them. Here, APHIS reaches the entirely trivial conclusion that when Enlist crops cannot be used for their sole intended purpose (heavy application of 2,4-D and other herbicides they are engineered to resist), their impacts would be similar to those of other corn and soybean varieties. This pervasively biased treatment of herbicide use generates a falsely positive picture of the Preferred Alternative and a falsely negative impression of No Action. APHIS's original contention – that herbicide impacts are "outside the scope of this EIS" (EIS at v) – is also belied by past assessments of HR crops. In the EIS for Roundup Ready alfalfa, for instance, APHIS devoted hundreds of pages to assessing the impacts of herbicide use. Apparently, herbicide use impacts are addressable by APHIS when they can be used to make the case for an HR crop; and outside the scope of assessment when they reflect badly on it. **(10202)**

**Response:** APHIS disagrees with the comment. The commenter asserts that "Section 4 of the EIS addresses an entirely unrealistic scenario in which APHIS deregulates Enlist™ crops but EPA does not approve 2,4-D choline for use on them." This scenario is necessary to clarify that the impacts associated with Enlist™ crops are entirely associated with herbicide use which falls under the oversight of EPA. Although the commenter asserts that it is a trivial conclusion that the environmental impacts associated with the Enlist™ plant itself are no different than other corn or soybean varieties, APHIS considers this conclusion important because it is precisely the question APHIS seeks to answer under its authority. APHIS does not analyze the direct impacts on human health and the environment from 2,4-D use on Enlist™ crops in section 4 because these impacts fall under the jurisdiction of the EPA and are being thoroughly considered by EPA in their risk assessments (briefly described in the DEIS on pp. 117-118 and Appendix 8). While it is true that in the Roundup Ready® alfalfa EIS, APHIS discussed at length direct herbicide impacts on the environment and human health, this by no means indicates that it was necessary or even helpful to do so. APHIS did not choose to include this data in the alfalfa EIS and omit it in the Enlist™ corn soybean EIS to make a case for an HR crop as the commenter contends. In fact, APHIS concluded for alfalfa, that the No Action Alternative was the environmentally preferred alternative because relatively few growers (less than 20%) used herbicides on the crop but that percentage was expected to increase under the Preferred Alternative. APHIS chose to omit the direct herbicide impacts in the Enlist™ corn soybean EIS because EPA is the expert agency on the environmental impacts of herbicide use and it is a wasteful duplication of effort to reproduce their work in the EIS. APHIS and EPA expect to complete their respective reviews about the same time and are consulting with each other about their respective findings.

## Herbicide resistant weeds

**131. Comment**: Dow is hyping 2,4-D corn as the solution to glyphosate resistant weeds, which themselves were fostered by GE Roundup Ready crop systems. Yet, studies already indicate this approach will rapidly generate weeds with resistance to both herbicides. As companies develop new crops resistant to a growing list of multiple herbicides, weeds will evolve multiple resistances, and farmers will respond with increasingly toxic herbicidal cocktails. **(3106)**

**Response:** APHIS disagrees with the comment. Enlist™ corn and soybean are expected to make it easier to manage weeds resistant to single or multiple herbicides. If anything, Enlist™ corn and soybean will reduce farmer dependence on increasingly toxic herbicide cocktails that would otherwise be employed to manage glyphosate resistant weeds, not the reverse as asserted by the commenter. APHIS has emphasized in the EIS that it is not possible to predict how long the benefits of Enlist™ corn and soybean will last because it depends on the extent to which farmers adopt best practices and stave off the selection of 2,4-D resistant weeds. However, even if this benefit is only realized in the short-term, the weed management strategies are likely to be similar in the case of the No Action Alternative where farmers are dealing with glyphosate resistant weeds and the Preferred Alternative where farmers are dealing with glyphosate and auxin resistant weeds. In both cases, farmers are likely to rely more heavily on herbicides other than glyphosate and auxin and other non-chemical methods such as tillage for weed control.

**132. Comment:** At the USDA public meeting in January 2014, George Naylor, a corn and soybean farmer from Iowa, told the agency that any utility of 2,4-D may be lost upon the approval of the Enlist system: “This summer I needed 2,4-D to kill waterhemp in my corn because of the really wet season I had for planting and I wasn't able to get in and spray my normal post-emergence herbicide on my corn, so the weeds got too big and I had to depend on a high clearance sprayer to spray 2,4-D. Now, if you bring out this Enlist technology, it won't be long before weeds become resistant to 2,4-D and that means that option will not be available. In other words, I will have new weeds that I can't kill even if I didn't use Enlist technology." **(6923)**

**Response**: APHIS has discussed this impact in the cumulative impacts section of the DEIS.

**133. Comment**: it is abundantly clear that herbicide resistant weeds will suffer a short-term setback from early use of 2,4-D and glyphosate, however in the mid- to longer-term, resistance will be a growing problem. We are burying our heads in the sand if we don't believe this to be the case. It doesn't take much searching in the literature to find biologically naïve quotes regarding the likelihood that herbicide resistance will arise in the face of such intensive herbicide use. For example in 1997 as commercialization of glyphosate resistant soybean was in it's second year, Bradshaw et al. (1997) stated "The lack of evolution of weed resistance to the herbicide glyphosate has been considered from several perspectives. Few plant species are inherently resistant to glyphosate. Furthermore, the long history of extensive use of the herbicide has resulted in no verified instances of weeds evolving resistance under field situations." Therefore "the complex manipulations that were required for the development of glyphosate-resistant crops are unlikely to be duplicated in nature to evolve glyphosate-resistant weeds." Imagine, there are now 24 weed species resistant to glyphosate infesting some 60 million acres of cropland. **(9938)**

**Response**: APHIS has acknowledged in the EIS the possibility that 2,4-D resistant weeds may be selected as a result of the adoption of Enlist™ corn and soybean.

**134. Comment**: *An increase in herbicide resistant weed pests* – What follows is an excerpt from our *Navigating a Critical Juncture* paper (Mortensen et al. 2012), it is included because the problem of pests arising from a solely herbicide dependent form of weed control will strongly select for an increase in herbicide resistant weeds and this profoundly important point is largely or inadequately addressed in the USDA APHIS EIS.

Glyphosate resistant weeds rapidly evolved in response to the intense selection pressure created by the extensive and continuous use of glyphosate in resistant crops. Anticipating the obvious criticism that the new synthetic auxin resistant cultivars will enable a similar overuse of these herbicides and a new outbreak of resistant weeds, scientists affiliated with Monsanto and Dow have argued that synthetic auxin resistant weeds will not be a problem because: i) currently very few weed species globally have evolved synthetic auxin resistance despite decades of use; ii) auxins play complex and essential roles regulating plant development, suggesting that multiple independent mutations would be necessary to confer resistance; and iii) synthetic auxin herbicides will be used in combination or rotation with glyphosate, requiring multiple resistance traits for weeds to survive (Behrens et al. 2007, Wright et al. 2010). Although these arguments have been repeated in several high-profile journals, they conspicuously leave out several important facts about current patterns in the distribution and evolution of herbicide resistant weeds.

First, similar arguments were made during the release of glyphosate resistant crops. Various industry and university scientists contended that details of glyphosate's biochemical interactions with the plant enzyme EPSPS combined with the apparent lack of resistant weeds after two decades of previous glyphosate use indicated that the evolution of resistant weeds a negligible possibility (Bradshaw et al. 1997).

Secondly, it is not the case that "very few" weed species have evolved resistance to the synthetic auxin herbicides. Globally, there are 28 species, with 6 resistant to dicamba specifically, 16 to 2,4-D, and at least two resistant to both active ingredients. And while many of these species are not thought to infest large areas or cause significant economic harm, data on the extent of resistant weeds is compiled through a passive reporting system, where area estimates are voluntarily supplied by local weed scientists once a resistant weed problem becomes apparent. Synthetic auxin resistant weeds may appear unproblematic because these species currently occur in cropping systems where other herbicide modes of action are used that can effectively mask the extent of the resistant genotypes (Walsh et al. 2007). Furthermore, the claim that 2,4-D resistance is unlikely to evolve due to the complex and essential functions that auxins play in plants is unsubstantiated. In many cases where resistance has evolved to synthetic auxins, the biochemical mechanism is unknown. However, in at least two cases, dicamba resistant *Kochia scoparia* (Preston et al. 2009) and dicamba resistant *Sinapsis arvensis* (Zheng and Hall 2001), resistance is conferred by a single dominant allele, indicating that resistance could develop and spread quite rapidly (Jasieniuk and Maxwell 1994).

The final dimension of the industry argument is that by planting stacked resistant traits, farmers will be able to easily use two distinct herbicide modes of action and prevent the evolution of weeds simultaneously resistant to both glyphosate and dicamba or 2,4-D. The logic behind this argument is simple. Because the probability of a mutation conferring target site resistance to a single herbicide mode of action is a very small number (generally estimated as one resistant mutant per $10^{-5}$ to $10^{-10}$ individuals (Jasieniuk and Maxwell 1994), and because distinct mutations are assumed to be independent events, then the probability of multiple target site resistance to two modes of action is the product of two very small numbers, i.e. $10^{-10}$ to $10^{-20}$. For instance, if the mutation frequency for a glyphosate resistant allele in a weed population is $10^{-9}$, and the frequency for a dicamba mutant is also $10^{-9}$, then the frequency of individuals simultaneously carrying both resistant alleles would be $10^{-18}$. If the population density of this species is assumed to be around 100 seedlings per $m^2$ of cropland ($10^6$ per ha), then it would require $10^{12}$ ha of cropland to find just one mutant individual with multiple resistance to both herbicides. For point of reference, there are only about 15 x $10^8$ ha of cropland globally. Thus, even if the weed species was globally distributed and all of the world's crop fields were treated with both herbicides, it would appear virtually impossible to select a single weed seedling exhibiting multiple resistance.

The problem with this reassuring analysis is that it contradicts recent experience. Weed species resistant to multiple herbicide modes of action are becoming more widespread and diverse (Fig. 3). There are currently 108 biotypes in 38 weed species across 12 families possessing simultaneous resistance to 2 or more modes of action, with 44% of these appearing since 2005 (Heap 2011). Common waterhemp (*Amaranthus tuberculatus*) simultaneously resistant to glyphosate, ALS, and PPO herbicides infests 0.5 million corn and soybean hectares in Missouri (Heap 2011). Rigid ryegrass (*Lolium rigidium*) populations resistant to seven distinct modes of action infest large areas of southern Australia (Heap 2011). Weeds can defy the probabilities and develop multiple resistance through a number of mechanisms.

First, when a herbicide with a new mode of action is introduced into a region or cropping system where weeds resistant to an older mode of action are already widespread and problematic, the probability of selecting for multiple target site resistance is not the product of two independent, low probability mutations. In fact, the value is closer to the simple probability of finding a resistance mutation to the new mode of action within a population already extensively resistant to the old mode of action. For instance, in Tennessee, an estimated 0.8-2 million ha of soybean are infested with glyphosate resistant horseweed (*Conyza canadensis*) (Heap 2011). Assuming seedling densities of 100 $m^{-2}$ or $10^6$ $ha^{-1}$ (Dauer et al. 2007) and a mutation frequency for synthetic auxin resistance of $10^{-9}$, this implies that next spring, there will be 800-2000 horseweed seedlings in the infested area that possess combined resistance to glyphosate and a synthetic auxin herbicide (($2x10^6$ ha infested with glyphosate resistance) * ($10^6$ seedlings/ha) * (1 synthetic auxin resistant seedling/$10^9$ seedlings) = 2000 multiple resistant seedlings). In this example, these seedlings would be located in the very fields were farmers would most likely want to plant the new stacked glyphosate and synthetic auxin resistant soybean varieties (the fields where glyphosate resistant horseweed problems are already acute). Once glyphosate and synthetic auxin herbicides have been applied to these fields and killed the large number of susceptible genotypes, these few resistant individuals would have a strong competitive advantage and be able to spread and multiply rapidly.

Secondly, several weed species have evolved cross resistance, in which a metabolic adaption allows them to degrade several different herbicide modes of action. Mutations to cytochrome P450 monoxygenase genes are a common mechanism for cross resistance (Powles and Yu 2010). Plant species typically have a large number of P450 genes (the rice genome contains 458 distinct P450 genes) involved in a variety of metabolic functions including the synthesis of plant hormones and the hydrolyzation or dealkylation of herbicides and other xenobiotics. Weeds with P450 mediated resistance are widespread and increasingly problematic. For instance, across Europe and Australia, numerous populations of *Lolium rigidum* and *Alopecurus myosuroides* occur with various combinations of P450 resistance to the ALS, ACCase, and PSII inhibitor herbicides (Powles and Yu 2010). Given the diversity and ubiquity of P450 monoxygenases in plant genomes, it is possible that in the near future a weed species could evolve a mutation that enables it to degrade glyphosate and the synthetic auxins.

Historically, use of the synthetic auxins have been limited to cereals or as pre-plant applications in broadleaf crops. The new transgenes will allow 2,4-D and dicamba to be applied at higher rates, in new crops, in the same fields in successive years, and across dramatically expanded areas, creating intense and consistent selection pressure for the evolution of resistance. Taken together, the current number of synthetic auxin resistant species, the broad distribution of glyphosate resistant weeds, and the variety of pathways by which weeds can evolve multiple resistance suggest that the potential for synthetic auxin resistant or combined synthetic auxin/glyphosate resistant weeds in transgenic cropping systems is actually quite high. One hundred-ninety seven weed species have evolved resistance to at least one of 14 known herbicide modes of action (Heap 2011), and the discovery and development of new herbicide active ingredients has slowed dramatically over recent decades. Given that herbicides are a cornerstone of modern weed management, it seems unwise to allow the new GM herbicide resistant crops to needlessly accelerate and exacerbate resistant weed evolution. **(9938)**

**Response**: APHIS has not concluded that 2,4-D resistant weeds would be unlikely to occur based on the "industry arguments." To the contrary, APHIS has concluded that it may occur depending on the extent to which growers adopt best practices. APHIS has also acknowledged in the EIS that the areas where Enlist™ crops are most likely to be adopted are areas where glyphosate resistant weeds are widespread and notes the very real possibility of selection of weeds resistant to both glyphosate and 2,4-D. Table 16 of the DEIS, lists all the weeds that are resistant to synthetic auxins. Most of the points in this comment are consistent with the analysis in the EIS.

As stated in the response to comment #5, APHIS' decision on the petition for nonregulated status is constrained by the PPA and part 340. Under 7 CFR part 340, herbicide resistant weeds are not considered to be plant pests.

**135. Comment**: APHIS concedes that Enlist crop systems would foster emergence of weeds with resistance to 2,4-D, but fails to assess the cumulative impacts of multiple resistance. Additional 2,4-D resistance would transform already troublesome HR weeds into noxious ones, and exacerbate the noxious character of already noxious weeds such as resistant Palmer amaranth by making them still more recalcitrant to control. Because HR weeds spread, the negative impacts of Enlist would not be confined to Enlist crop fields, but would rather become widespread. **(10202)**

**Response**: APHIS discusses the likelihood of multiple resistance in the cumulative impacts section and appendix 6. APHIS acknowledges that multiple resistance may occur and the benefits of the Enlist™ crop system may diminish if weeds become resistant to both glyphosate and 2,4-D. In that case, the environmental impacts will increase to that expected to occur under the No Action Alternative, namely an increase in aggressive tillage and additional costs associated with weed control. APHIS disagrees with the characterization that 2,4-D resistance will transform a troublesome HR weed into a noxious one. Under the No Action Alternative, certain herbicide resistant weeds are now more difficult to control with herbicides and will be less so under the Preferred Alternative. According to the commenter's logic, these troublesome weeds under the Preferred Alternative have become noxious weeds under the No Action

Alternative. A more accurate description is that they are less effectively controlled by herbicide under the No Action Alternative, not more noxious, and will require control by non-chemical alternatives.

**136. Comment**: Farmers would have no interest in 2,4-D crops if there weren't a raging epidemic of weeds resistant to glyphosate, the active ingredient in Monsanto's Roundup herbicide. Glyphosate-resistant weeds evolved to infest millions of acres of cropland through massive, unregulated use of glyphosate on Monsanto's Roundup Ready® soybeans, corn and cotton. This epidemic has alarmed agricultural scientists, triggering a substantial increase in herbicide use, greater use of soil-eroding tillage operations, and a return to weeding crews hoeing hundreds of thousands of acres, dramatically increasing production costs. A National Academy of Sciences committee singled out glyphosate-resistant weeds as an issue demanding national attention. However, Dow's 2,4-D crops are no "solution" to glyphosate-resistant weeds. After at best temporary relief, they will trigger an outbreak of still more intractable weeds resistant to both glyphosate and 2,4-D. Weeds resistant to multiple herbicides are already on the rise, prompting an Illinois weed scientist to warn that "we are running out of options" to confront what is rapidly becoming an "unmanageable problem." Weed resistance to 2,4-D will not be prevented or even slowed by the approaches that failed so spectacularly with Roundup Ready crops: voluntary "stewardship" plans and grower education. If these new HR crop systems are to be introduced at all, mandatory weed resistance management programs with strict limitations on frequency of use over time are absolutely necessary. USDA must also provide support to help farmers adopt integrated weed management approaches that prioritize non-chemical tactics. **(6905-007)**

**Response:** The analysis in the EIS is consistent with many of the points in this comment. APHIS does not agree that voluntary stewardship plans and grower education are destined to spectacularly fail in the case of Enlist™ crops because of several key differences with the situation for Roundup Ready® crops. First with Roundup Ready® crops, Monsanto believed that weeds would not develop resistance to Roundup® and advocated exclusive use of the technology. Growers did not adopt good stewardship practices because they did not know any better. Monsanto has dramatically changed its message to growers and has initiated incentive programs to encourage growers to use residual herbicides to reduce their reliance on glyphosate. Dow's position from the start is to encourage growers to follow best practices including limiting Enlist™ use to two applications a season and to include residual herbicides as well. Second, grower education programs only started after glyphosate resistant weeds became widespread. In contrast, grower programs have been ongoing for years now so many more growers have been educated from the start about the need to adopt best management practices. Third, many growers who adopted Roundup Ready® crops had the expectation that weed resistance to glyphosate would not occur. Today's growers will not have that same expectation for Enlist™ crops because of their personal experience and education programs. Fourth, the customers who are likely to adopt Enlist™ crops are those who have realized the benefits of Roundup Ready® technology and then experienced dismay from the loss of those benefits. They are now more likely to be protective of a new technology which they know can be lost due to poor management.

Fifth, according to several weed science experts, 2,4-D is not as effective an herbicide as glyphosate so growers will out of necessity be less reliant on Enlist Duo™ then they were on glyphosate (APHIS-2013-0042:1911,3217 , 8196) For effective weed control they will need to use more herbicide chemistries and thereby be less likely to select for herbicide resistant weeds. In addition EPA is requiring Dow to engage in an active stewardship plan with its customers aggressively resolving any situations were resistant weeds are discovered (US-EPA, 2014b). It is outside the scope of 7CFR part 340 and part 360 authority to support farmers to adopt integrated weed management approaches that prioritize non-chemical tactics. . The USDA through the the Natural Resources Conservation Service currently offers farmers incentives to pursue cover cropping through two programs: the Conservation Security Program and the Environmental Quality Incentives Program (Robinson, 2011; 2013).**137. Comment**: It is a certainty that in the mid- and long-run herbicide resistance will increase as will the amount of herbicide used. Nothing about these deregulation scenarios is sustainable, here again the report fails to adequately address this problem, in fact it goes largely unaddressed. At what point will we learn that an over reliance on any practice and particularly one that is marketed as a package (as is and was the case with glyphosate resistant crops) will result in pest resistance? The oversight regarding selection for new and more abundant pests doesn’t end with herbicide resistant weeds. **(10095)**

**Response**: While APHIS acknowledges the possibility that growers may over-rely on Enlist Duo™ as they have done with glyphosate, there are several key differences that offer hope that the same mistakes will not be repeated. First, there is a clear message by Dow (0064), university extension (1911), and the Weed Science Society (6165), that herbicides should be used in combination with other herbicides including residuals. In contrast, Monsanto widely marketed the fact that glyphosate could be used as the sole weed control agent. Second, 2,4-D alone gives poor weed control compared to glyphosate alone, and so is not likely to be over relied upon out of necessity (1911, 3217, 8196). Third, outreach activities to educate growers about best practices are more pronounced and visible than when Roundup Ready® crops hit the marketplace. Fourth, growers have personal experience with the threat of losing a valued technology through over reliance. It is not within APHIS’ authority to dictate what agronomic practices farmers can use.

**138**. **Comment:** APHIS recognizes that the almost ubiquitous adoption of glyphosate among conventional corn and soybean growers has led to widespread problems with glyphosate-resistant weeds. These super-weeds have had an adverse impact on all types of farms and have moved farms away from no-till and other conservation practices that were originally set forth as a potential benefit of these genetically modified seed varieties. We are deeply concerned that the immediate solution identified for this problem is the proposed adoption of an almost identical technology that likely will lead to an identical set of problems with the chemical 2,4-D. Continuing to develop and approve herbicide-resistant varieties of seeds ignores the lessons of the past and moves our farms toward a future where no chemical will be able to kill the super-weeds that we will have allowed to develop unchecked. In comparing the relative impacts of the no action/preferred action alternatives, it is not reasonable for APHIS to assume that farmers who choose to adopt 2,4-D resistant varieties of corn and soybeans will avoid the negative consequences of a new strain of super-weeds by adopting better production practices. Glyphosate-resistant weeds have been a recognized problem for a significant period of time, but farms generally have not modified production practices until forced to do so by the appearance of glyphosate-resistant weeds in their own fields. This is not owing to any ill intent or lack of due diligence on the part of the farmer. Rather, individual farmers lack an adequate incentive for early adoption of preventive practices unless the wider farming community follows suit. One person incurring the time and expense to follow recommendations for management practices such as improved crop rotation will not see any significant benefit from those practices if the neighboring farms are allowing herbicide-resistant weeds to spring up unchecked. **(8007**)

**Response:** see response to the comment #137.

**139. Comment:** "Weeds resistant to synthetic auxin herbicides [the class to which 2,4-D belongs], are already numerous, indicating auxin-resistance is prevalent in the plant world" (Freese & Crouch, 2013). Employing 2,4-D HR technology will be short-lived; much shorter than glyphosate HR crops. Continuing the promotion of HR technology, expecting a different result, is clearly unsustainable and a failure to carry out USDA's mission of "promoting agriculture production sustainability." **(8059)**

**Response:** APHIS agrees that 31 species have developed resistance to auxin worldwide. In the U.S., the number of species with known resistance to 2,4-D is 5 and their prevalence is not widespread. APHIS acknowledges that the 2,4-D technology can be short lived if adopters fail to heed best practices. The technology can also be useful for decades if best management practices are followed. APHIS believes that herbicides can be used sustainably and that allowing growers the choice to use HR technology is consistent with USDA's mission of promoting agriculture production sustainably.

**140. Comment**: JLI believes the most troubling aspect of USDA's decision to deregulate 2, 4-D resistant crops is the agency's failure to recognize the "chemical treadmill" created by the dramatic expansion of herbicide tolerant crops. As weeds have become more resistant to glyphosate, farmers have been forced to turn to more powerful herbicides like 2, 4-D – a chemical treadmill that benefits companies like Dow at the expense of farmers, human health and the environment. While Dow contends that 2, 4-D will help alleviate the "super weed" problem create by extensive use of glyphosate, Enlist will actually trigger the growth of still more resistant weeds and invite the use of even more toxic herbicides. **(10162)**

**Response**: see response to comment #136

**141. Comment**: What's worse is that the USDA also admits, "Multiple resistance to 2,4-D and another herbicide class has not been reported in the U.S., but has been reported in five weeds species in other countries." The International Survey of Herbicide Resistant Weeds reports that weed resistance to 2,4-D has been a problem since at least 1957, and that the number of multiply resistant species is in fact nine, with some species resistant to many different combinations of herbicides in different locations including

Washington and Nebraska. This situation needs controlling, not accelerating. Instead of attempting to contain the potential for further HT weeds to develop and spread on U.S. farmland, the USDA imagines mitigation measures that have failed in the past will now somehow curb the inevitable **(7706)**

**Response:** APHIS believes that herbicides can be used sustainably and that herbicide resistant crop systems facilitate the sustainable use of herbicides, not hinder it. The problem with Roundup Ready® technology was an over-reliance on Roundup®. Sustainable use of herbicides entails increasing the variety of chemistries and incorporating other non chemical strategies into the management program. Herbicide resistant crops allow more herbicide chemistries to be used and increase the effectiveness at which they can be used. Sustainable use of herbicides does not mean abandoning the use of herbicides altogether.

**142. Comment**: *Resistant weeds will increase* The EIS recognizes that 2,4-D resistant weeds may become a problem. Indeed, the accumulating evidence indicates that 2,4-D resistance is already a problem, and that cross-resistance to 2,4-D and multiple herbicides will likely pose a serious challenge for 2,4-D crop farmers in the future. However, the EIS goes on to suggest that at least a *short-term* benefit of introducing 2,4-D-resistant seeds is the opportunity to "delay the need to adopt a more diversified weed management program" (p. 121). But any delay in transitioning towards more diversified farming practices—particularly those based in ecological weed management principles—should be considered a negative outcome, as we otherwise lose critical time by merely shifting our dependence from one unsustainable model (Roundup Ready crops) to another unsustainable model (2,4-D crops). The EIS explains that weed resistance to 2,4D "could necessitate" the adoption of "more costly and less environmentally beneficial weed management practices." First, the damaging effects that 2,4-D has on broadleaf plants—not to mention its human health impacts—does not make it an "environmentally beneficial" tool. The underlying assumption here that 2,4-D is the only or best way to avoid recourse to aggressive tillage has been disproven by the success of organic and non-chemical-based low tillage practices. Furthermore, 2,4-D-resistant volunteer corn in corn and soybean fields (p. 95) will likely become an additional problem. EIS states that the problem as currently experienced by GE farmers will be similar under all alternatives, but this again fails to consider a comparison "no action" scenario in which farmers shift out of GE production in the coming years and therefore encounter fewer rather than increasing problems of herbicide-resistant volunteer corn plants. A revised EIS should recognize the increased cost to farmers of 2,4-D resistance in weeds and volunteer corn in comparison with a no-action alternative scenario of reduced reliance on GE seeds. **(10203)**

**Response:** APHIS does not consider a delay in the adoption of a more diversified weed management program to be a short term benefit of Enlist™ technology. Rather APHIS was pointing out a potential negative consequence that might ensue with the adoption of Enlist™ technology. Namely non chemical strategies that might prove valuable to delay the selection of herbicide resistant weeds are more likely to be used under the No Action Alternative than the Preferred Alternative because they are either more expensive, resource intensive, or less familiar to use. The commenter suggests that the No Action Alternative might be more environmentally beneficial than the Preferred Alternative because it might lead to the adoption of non chemical based low tillage practices. APHIS agrees that if this were the case, the No Action Alternative would be more environmentally beneficial. However there is no sign that corn and soybean growers will move towards non chemical based low tillage or even use less herbicide. There also is no sign that growers are shifting out of GE production. It is unrealistic to consider these scenarios suggested by the commenter in a revised EIS.

**143. Comment**: APHIS explains how these resistant weeds were created by "nearly exclusive use of glyphosate over the past fifteen years" due to widespread grower adoption of Roundup Ready crops. This suggests that the regulatory process does not adequately control unintended consequences of transgenic crops and needs to be strengthened. **(10152)**

**Response**: This comment is outside the scope of the EIS because APHIS does not regulate herbicide use. The decision before the agency is not whether to change APHIS regulations 7 CFR 340.

**144. Comment**: The DEIS failed to address the global increase in invasive/weedy grasses due to 2,4-D use or provide mitigation for this impact (40 CFR § 1502.14 (f)). The DEIS focuses on resistance, while ignoring the issue of selection in the case of invasive grasses that are not killed by 2,4-D. This issue needs to be analyzed as an indirect effect, along with the issue of resistance. Together they are cumulative impacts. Increased uses of 2,4-D are acknowledged in the DEIS (eg., p. 81) and increased use will likely promote further spread of invasive grasses and other invasive weeds. As early as the 1960's, scientists had noted that the global use of 2,4-D had resulted in a *global increase* in weedy grasses that are already tolerant to the herbicide (Fryer and Chancellor 1970). It also failed to address the indirect effect that 2,4-D will have in killing associated, competitor species in ecosystems while providing a competitive edge to all species of grasses that are not affected by the herbicide. Further, an increase in the extent of weedy grasses in the U.S. will likely trigger increased uses of other herbicides. **(3105)**

**Response**: APHIS disagrees with the statement that 2,4-D use is leading to a global increase in invasive/weedy grasses. In the 1960's, alluded to by the commenter, there were much fewer herbicide options. Growers today use herbicides such as glyphosate, grass selective, and pre-emergent residual herbicides that effectively control grass weeds. Enlist Duo™ is a mix of both glyphosate and 2,4-D and together with the other herbicide options that growers routinely use would not be expected to lead to a selection of invasive grasses.

**145. Comment:** APHIS mistakenly calls Rigid Ryegrass, which has a glyphosate resistant biotype, annual ryegrass**. (10202)**

**Response**: APHIS acknowledges the error and has revised the FEIS accordingly.

**146. Comment:** It is a general and serious deficiency of the EIS that APHIS nowhere provides even rough quantitative estimates of acres infested with any particular GR weed species or population, and does even provide a consistent figure for national GR weed-infested acres. **(10202)**

**Response**: APHIS is unaware of reliable quantitative estimates of the amount of the acres infested with any particular GR weed, and the commenter has provided none. The International Survey of Herbicide Resistant Weeds previously provided estimates on their website, but it has since taken these down because they were unreliable. APHIS has used the best available data, which includes three estimates for the national GR weed infested acres in the DEIS (Figure 4-13, p.140, p 145).

**147. Comment:** Herbicides do not automatically trigger weed resistance, as APHIS falsely assumes (EIS at 148). Much depends upon how they are used. Experience shows clearly that herbicide-resistant crop systems are particularly prone to promote rapid evolution of weed resistance by fostering repeated, exclusive and late post-emergence application of the HR crop-associated herbicide(s) (CFS Science Soy at 21-24). This explains why no glyphosate-resistant weeds emerged over the first 20 years of glyphosate's commercial use, but rather only emerged to reach epidemic proportions in step with the adoption of Roundup Ready crops (CFS Science Soy at 23 24-27). A modeling study by UK weed scientist Paul Neve (2008) (frequently cited by APHIS in past regulatory documents) concurs: "Glyphosate use for weed control prior to crop emergence is associated with low risks of resistance. Post-emergence glyphosate use, associated with glyphosate- resistant crops, very significantly increases risks of resistance evolution." **(10202)**

**Response**: APHIS agrees with the commenter that herbicides can be used sustainably where selection of resistant weeds can be minimized by best practices (DEIS p. 140). APHIS acknowledges (DEIS p. 140) that Dow is recommending to growers to follow best practices such as:

Rotate the use of Enlist Duo™ Herbicide with non-auxin (non-Group 4) and non-glycine (Group 9) herbicides

Utilize a broad spectrum soil-applied herbicide as a foundation treatment

Utilize herbicides with alternative modes of action

Avoid using more than two applications of a Group 4 herbicide within a single growing season unless mixed with another mode of action herbicide with overlapping spectrum

Apply labeled rates of Enlist Duo™ herbicide at the specified time (correct weed size) to minimize escapes of tolerant weeds.

APHIS disagrees with the commenter that no glyphosate resistant weeds emerged over the first 20 years of glyphosate use or that the only cases that did emerge were from post-emergent use of glyphosate. See for example Neve (Neve, 2008) “The earliest confirmed cases (glyphosate resistant weeds) were from broad-area crop production in Australia, where glyphosate was used repeatedly for weed control prior to crop seeding. In the late 1990s and early 2000s, glyphosate resistance was also reported in orchards and vineyards where glyphosate was being used for year-round weed control. More recently, the majority of newly reported glyphosate resistant species have been from agroecosystems where glyphosate-resistant crop varieties are being grown.”

APHIS acknowledges that exclusive use of an herbicide is a practice associated with a high risk of selection of herbicide resistant weeds. APHIS does not agree that post-emergent use is in itself a problem. For example, Neve (Neve, 2008) indicates that the “risk can be reduced to close to zero by mixing two of the three post-emergence glyphosate applications with alternative herbicide modes of action.” Thus it is the exclusive use of the herbicide that is the poor practice, not the use of the herbicide in a post-emergent application.

**148. Comment:** Once established, an herbicide-resistant weed population can spread via cross-pollination or long-distance seed transport. In Indiana, researchers believe that glyphosate-resistant Palmer amaranth was introduced to northern Indiana in dairy or beef manure from animals that were fed cotton seed hulls or other feed stocks from the South that were contaminated with Palmer amaranth seed (Leglieter & Johnson 2013). Other modes of transport include combines and other agricultural equipment as well as birds and other animals (Ellis 2013). Certain weeds (e.g. horseweed) can send pollen on the wind over long distances, while seeds washed into rivers can also spread [herbicide-resistant] seed long distances (see CFS Science Soy, 38-39). Thus, HR weeds cannot be effectively prevented or controlled by approaches that rely solely on individual growers following “best management practices” (BMPs) reputed to slow or prevent HR weed emergence. Likewise, because implementation of BMPs can be costly, any individual grower has less incentive to implement them if he/she can expect his/her field to be invaded by resistant weeds from those of a less diligent farmer anyway (see Webster & Sosnoskie 2010 and CFS Science Soy at 38-39). If a noxious, herbicide-resistant weed were always confined to the field of the farmer whose farming practices fostered its emergence, there might be less need for USDA action. Since this is not the case, and spread can cause area- or region-wide harm, action is essential. **(10202)**

**Response**: APHIS acknowledges that herbicide resistant weeds can spread via pollination or long distance seed transport. Best practices can limit this spread through the active monitoring of resistant weeds and elimination of plants prior to flowering. APHIS also acknowledges that it is not possible to predict the extent that growers follow best management practices that may be more expensive in the short term. APHIS does not regulate herbicide use or specify management techniques. In EPA’s proposed registration decision of Enlist Duo™ herbicide, they determined that the registration must contain a term that requires Dow to have a stewardship program with its customers that includes requirements for scouting, reporting resistance, aggressively resolving any situations were resistant weeds are discovered, and training and education to help users of the Enlist™ technology avoid weed resistance (US-EPA, 2014b).

**149. Comment**: 2,4-D is the most widely used member of the synthetic auxin class of herbicides. Weed populations or biotypes that evolve resistance to one member of this group may have cross-resistance to other members. APHIS falsely states that "relatively few weeds have developed resistance to 2,4-D" (EIS at 16). In fact, biotypes of 31 weed species around the world have evolved resistance to synthetic auxins (Synthetic Auxin Resistance 2014) **(10202).**

**Response**: Table-16 of the DEIS, based on the International Survey of Resistant Weeds (Heap, 2013), lists all the weeds that are resistant to synthetic auxins which at the time of publication numbered 30. APHIS has revised the table in the EIS to include the 31st reported species, but this change does not alter its analysis. APHIS further reported that of these 30 species, there were 17 species with known resistance to 2,4-D worldwide where 12 were found outside the US and 5 were reported to be present in the US. Thirteen of the species (now 14) are known to be resistant to synthetic auxins other than 2,4-D. In the 14 cases where resistance to 2,4-D is not listed, it is not known whether the biotype is sensitive to 2,4-D or the biotype is resistant but has not been tested for resistance against 2,4-D. The commenter makes an unsupported assumption that any weed that has resistance to a synthetic auxin is also resistant to 2,4-D. This assumption, if true, would nearly double the number of resistant weeds the commenter implies is 2,4-D resistant. However, because APHIS has no evidence in support of the commenter's assumption, it has not made any further revisions to the EIS based on this comment.

**150. Comment:** There is very little risk of 2,4-D-resistant weeds under the No Action Alternative, for several reasons. First, 2,4-D has been used for over 60 years, and while a number of weed species have shown the genetic capacity to evolve resistance to this herbicide (which is concerning, as discussed above), as APHIS notes the few populations that exist tend to be small and are not regarded as especially problematic. This indicates that current 2,4-D use patterns are not resistance-promoting. Second, the volume of 2,4-D use would not increase much under the No Action Alternative; it would continue to be used just once per season as at present; and it would be used mainly in combination with other herbicides – all factors which are said to impede resistance evolution. Finally, under the No Action Alternative there would be greater use of beneficial non-chemical weed control tactics like cover crops and crop rotations, which suppress weeds without exerting any selection pressure for resistance to any herbicide. These factors explain why APHIS projects little or no additional 2,4-D resistance under the No Action Alternative. **(10202)**

**Response**: APHIS largely agrees with the comment. APHIS acknowledges that the risk of selecting 2,4-D resistant weeds is higher under the Preferred Alternative than under the No Action Alternative. However APHIS disagrees with the conclusion that under the No Action Alternative there is very little risk of selection of 2,4-D resistant weeds while under the Preferred Alternative, the risk is very high. As stated in the DEIS (pp.134-143), the risk is dependent on the extent of adoption of good management practices. The commenter assumes that under the Preferred Alternative, growers who adopt Enlist™ technology will over-rely on Enlist Duo™ as growers have over-relied on glyphosate, while growers who use 2,4-D for other uses will use it judiciously. APHIS acknowledges the possibility that Enlist™ adopters will misuse the technology but also notes a difference from the previous situation in that herbicide manufacturers, the biotech industry, the Weed Science Society, and University Extension Services are making a concerted effort to educate growers and encourage their use of better practices to preserve the effectiveness of the technology. Furthermore, weed science experts have commented on this docket (1911, 3217, 8196) that 2,4-D is a less effective herbicide than glyphosate and, as a result, additional herbicides are inevitably going to be used for effective control of glyphosate resistant weeds thereby reducing the selection pressure against 2,4-D . While it is plausible that under the No Action Alternative, there would be greater use of beneficial non-chemical weed control tactics such as cover cropping (see DEIS p.83), relatively few farmers have chosen to use cover cropping for weed control (Wallander, 2013). In contrast, environmentally harmful non-chemical weed control tactics such as tillage are increasing and are expected to increase further under the No Action Alternative (see response to comment #1)

**151. Comment:** APHIS notes that a biotype of one of the most troublesome corn/soybean weeds, common lambsquarter, is resistant to dicamba, but falsely concludes that it is *not* resistant to 2,4-D (EIS at 4-4), when in fact the report cited for that weed states that it "may be cross-resistant to other Group O/4 herbicides," the class of synthetic auxins which includes 2,4-D. Less than one month ago, scientists identified a wild radish population resistant to both glyphosate and 2,4-D (WeedSmart 2014). Such dual- resistant weeds would increase dramatically under the Preferred Alternative. CFS Science Soy (27-29) provide further discussion of synthetic auxin-resistant weeds. **(10202)**

**Response**: In the section referred to by the commenter (4-4), APHIS makes the point that weeds can be resistant to either dicamba, 2,4-D or both herbicides. APHIS acknowledges that the lambsquarter example does not illustrate this point having subsequently learned that the investigator did not test the dicamba resistant biotype for resistance to 2,4-D (James, 2014). Thus it is uncertain whether this biotype of lambsquarters is resistant to both dicamba and 2,4-D. However the point is valid that a plant can be resistant to one herbicide and not the other. For example, Enlist™ soybean is resistant to 2,4-D and sensitive to dicamba (Krieger, 2014) and Monsanto's Xtend soybean is much more resistant to dicamba than it is to 2,4-D (Feng and Brinker, 2010). APHIS acknowledges that weeds selected for resistance to both glyphosate and 2,4-D are more likely under the Preferred Alternative. This point is discussed thoroughly in the cumulative impacts section (DEIS p. 116 ,141 and following).

**152. Comment:** APHIS also projects declining use of glufosinate and quizalofop under the Preferred Alternative; while a questionable assumption, if it holds true it would mean still greater reliance on and more resistance to 2,4-D. **(10202)**

**Response**: As stated in the response to comment #26, APHIS predicts that glufosinate use will increase more under the No Action Alternative compared to the Preferred Alternative. APHIS believes that glufosinate use will remain a valuable tool under the Preferred Alternative. APHIS disagrees with the commenter that quizalofop use will increase under the Preferred Alternative. Quizalofop is currently not used on corn and is rarely used on soybean. The preferred grass herbicide for use on soybean is clethodim (DEIS appendix 4). There are at least two other herbicide chemistries besides glufosinate which are expected to be used in corn and soybean under the Preferred Alternative that would provide alternatives to glyphosate and 2,4-D. These are the chloroacetamides, acetochlor and metolachlor-S and the HPPD inhibitors, mesotrione and isoxaflutole. Comment #157 corroborates the widespread use of chloroacetamides for corn and soybean production and the expectation that they would continue to be used on Enlist™ corn and soybean.

**153. Comment**: APHIS states that weeds resistant to glyphosate and other non-2,4-D herbicides would increase more in the No Action than in the Preferred Alternative, but it is entirely unclear why this should be so. APHIS maintains that using a diversity of herbicide classes with different "modes of action" (aka "sites of action") is the key to preventing resistance from emerging to any one class of herbicide. APHIS also describes, based on data provided by Dow, how soybean and corn farmers have been increasing the diversity of herbicides they employ in response to glyphosate- resistant weeds for several years now (EIS, Appendix 4). As this trend would continue under the No Action Alternative, it would seem to suggest lesser, not more, emergence of weeds resistant to non-2,4-D herbicides. Conversely, the growing diversity in types of herbicide used would be reversed under the Preferred Alternative, as farmers revert to the simplicity and convenience of the total post-emergence weed control paradigm that would be offered by Enlist crops, and to which farmers have grown accustomed through 15 years of Roundup Ready crops. Indeed, there is evidence to support this assessment from trends in the use of another HR crop system, glufosinate-resistant, LibertyLink (LL) soybeans. Tennessee weed scientist Larry Steckel reports that in his state, a survey showed that "60 percent of our Liberty Link soybeans got nothing but Liberty on them." University of Arkansas weed scientist Jason Norsworthy, reporting a similar trend in Arkansas, said: "Folks, we're going to run Liberty into ground if that's the case. We've got to use other modes of action if we're going to protect it and keep it around for any length of time" (Bennett 2014). The implication is clear. Enlist crop systems would similarly "run 2,4-D into the ground" by generating 2,4-D-resistant weeds under the Preferred Alternative**. (10202)**

**Response:** Under the No Action Alternative, weed control is not expected to be as good as under the Preferred Alternative and, as a result, weeds resistant to glyphosate, PPO inhibitors, photosystem II inhibitors, and ALS inhibitors are expected to reproduce and become even more widely prevalent. Furthermore, weeds with resistance to multiple herbicides are expected to increase because many weeds have already developed resistance to the herbicides that will continue to be used under the No Action Alternative. APHIS acknowledges in the DEIS (pp. 134-143) that it is possible that growers will exclusively use Enlist Duo™ despite the effort by industry and weed scientists to discourage this practice and the evidence demonstrating that growers are now using more herbicide chemistries (DEIS Fig 4-4)

**154. Comment:** APHIS describes HR weeds as an "unavoidable impact" wherever herbicides are used in corn/soybean production (Section 6, EIS). This is false. Weed control strategies that prioritize non-chemical tactics and make sparing use of herbicides can reduce selection pressure sufficiently to prevent HR weed emergence. Even where herbicides are the primary means used to control weeds, resistance can be prevented (Neve 2008). Indeed, preventing weed resistance is the whole point of "best management practices" cited by APHIS and promoted by weed scientists. In a paper often cited by APHIS in past assessments, weed scientist Paul Neve modeled GR weed emergence under different herbicidal weed control regimes, finding that "the low mutation rates for glyphosate resistance means that resistance need not be an inevitable outcome of glyphosate use" (Neve 2008). **(10202)**

**Response**: (Neve, 2008) used simulation models to predict glyphosate resistance evolution and strategies that mitigate these risks. In some simulations, resistance was not predicted to occur over a twenty year period of herbicide use. APHIS agrees with the commentor that the Neve study supports the conclusion that herbicide use can be sustainable in the sense that management practices can be used that minimize the selection of herbicide resistant weeds. That is why in the DEIS (p. 139-140), APHIS concluded "Thus, depending on how glyphosate and 2,4-D are used on Enlist™ corn and soybean crops, selection of 2,4-D resistant weeds may be preventable." (Neve, 2008) did not demonstrate, as the commenter asserts, that where herbicides are the primary means of weed control, resistance can be prevented. After all, a simulation study is not proof that an event will never happen. The value of the study is in predicting which management options are likely to be most effective in minimizing selection of herbicide resistant weeds. Even if a method is 100% effective, it is unrealistic to assume that over 170 million acres planted to corn and soybean, the method will be applied flawlessly. That is why APHIS considers selection of herbicide resistant weeds to be an unavoidable impact. Though the rate of their spread may vary, APHIS cannot predict when and how frequently 2,4-D resistant weeds will be selected as it will depend on the extent to which best management practices are adopted (DEIS p. 139-140).

**155. Comment:** Neve found that post- emergence glyphosate use patterns typical of RR crops have a much higher likelihood of fostering GR weeds than other uses of glyphosate. This finding is consistent with the complete lack of glyphosate-resistant weeds in the 20 year history of glyphosate use prior to Roundup Ready crop introduction. Likewise, Enlist crop systems will rapidly foster weeds resistant to 2,4-D, which have been relatively infrequent over the herbicide's nearly 70-year history**. (10202)**

**Response:** (Neve, 2008) also identified simulations that predicted no selection of herbicide resistant weeds with postemergent glyphosate use when the glyphosate was used with an additional unrelated herbicide for both burndown and post-emergent treatments. APHIS interprets this result to mean that post-emergent use of Enlist Duo™ could be used without selection of resistant weeds. For this reason, neither APHIS nor the commenter can predict when and how frequently 2,4-D resistant weeds will be selected as it will depend on the extent to which best management practices are adopted (DEIS p. 139-140). APHIS disagrees with the commenter's assertion that glyphosate resistant weeds were not selected prior to the introduction of Roundup Ready® cropping systems. This view is contradicted by data on the International Survey of Resistant Weeds that reports glyphosate resistant biotypes of goosegrass in Malaysia in 1997, rigid ryegrass in Australia 1996, rigid ryegrass in the US in almonds and orchards (1998) , and Italian ryegrass in Chile in 2001 (Chile didn't grow GE crops till 2002, (James, 2009)). Furthermore, in many cases glyphosate resistant weeds were selected in cropping systems where Roundup Ready® crops were not grown. So although selection may have occurred after Roundup Ready® crops were grown, in the following cases the selection had nothing to do with Roundup Ready® cropping systems. These include hairy fleabane in grapes and orchards in South Africa in 2003, ripgut brome in fencelines and wheat in Australia in 2012, woody borreria in palm oil plantations in Malaysia in 2005, tropical sprangletop in orchards in Mexico in 2010, Sumatran fleabane in orchards in Spain in 2009, Ragweed parthenium in orchards in Columbia in 2004, buckhorn plantain in grapes and orchards in South Africa in 2003, annual bluegrass in turfgrass in the US in 2010, wild radish in fallow land in Australia in 2010, and liverseed grass in sorghum and wheat in Australia in 2008.

**156. Comment**: We have also conducted significant work in the area of herbicide-resistant weeds. One of the resistant weeds that we have worked on is 2,4-D-resistant waterhemp. We have found a population of waterhemp that has high levels of resistance to the compound. What is imperative to know is that resistance to 2,4-D has occurred separate from the deregulation of the trait indicating that merely keeping another tool from growers which allows them to diversify their weed control strategies will not stop resistance to 2,4-D or any other compound for that matter. Additionally, reducing the tools that growers have available to them will only increase the number of herbicide-resistant weeds that we have no decrease them. So while resistance is clearly a possibility of developing, by banning its use, it is more likely that we will come across a greater number of herbicide resistant weeds because we limit the diversity of options available. **(10039)**

**Response**: The analysis in the EIS is consistent with this comment.

**157. Comment:** As the authors noted, growers are already integrating other herbicides into management systems in an attempt to manage glyphosate-resistant weeds. That has certainly been the case in the southern U.S. The authors recognized that such usage is placing greater selection on these other herbicides but I do not think the authors sufficiently emphasized just how precarious this situation is. Glyphosate-resistant Palmer amaranth is a good example. Growers are already using multiple herbicides to control this weed. Resistance to both glyphosate and ALS-inhibiting herbicides is very widespread, effectively eliminating both modes of action for management of this weed. Corn growers are relying heavily on chloroacetamides and triazines. Soybean growers are relying heavily on chloroacetamides and various PPO-inhibiting herbicides and to a lesser extent on glufosinate. Cotton growers are relying heavily on PPO inhibitors, chloroacetamides, and glufosinate. Chloroacetamides and PPO inhibitors are also widely used in other crops, such as peanuts, sweetpotatoes, and tobacco. Palmer amaranth resistant to any of these herbicides would be devastating as no other options currently exist. Enlist crops, with the option to use 2,4-D, give growers another tool to aid in managing glyphosate-resistant Palmer amaranth and other species and will significantly reduce selection pressure on other herbicides. It is my opinion that the risk of selecting for auxin-resistant weeds is relatively low because, in the South at least, few growers will rely solely on glyphosate plus 2,4-D. Growers are surprisingly attuned to the principles of resistance management. Because of their past experiences, along with strong educational programs from both the public and private sectors, I think growers will recognize that glyphosate plus 2,4-D should not be a stand-alone program and they will continue to incorporate other chemistry into their programs. This should slow selection for resistance to all the herbicides involved.

The authors emphasized that resistance to 2,4-D resulting from widespread 2,4-D usage in Enlist corn or soybean could adversely impact weed management in other crops, such as small grains or pastures. While that is true, the impact is likely less than the EIS would lead a casual reader to conclude. While there are a few exceptions, such as horseweed (*Conyza*), one needs to understand that the common weeds in small grains and pastures are seldom the same species as in corn and soybean, and vice versa. Auxin-resistant weeds could impact grain sorghum producers. A combination of atrazine and a chloroacetamide is the most commonly used program in sorghum. I have already mentioned the selection pressure on these herbicides from widespread usage in other crops. One could argue that Enlist technology could indirectly help preserve chloroacetamides and triazines for use in sorghum. **(3217)**

**Response:** APHIS acknowledges the comment and has incorporated relevant information from the comment into the EIS.

**158. Comment:** During the past four growing seasons, my research laboratory tested samples of waterhemp (*Amaranthus tuberculatus*), a particularly problematic weed in Midwest agriculture, for resistance to glyphosate, diphenylethers, and acetolactate-synthase (ALS) inhibitors. These herbicide/herbicide groups comprise the only effective postemergence herbicide options currently available for waterhemp control in Roundup Ready soybean. Samples were submitted to us by weed management practitioners (e.g., farmers, farm managers, retail applicators, etc.) who suspected the plants were resistant to glyphosate. From this sampling alone, we have now confirmed that glyphosate-resistant waterhemp is present in over 40 Illinois counties. More disconcerting is that numerous populations also are resistant to the other two groups of herbicides as well. The Liberty Link system provides another alternative for managing waterhemp in soybean, but this system has limitations (in particular, glufosinate herbicide is effective on waterhemp plants only when they are small). The take-home message from these findings is that we are rapidly running out of options for effective control of waterhemp in soybean. Although there are generally more herbicidal options for control of waterhemp in corn than in soybean, the recent occurrence of resistance to hydroxyl-phenyl-pyruvate-dioxygenase (HPPD) inhibitors, along with resistances to atrazine, ALS inhibitors, and glyphosate, is greatly limiting options in corn as well. The ongoing evolution of herbicide resistance in weeds is more than an academic curiosity; it is a real threat to our food production systems.

Recently, the Weed Science Society of America published a special issue of *Weed Science* (Vol 60, 2012) devoted to herbicide-resistant weeds. A recurring theme throughout this issue is that we need a diversity of tools, including a diversity of herbicide modes of action, to mitigate the evolution of resistant weeds. **(4402)**

**Response**: The analysis in the EIS is consistent with this comment.

**159. Comment**: My key responsibility since I was fourteen years old was to kill weeds. I have sprayed chemicals all of my life you could say. I have watched Palmer Amaranth or Palmer Pigweed as the farmers call it literally cause farmers to lose total fields of soybeans. The story I like to tell is when I was fourteen I liked to go to the lake during the weekend but almost always a flush of pigweed would make me miss the trip because my father made me stay home and spray. If these weeds were not sprayed on Friday by the time Monday rolled around they would be too big to kill using the herbicides that I had back in the late seventies early eighties. Blazer was typically all I had. Weeds had to be sprayed when they were small to achieve an effective kill.

Then the miracle product came to the market. Roundup or Glyphosate was introduced along with Roundup Ready Soybeans. Timing back then was not as critical. Roundup made bad farmers good ones.

My family was much into conservation. We produced over two thousand acres of wheat every year. We began no-tilling our double crop soybeans into the wheat straw and by spraying roundup over the straw for the initial burn down then following with sequential sprayings we could have a clean crop of soybeans and never work the soil. The straw held moisture in the soil and also naturally helped prevent weeds and grass from growing. We used rotation to further aid in our weed control scenario. We rotated every year with Corn, Fall-Winter Wheat then Double-Crop Soybeans followed by Corn.

We were lucky in the fact that weed resistance on our farm was held at bay I believe because of the rotation practices and the use of conventional chemicals on the alternate crops which aided in the non-resistance of certain weeds. However resistance finally reared its ugly head in the summer of 2009. We first noticed it in our Center Pivot Corners which did not receive the rotation like the irrigated portions of the field had. This non-rotation and lack of good canopy caused the Pigweed to find a home and become resistant to Glyphosate treatments. We saw this resistance spread into the main parts of the field in 2010 and by 2011 we knew our good years of weed control with Glyphosate was over. **(5511)**

**Response**: APHIS acknowledges the comment.

**160. Comment**: Georgia soybean production increased dramatically during the 1970’s from 200,000 to two million acres as US and world soybean consumption increased. Georgia soybean acreage also decreased sharply during the 1980’s to less than

500,000 acres due to increased competition from South American soybean production, and to increased profitability of traditional southern crops such as cotton and peanut.

Much of my career centered around researching and developing education programs to improve the production efficiency of southeast soybeans. Part of that effort was to identify major strengths and weaknesses of Georgia and Southeast US soybean production. Our greatest strength or asset has been our long growing season and potential for growing two or more crops a year. Soybeans are a top summer crop consideration for multiple cropping systems here. Georgia soybean acreage will typically vary considerablely from year to year depending upon cost/profit opportunities of various crop components.

Some major problems or obstacles to growing soybeans in Georgia include: drought, weeds, insects, diseases, erosion control, and production cost management. During the past fifty years, weeds always ranked as the number one or two obstacle. Before "yellow herbicides" grass control was the biggest concern. During the 1970's and 1980's, control of large seeded broadleaf weeds was the big issue. In recent years after the widespread use of glyphosate herbicide, control of resistant weeds such as palmer amaranth have become the big concern. Each new herbicide development has contributed to improving our soybean production efficiency. But shifts in weed populations have typically resulted with intensive use of new technologies. Continued effective soybean weed control here will likely require further new herbicide developments and strategies. **(5523)**

**Response**: APHIS acknowledges the comment

**161. Comment**: The vast majority of cotton acreage in the south-eastern states is now infested with glyphosate-resistant Palmer amaranth leading cotton growers to move to cultivation, expensive hand-weeding or even abandoning cotton production in order to manage this weed (Price et al. 2011). Similar problems occur in the corn and soybean producing areas of the mid-west with glyphosate-resistant waterhemp and giant ragweed. However, in my opinion, one of the greatest threats is the appearance of glyphosate-resistant kochia in the US Great Plains. This first appeared in corn production in Kansas in 2005 (Waite et al. 2013), but since 2008 has spread to all corn and wheat producing areas in Kansas and Colorado and is spreading widely in North and South Dakota. Failure to adequately manage this weed could greatly curtail crop production in these areas, **(6793)**

**Response**: APHIS acknowledges the comment.

**162. Comment**: In many areas where glyphosate-resistant weeds occur, there are a limited number of herbicides that can be used in crop production to control these weeds. The availability of other effective herbicide modes of action would greatly ease the threats posed by glyphosate resistant weeds. In addition, research from my group and that of Professor Powles in Australia has consistently shown that having multiple herbicide modes of action available in crop can help delay the evolution of resistance (Preston et al. 2009; Neve et al. 2003). Using a second herbicide to control the survivors of the first herbicide (a practice we call ‘double knock’) can do much to protect the first herbicide from resistance. However, the choice of the second herbicide is vital. Using a herbicide that is at high risk for resistance evolution, such as inhibitors of acetolactate synthase, is generally ineffective. This is where, for broadleaf weeds, 2,4-D can be a useful management tool.

Resistance to 2,4-D is known to occur (Walsh et al. 2004; Preston et al. 2013); however, this herbicide has been used for more than 60 years in crop production and there is a limited number of cases of resistance. This demonstrates the robustness of this mode of action for resistance evolution. Therefore, 2,4-D makes an ideal companion to glyphosate for a ‘double knock’ application to broadleaf weeds.

The reasons for the robustness with respect to 2,4-D are not fully understood. Several reasons have been proposed. Auxins are vital to the growth and development of plant species and interference with signalling processes and responsiveness to auxins is likely to result in a significant fitness penalty making the weeds easier to manage with other weed control tactics. Target site resistance to 2,4-D is likely to be a recessively inherited trait (Walsh et al. 2006) making it manageable with a version of the high rate/refuge strategy used in Bt crops (Roush 1998) in some weed species. In the case of weeds, the refuge is the soil seed bank and the strategy will require rotation of modes of action.

Increased use of 2,4-D will inevitably increase the selection pressure for resistance to this herbicide and this requires management. Carefully management of Enlist crops will do much to maintain the robustness of this product. Such management will require use of both modes of action in a ‘double knock’ as well as judicious use of other tactics and rotation with other modes of action. In my opinion, Dow must develop and promote resistance management plans as part of their best management plans for Enlist crops**. (6793)**

**Response**: In EPA’s proposed registration decision of Enlist Duo™ herbicide, they determined that the registration must contain a term that requires Dow to have a stewardship program with its customers that includes requirements for scouting, reporting resistance, aggressively resolving any situations were resistant weeds are discovered, and training and education to help users of the Enlist™ technology avoid weed resistance (US-EPA, 2014b).

**163. Comment**: In our evaluations of the Enlist soybean and Enlist Duo we have observed excellent control of two glyphosate resistant weeds that are very troublesome in our state, Palmer Pigweed and Horseweed. This technology will provide Arkansas growers with a much needed option for these weeds. The fact that this technology also affords growers the option to us glufosinate as well as glyphosate makes it a natural choice for resistance management. I have observed reduced volatility with the Enlist Duo or Choline formulation of 2,4-D. Although no herbicide can be made “drift proof”, this technological advance should help to mitigate off-target movement of the 2,4-D molecule. This is a herbicide that Arkansas growers are comfortable with and understand how to use. Currently restrictions on the use of 2,4-D in Arkansas will also help to ease this product into the market here and I believe is a good path for state adoption of this technology where it is needed most too fight resistant weeds. **(6950)**

**Response:** The analysis in the EIS is consistent with this comment.

**164. Comment**: In 1999, I conducted and published findings on the first random survey for herbicide resistance in wild radish populations in Western Australia (Walsh et al. 2001). This survey indicated significant frequencies (21%) of herbicide resistance in wild radish populations highlighting a looming threat for crop producers. In 2002, I identified the first ever cases of phenoxy herbicide resistance in Australia (Walsh et al. 2004). Two wild radish populations from the northern Western Australian wheat-belt were confirmed resistant to 2,4-D and MCPA. These populations were also identified as multi-resistant with mechanisms conferring resistance to herbicides with three modes of action.

In 2003, I conducted a follow-up survey that confirmed very high levels of resistance to the ALS-inhibiting herbicide chlorsulfuron (54%), auxin analogue herbicide, 2,4-D amine (60%) and the phytoene desaturase inhibiting herbicide diflufenican (40%) (Walsh et al. 2007). This survey also determined that over half (58%) of these populations were multiple resistant across at least two of the four herbicide modes of action screened. My research on herbicide resistance in wild radish had clearly identified this species, like annual ryegrass (*Lolium rigidum* L.) as being a highly resistance prone. However, despite the continuing escalation in frequency and distribution of herbicide resistance in this species herbicides are and will remain the most effective weed control tool in Australian conservation crop production systems.

With the herbicidal options diminishing for wild radish and other weeds it is essential that additional weed control tools are included in weed management programs. Towards alleviating the reliance on herbicides alone for weed control in Australian cropping systems I have worked for many years on the research and development of suitable alternate non-herbicidal weed control strategies. Principally over the last decade I have focused on the development and introduction of systems that target weed seeds during commercial grain harvest. This work has led to the development and subsequent widespread introduction of chaff cart and narrow windrow burning systems in to Australian cropping (Walsh et al. 2007; Walsh and Newman 2007).

Recently this focus on harvest weed seed control (HWSC) has realized the introduction of a mechanical weed seed destruction system, the Harrington Seed Destructor (Walsh et al. 2012). The continued development and introduction of HWSC systems in Australia is now being driven by the excellent weed control results experienced by early adopters of these technologies. There is clear evidence that the incorporation of HWSC systems in to herbicide based integrated weed management programs delivers very low (<1.0 plant/m2) in-crop weed populations (Walsh et al 2013). The consequences of these low densities are reduced herbicide reliance, more flexible crop options and ultimately more profitable production systems. Weed species in Australia and globally have the proven ability to adapt to all forms of weed control. Herbicide resistance in weed species is a clear example of this adaptation. The presence of genetically variable, highly adaptive weed species such as annual ryegrass and wild radish in Australian cropping systems means that resistance to any and all forms of weed control is an ongoing threat. Thus the only feasible means of avoiding or at least reducing this threat is through restricting weed densities to very low levels. Towards this there is a continuous need for new and better herbicidal and non-herbicidal weed control tools.

The introduction of the Enlist technology into US crop production systems is a significant achievement in the development of a new weed control tool. The refinement of a highly effective and durable herbicide for use on crop species with an included resistance trait is a significant event in the development of a new weed control technology. Initially US growers will greatly benefit from the introduction of Enlist and 2,4-D choline technologies. However, it is hoped that Australian growers will also, in time, benefit from their introduction to Australian cropping industry. The Australian crop protection market is small and the introduction of new herbicides only occurs following their successful introduction in larger markets such as the US. This will certainly be the case with Enlist traits and 2,4-D choline with their introduction to Australia dependant on the success of this technology in the US.

The Australian conservation crop production system is based on highly effective herbicidal weed control. However, high frequencies of multi-resistant weed populations have effectively removed many valuable herbicide resources from weed management programs. Thus there is a real need for additional herbicide resources to be introduced towards sustaining this effective, viable production system. Although there are concerns that any new herbicides will also lead to further resistance evolution, a distinct possibility, but not a valid reason for withholding a valuable weed control system. The threat of resistance though, is reason for effective stewardship and the implementation of multifaceted weed management programs. Despite the already relatively high frequencies of 2,4-D resistance present in Australian wild radish populations there remains a significant role for this herbicide in cropping systems. Phenoxy herbicide resistance in wild radish population is typically due to a weak resistance mechanism that can be overcome with increased application rates. The current recommended application rates of phenoxy herbicides are restricted because of crop safety concerns. However, even at these relatively low recommended rates the growth of resistant plants is severely affected and control can be achieved when combined with competitive crops (Walsh et al 2009). Thus, despite widespread resistance, phenoxy herbicides continue to be extensively used in the management of Australian wild radish populations. The introduction of Enlist traits would likely improve the control of resistant populations by allowing the use of more effective rates without concern for crop herbicide injury. If this were combined with other robust herbicide modes of action, like glufosinate or other biotechnology-enabled herbicides, the longevity and cross protection of the herbicide component of an overall integrated weed management system would be vastly improved. Thus the potential value of this technology for Australian growers should not be underestimated. **(5409)**

**Response:** APHIS also noted that in some weed populations in the US, resistance alleles to ALS herbicides were very widespread and that some species such as waterhemp had multiple resistance alleles to up to 5 herbicides. APHIS agrees with the commenter that despite the prevalence of herbicide resistant weeds, herbicides can remain an effective tool for weed control. APHIS acknowledges the comment about Harvest Weed Control Systems and has noted their successful use in Australia in the EIS. APHIS agrees with the comment that Enlist™ technology is likely to help and not hinder weed control in the future.

**165. Comment**: We have supported and utilized new technology on our farm for as long as I can remember. In recent years we have been making huge strides with all that has come available to us with things like GPS and Precision Farming and we are more accurate than ever at what we are doing. However we have been lacking in one area of technology for many years and that is new herbicides to use on our crops. With the release of Glyphosate (Roundup) tolerant crops our industry backed off of new technology leaving us short in the long run. Weeds have always adapted to herbicides used. However, with good management practices the resistant issues can be minimized. I know this from university studies and personal experience.

When Roundup came to market we knew from past experience with herbicide that if we used one herbicide over and over it would lose its effectiveness. So, to ensure that we would not have that problem on our farm we have always used multiple modes of action to control weeds. This forethought has successfully kept us from having issues on our farm. Today more than ever we need different herbicides and herbicide tolerant crops to address weeds that have adapted to older herbicides. Weed seeds are naturally transferred from field to field by animals and wind. So even though the herbicide resistant weeds may not come from my farm I will still have to address them when they move in. Technology can be very effective when managed properly, and I feel that today's farmers realize that. We are ready and willing to make sure we don't lose control of the very important aspect of farming that is weed control. With herbicide tolerant crops like Enlist we use less herbicide per acre than older technology and its safer for us and the environment.

I had an Enlist corn plot on my farm this year, and I feel very fortunate to have been selected to test and review new technology for agriculture. The Enlist corn performed just as I expected it to. It is not any harder to manage than any other crops or crop traits that we plant on our farm today. I have been asked about drift issues and I can tell you that the Colex D characteristic of the Enlist herbicide is like nothing I have ever seen. The "on target" placement of the herbicide is very impressive and it does not move. I field many questions and concerns about the "chemicals" that farmers are using. Many ask me, "Why can't we go back to the way it used to be?" My response is that going back is not in our best interest. It will be more detrimental to the environment and will reverse all the hard work farmers have put into the land to preserve it. Having herbicides to use on weeds is a direct link to preventing soil erosion. Without effective herbicides to use farmers are going to be forced back to physical soil cultivation to remove weeds which will cause erosion of the most valuable top soil. **(10153)**

**Response:** The analysis in the EIS is consistent with this comment.

**166. Comment**: Development of 2,4-D-tolerant soybean represents a novel solution to the postemergence control of glyphosate-resistant weeds. Over the past 4 years, I have first-hand observed the potential integration of 2,4-D into weed management systems for soybean. The 2,4-D-tolerant soybeans are highly tolerant to 2,4-D, and the herbicide results in effective control of the glyphosate-resistant weed species listed above, when applications are timely. The big question surrounding the adoption of this new technology is the risk for selection of 2,4-D-resistant weed species. Few 2,4-D-resistant weed species currently exist in the US, but are relegated to cropping systems where use of preemergence (residual) herbicides is minimized; namely cereal crops and pasture/rangeland. The pattern for selection of 2,4-D-resistant weed species is the same broken record we observe for selection of all herbicide-resistant weed species: continuous use of the same mode of action within and over years. I believe that adoption of 2,4-D-tolerant soybean technology will be different than adoptive practices of glyphosate-resistant soybean, and the potential for selection for 2,4-D-resistant weeds will be lower than for glyphosate. Below are my reasons to support the previous statement:

1) Initial use of glyphosate (before the Roundup-Ready® technology) was as a broadcast application on weeds and before crop planting (burndown). Growers were accustomed to using glyphosate on a range of weed sizes and increasing rates as weeds grew larger. Once glyphosate-resistant crops were introduced, growers took the burndown mentality and applied glyphosate to a range of weed sizes in-crop. With 2,4-D, it has been used as a burndown, but growers are also familiar with using 2,4-D in-crop for cereal grains and other grass crops (tall fescue, etc.). In-crop, growers know that weed size is important for using 2,4-D. I believe this same mentality can be transferred to postemergence use of 2,4-D on tolerant soybean.

2) In the initial years following adoption of glyphosate-resistant soybean, many growers reduced or abandoned the use of effective residual herbicides because of simplifying weed control practices and reduced cost of a total postemergence program. However, the burgeoning of crop acreage infested with glyphosate-resistant weeds has forced many growers to re-initiate use of residual herbicides. These herbicides are effective on glyphosate-resistant weeds. I believe that the current mind-set of soybean growers, especially in Missouri, is to apply labeled rates of residual herbicides in soybean, and clean up escape weeds with a timely postemergence herbicide. This is the pattern that was practiced before glyphosate-resistant soybeans were introduced, and I believe sets the stage for proper use of the 2,4-D-tolerant technology.

3) Current options for postemergence control of glyphosate-resistant weeds in soybean are limited. We have observed a dramatic increase in the use of PPO herbicides (lactofen, fomesafen, etc.). However, prior to the introduction of glyphosate-resistant soybean, a number of biotypes of waterhemp were found resistant to lactofen and fomesafen. Re-release of Liberty Link® soybean has resulted in effective control of glyphosate-resistant weeds in soybean. However, growers have few other options and my fear is that glufosinate-resistant weeds in soybean will occur. Now is the time to adopt the use of 2,4-D-tolerant soybean to preclude selection for weed resistance to glufosinate.

4) 2,4-D use postemergence in tolerant crops is most effective on small weeds (less than 4 inches). Dr. Steve Powles in Australia has clearly shown that use of an herbicide at a sub-lethal dose enhances the selection for herbicide resistance. 2,4-D use will be limited in amount (total applied per cropping year) and to specific weed sizes, which should reduce selection pressure for resistance.

5) Amaranthus species such as waterhemp and Palmer amaranth are often the major weed problem in Mid-west and Mid-south soybean fields. Research has shown that these species germinated over an extended part of the growing season, and emerged weeds can reach a size of 4 inches in as little as 2 weeks after emergence. Waterhemp and Palmer amaranth are greater problems today than at the time glyphosate-resistant crops were introduced. I believe increased grower knowledge about Amaranthus species will improve decision-making with 2,4-D-tolerant soybean, which will lower the risk for selection of resistant Amaranthus species.

6) The price of soybeans as a commodity has increased significantly the past 2-3 years. Farmers recognize this and want to implement weed control practices that minimize reductions in crop yield. Although reduction of production costs remains important, the higher commodity price for soybean has resulted in openness of the grower to adopt use of residual herbicides to protect soybean yield. Use of residual herbicides will be important for protecting the integrity of the 2,4-D-tolerant crop technology.

7) The size of farms today and number of acres farmed per person are dramatically greater today compared to the time glyphosate-resistant crops were released. That fact means that we cannot go back to labor-intensive practices of weed management in soybean, namely in-crop cultivation. I remember the muddy creeks and rivers in cultivated cropping systems, and we should not accept poor water quality in place of herbicide use. As a result, herbicide use cannot be reversed or abandoned for the majority of our soybean acres. Continued education on proper herbicide use is, in my opinion, the only path forward. 2,4-D-tolerant soybeans provides crop producers with a highly effective tool, and integration of 2,4-D should be in the context of proper use of residual herbicides. **(8196)**

**Response:** APHIS acknowledges the comment and has incorporated relevant information from the comment into the EIS.

**167. Comment**: With the characteristics of 2,4-D and the grower mind-set for using residual herbicides, I believe that approval of Enlist corn and soybean traits and Enlist Duo herbicide is prudent to the sustainability of protecting crops from broadleaf weeds. Weed management constantly changes with biological organisms (weeds) and available weed control tools. I would urge you to not limit a potentially significant management tool (2,4-D) because of fears that past mistakes will be repeated. The path forward should be an integrated approach to weed management in soybean. Denying this may result in reduced soybean yields in the near term. There are some that have expressed concern with approval of both dicamba-tolerant and 2,4-D-tolerant crops. The metabolism-based survival mechanism of corn and soybean is unique for each herbicide. Therefore, I do not feel that there is a danger for more rapid selection of broadleaf weeds with resistance to dicamba and 2,4-D by having both traits approved. Rather, there will be a decreased selection pressure for resistant weeds, because the development of resistance mechanisms must be different for each herbicide. Proper education and integration of Enlist corn and soybean traits and Enlist Duo herbicide is a key to the sustainability of these technologies. Finally, there are many concerned with the off-target movement of 2,4-D to sensitive crops and subsequent damage. While current formulations of 2,4-D demonstrate the propensity to move off-site when applied under unfavorable environmental conditions, the Enlist Duo herbicide is a different formulation. From my direct experience, I have observed that the Enlist Duo is more likely to remain in the site where applied, and volatility is much lower than current 2,4-D formulations. **(8196)**

**Response**: The analysis in the EIS is consistent with this comment.

## Water Quality

**168. Comment**: The section of the EIS on water quality related to 2,4-D use is extraordinarily brief considering the long list of well-documented problems associated with its presence. US EPA states 2,4-D can be "very highly toxic to slightly toxic to freshwater and marine invertebrates." The National Marine Fisheries Services issued a final biological opinion that concluded that registration of pesticides containing 2,4-D is likely to jeopardize the 28 endangered and threatened Pacific salmon species and to adversely modify the designated critical habitat of some of them. Given the predicted rise in use and the lack of proper enforcement of already weak stewardship requirements noted above, the USDA's approach is inadequate, including in relation to statutory requirements of the National Environmental Policy Act (NEPA). **(7706)**

**Response:** Pesticide impacts on aquatic organisms are outside the scope of this EIS. EPA considers the impacts of pesticides on aquatic organisms in its Environmental Risk Assessment (US-EPA, 2013c).

**169. Comment**: APHIS has failed to sufficiently explain the effects the Preferred Alternative will have on water quality. APHIS asserts that the Preferred Action Alternative will benefit water quality because under the No Action Alternative, "increased tillage to manage glyphosate-resistant weeds may occur and lead to decreases in water quality from sedimentation," while under the Preferred Alternative, the need for tilling may be reduced. DEIS at 144. However, APHIS also admits in the same paragraph that "[i]n the long term, selection of 2,4-D-resistant weeds may result in similar aggressive tillage practices that are expected to occur under the No Action Alternative and negate the benefits [of preserving gains in conservation tillage in the short term]." DEIS at 144–45. Stated differently, over time there is no benefit in the Preferred Alternative over the No Action Alternative. APHIS must explain both how it can square such contradictory statements, and what the effects the Preferred Alternative will have on water quality. **(8097)**

**Response**: APHIS explains in the EIS that the benefits of the Preferred Alternative are dependent on the extent to which growers adopt best practices. If most growers follow best practices, the benefits are expected to last for one or more decades. APHIS acknowledges there may be a time when tillage under the Preferred Alternative is comparable in frequency to the No Action Alternative.

**170. Comment**: Agricultural activities are the largest cause of nonpoint source pollution. David Zaring, *Agriculture, Nonpoint Source Pollution, and Regulatory Control: The Clean Water Act's Bleak Present and Future*, 20 Harv. Envtl. L. Rev. 515, 515 (1996). Sixty-five to seventy-five percent of America's most polluted waters are polluted by nonpoint sources. These waters include groundwater, which makes up a large portion of American drinking water, polluted by the pesticides, herbicides, and manure from agriculture, which includes carcinogens like nitrates. The purpose of the Clean Water Act is to restore and maintain the waters of the United States. An EIS is required to address all reasonably foreseeable environmental impacts of proposed actions. 40 C.F.R. § 1508.25(a)(3). Yet the only section of APHIS' DEIS that addresses the Clean Water Act (CWA) is the single paragraph that comprises Section 8.3. This section should adequately explain how the CWA applies to this action, as well as what protections or controls are in place to ensure compliance with the substantive standards of the CWA. Ultimately, the purpose of NEPA is to provide the public with information and to provide the public with a meaningful opportunity to comment. *Methow Valley* at 349. However, this DEIS does not include any meaningful information regarding water quality standards, data, or even how the CWA applies in the context of this proposed deregulation. Section 8.3 of the DEIS simply notes that the deregulation of the Enlist DuoTM crops will not have an impact on "water usage." 163. However, APHIS seems to have confused the water quality issues addressed under the CWA with general issues of water quantity. This statement from APHIS does nothing to assure the public that CWA standards will not be violated. Information such as the applicable technology-based standards and water-quality based standards should be readily available in the DEIS, along with an analysis of how these standards will be adhered to, and therefore whether there will be adequate protection of the waters of the United States.

Section 303(d) of the CWA requires states to make a list of impaired waters that are below the water quality standards the states set, establish priority rankings and establish total maximum daily loads for these waters. 33 U.S.C. § 1313(d). This means the lists and standards may vary from state to state. It is the duty of APHIS, not the public, to find out which water bodies are impaired, therefore this information should be included in the DEIS along with an explanation of how these impaired waters will be adequately protected. CEQ regulations in 40 C.F.R. § 122.44(d) require permit issuers to find out if an applicant's discharge will contribute to a violation. If so, then EPA must include conditions ensuring compliance in their permit, and if compliance cannot be insured, then the permit will not be issued. This analysis is lacking from the DEIS as well.

Section 208 of the Clean Water Act contains the statute's planning provision that is applicable to agricultural nonpoint source pollution. It was created to be mostly voluntary by the states, and then later amended to give financial incentives to decrease pollution. Zaring at 522. Little progress has been made since its enactment, however, as farmers have few incentives to participate in voluntary programs to reduce pollution. And absent federal control, continued high agricultural nonpoint source pollution levels reflect that state regulation on a voluntary basis has proven to be ineffective. Jan G. Laitos & Heidi Ruckriegle, *The Clean Water Act and the Challenge of Agricultural Pollution*, 37 Vt. L. Rev. 1033, 1040. APHIS has failed to analyze the impacts that the increased use of 2,4-D will have on the environment in light of this patchwork of ineffective nonpoint source regulation. **(8097)**

**Response**: APHIS does not agree that it is necessary to identify every impaired water body in the United States as the commenter suggests. The baseline for this EIS is the status quo of American agriculture. APHIS does not expect the adoption of Enlist™ corn and soybean to adversely impact water bodies compared to the status quo.

## Biodiversity

**171. Comment**: APHIS relies on a few industry-associated reviews instead of the large body of independent, peer reviewed primary studies and reviews that are available on impacts of agricultural practices on biodiversity, so does not base its assessment on sound science. For example, there are many recent reviews and studies of impacts to biodiversity of organic agriculture compared with other agricultural regimes (e.g., Andersson et al. 2012, Blaauw and Isaacs 2012, Gaba et al. 2013, Gabriel and Tscharntke 2007, Hyvonen and Huuselaveistola 2008, Kennedy et al. 2013, Kremen and Miles 2012, Lynch 2012, Morandin and Winston 2005, Nicholls and Altieri 2012, Power et al. 2012, de Snoo et al. 2013, Tuck et al. 2014). **(8081)**

**Response:** APHIS reviewed the articles noted by the commenter and found them to be outside the scope of the EIS. These articles compare organic agriculture to conventional agriculture and generally conclude that organic agriculture promotes biodiversity to a greater extent than conventional agriculture. While this may be true, it is not relevant because the desirability of one farming system over another is outside the scope of the EIS. Organic corn and soybean represent approximately 0.2% of the corn and soybean grown in the U.S. ((USDA-ERS, 2011; USDA-NASS, 2014a) while 90% of corn and 93% of soybean are GE (USDA-ERS, 2013a). These percentages are not expected to change under any of the alternatives. Therefore no changes in biodiversity from organic production are expected under any of the alternatives.

**172. Comment**: In addition, APHIS skirts the impacts of the specific herbicides that will be used on Enlist crops, saying that herbicide use cannot be predicted: “Herbicide use in agricultural fields can impact biodiversity by decreasing weed quantities or causing a shift in weed species. This can affect insects, birds, and mammals that use these weeds. The quantity and type of herbicide use associated with conventional and GE crops depends on many variables, including cropping systems, type and abundance of weeds, production practices, and individual grower decisions.” (EIS at 143) Elsewhere, APHIS does predict that 2,4-D use will increase dramatically with adoption of Enlist corn and soybeans. Impacts of this APHIS approval-associated increase in the specific herbicide 2,4-D, and the other herbicides Enlist corn and soybeans were engineered to withstand, must be assessed, rather than waved away by claims that quantity and type of herbicides used are too variable to predict. **(8081)**

**Response**: The commenter seems to be asserting that APHIS is contradicting itself by stating that on the one hand it predicts that 2,4-D use will increase but on the other hand, it cannot predict the impacts because the quantity and type of herbicide use associated with conventional and GE crops depends on many variables. This comment is misleading because it has excerpted the second quotation out of context. The second quotation is from a discussion of factors that impact biodiversity. The point of the discussion is that "habitat loss is the greatest direct impact agriculture has on diversity" and that habitat loss can occur through the use of herbicides, tillage, and from land conversions to agriculture. Although 2,4-D use is predicted to increase under the Preferred Alternative, tillage is predicted to increase under the No Action Alternative. Furthermore, because weed control is expected to be better under the Preferred Alternative, yields are expected to be better under the Preferred Alternative, too, and this is expected to decrease the pressure for land conversion to agriculture. There are many management choices that affect farm level biodiversity in opposing ways and, as a result, APHIS concluded that the magnitude of this impact on biodiversity is uncertain, even if an increase of 2,4-D is reasonably foreseeable under the Preferred Alternative..

Herbicide impacts on resident species are outside the scope of this EIS. They have been assessed by EPA in its Environmental Risk Assessment(US-EPA, 2013c).

## Threatened and Endangered Species

**173. Comment:** The fact that whooping cranes eat young corn plants means that the birds may be present in fields shortly after over-the-top herbicide applications are made to Enlist corn. The 2,4-D residues and metabolites in newly-sprayed seedling corn have not been reported by Dow in its residue and metabolite studies, nor have Enlist corn seedlings been examined for other compositional differences, so APHIS cannot claim that food and feed studies show lack of risk to listed species. In assessing potential effects of Enlist corn and soybeans on endangered plants, and on critical habitat that is composed of particular vegetation, APHIS does not consider impacts of herbicide use with Enlist corn and soybeans at all (EIS at 153, 156). However, in Appendix 8, APHIS provides information from EPA Environmental Fate and Effects Division showing that nonlisted plants are at potential risk from direct effects of drift and runoff of 2,4-D choline use on Enlist corn and soybeans (EIS Appendix at 8-10). Some non-listed animals are also at risk from direct effects of exposure to 2,4-D choline, and "…all non-listed taxa [are identified] as potentially at indirect risks from the proposed uses of 2,4-D choline salt because of potential dependencies (e.g., food, shelter, habitat) on species that are directly affected." (EIS Appendix at 8-10)

Listed species identified as being at potential risk from 2,4-D choline applications to Enlist corn and soybeans are also being assessed by EPA (EIS Appendix at 8-10). Enlist corn and soybeans are genetically engineered for resistance to herbicides in addition to glyphosate and 2,4-D, and use of these other herbicides with Enlist corn and soybeans must be analyzed for harm to listed species: •Enlist corn is resistant to quizalofop in addition to 2,4-D, and APHIS provides information on EPA's screening level ecological risk assessment for listed and non-listed species for the proposed label for quizalofop in Appendix 8 (EIS Appendix at 8-18). There are possible direct effects to various animals and plants, and also the potential for habitat modifications for all listed taxa. Enlist soybeans are also resistant to glufosinate, and APHIS expects glufosinate to be used as it is on other glufosinate resistant soybean events (Liberty Link soybeans) (EIS Appendix at 8-20). CFS discusses potential risks to various taxa of glufosinate as it will be used with Enlist soybeans in relation to beneficial organisms, above. APHIS cannot rely on EPA to analyze the foreseeable impacts of use of quizalofop and glufosinate on Enlist corn and soybeans, but must itself analyze impacts of these herbicides to listed species, as for use of 2,4-D with Enlist corn and soybeans. Given this preview from EPA, it is clear that some listed species will be at risk from the approval action by APHIS of Enlist corn and soybeans, and that APHIS cannot improperly delegate responsibility for these potential harms of its action. **(8081)**

**Response:** APHIS disagrees with the comment. EPA, not APHIS, considers the impacts of herbicide use on Threatened and Endangered Species. APHIS revised the FEIS to conclude that "Considering the compositional similarity between DAS-40278-9 corn and other varieties currently grown and the lack of toxicity and allergenicity of the AAD-1 protein, APHIS has concluded that exposure and consumption of DAS-40278-9 corn grain would have no effect on threatened or endangered animal species".

**174. Comment**: An organism may pose a plant pest risk through differences affecting "agricultural or cultivation practices" or through effects on "nontarget organisms," both of which APHIS has insufficiently analyzed under the DEIS. 7 C.F.R. 340(c)(4). First, APHIS must consider the differences in agricultural practices—in particular, whether or not pesticides are applied. EPA has oversight over which pesticides or herbicides are available for use, and in what quantity they may be applied. However, APHIS retains responsibility for differentiating genetically modified organisms from their conventional counterparts, including the common agricultural practices implemented with either crop. Here, APHIS has a duty to analyze deregulation of Enlist DuoTM herbicide resistant corn and soybeans while appropriately considering the reasonable expectation of the use of the pesticide 2,4-D. Second, APHIS needs to consider effects on nontarget organisms, including listed species under the Endangered Species Act (ESA), such as Pacific salmon. Given the failure to consider pesticide use commonly associated with these crops as a factor in the plant pest analysis, the analysis of these crops based solely on whether the crop consumption would pose a threat to threatened and endangered species is incomplete. DEIS at 153, 156. U.S. Fish & Wildlife Service (USFWS) and APHIS mistakenly agreed that APHIS need not perform an ESA effects analysis on herbicide use associated with GE crops currently planted. DEIS at 150. While APHIS may defer to an existing ESA analysis by USFWS or EPA, it does not have the authority to escape its obligation under the ESA through forming a private agreement with USFWS.

APHIS cannot deregulate these crops without performing a full and complete analysis of the potential impacts of all the implicated risks of deregulation including the increased prevalence of common agricultural practices such as pesticide use and the possible impacts on threatened and endangered species from such pesticide use. **(8097)**

**Response**: APHIS disagrees with the commenter's inteprertation of our regulations. Since APHIS has no discretion over pesticide use and therefore has not analyzed pesticide impacts to Threatened and Endangered species under the ESA, pesticide issues are outside the scope of the EIS.

## Advocacy for sustainable/organic farming

**175. Comment**: USDA states in its draft Environmental Impact Statement that it "must" approve new herbicide resistant seeds if they are found to pose no "plant pest risk" regardless of the impact of the expected increase in the herbicides that will accompany the planting of these seeds, but farmers are seeing the failures of genetically modified organisms (GMO) while consumers in the United States, the European Union and Asia are demanding non-GMO and organic foods. USDA should reject petitions for Dow's 2,4-D-resistant seeds to protect farmer livelihoods, human and environmental health and market opportunities for all farmers. Instead of supporting technologies that rely on harmful drift-prone chemicals, USDA should devote more attention to research, development and extension of seed bred for low-input systems that are adapted to diverse regions, ecologies, climates, and markets. **(9705)**

**Response**: The issues noted by the commenter are outside the scope of the EIS.

**176. Comment**: American agriculture stands at a crossroads. One path leads to more intensive use of old and toxic pesticides, litigious disputes in farm country over drift-related crop injury, still less crop diversity, increasingly intractable weeds, and sharply rising farmer production costs. This is the path American agriculture will take with approval of Dow's 2,4-D corn, soybeans and the host of other new herbicide-resistant (HR) crops in the pipeline. Another path is possible, but embarking upon it will take enlightened leadership from USDA. Agricultural biotechnology firms have long promised less dependence on toxic pesticides. Instead, hundreds of millions of dollars are being invested to engineer crops for resistance to multiple herbicides. Herbicides represent two-thirds of overall pesticide use in American agriculture, and two-thirds of genetically engineered (GE) crops pending deregulation by USDA are herbicide-resistant, including Monsanto's dicamba-resistant crops. Dow officer John Jachetta welcomes these new crops as inaugurating "a new era" and "a very significant opportunity" for chemical companies. **(6905-007)**

**Response:** The issue of whether herbicides should not be used in American agriculture is outside the scope of the EIS.

**177. Comment**: We are at a critical juncture. More herbicide resistant crop and matching herbicide input packages or working on ways that herbicides and other cultural, biological and mechanical practices can be adopted. Not seizing this opportunity to more fully integrate the method of weed management now will lock us into an ever accelerating “transgene facilitated herbicide treadmill” (Mortensen et al. 2012). I am deeply concerned that with deregulation of these Dow herbicide resistant crop traits we ratchet up herbicide use while at the same time increasing farmer dependence on herbicidal weed control and undermining the chances of seeing integrated practices adopted. It is clear that the authors of the USDA APHIS EIS recognize that risk of losing the chance for the adoption of a more integrated means of management]

[Clearly, it’s critical that we work together to identify a path forward that incentivizes (rather than creating barriers as elements of the Farm Bill does) the adoption of more sustainable and more diverse integrated methods of management] **(9938).**

**Response**: APHIS agrees that offering incentives to growers to adopt sustainable farm practices is a noble endeavor. This commenter and many others seem to imply that APHIS should deny the petition to deregulate Enlist™ corn and soybean so that growers will be forced away from the use of herbicides for weed control. APHIS does not have the authority to deny a petition on this basis.

**178. Comment**: The collateral damages associated with the escalating chemical warfare on herbicide resistant weeds include the loss of financial security, community and social capital, ecological health, and human-health; this is unacceptable. There are alternatives to this intensification of the chemical warfare on herbicide tolerant weeds. To “Enlist” is not the only option! Organic and sustainable farmers are demonstrating viable alternatives that focus on increasing, not decreasing, biodiversity. Methods include: effective crop rotations, alternating cool and warm season crops, the use of cover crops and mulches, utilizing the natural weed-suppressive crops and crop varieties, and judicious, low-tillage methods. These methods are proven, sustainable weed control strategies. Deregulating 2,4-D resistant crops would be a failure to “promote agriculture production sustainability that better nourishes Americans” and a failure to “preserve and conserve our Nation's natural resources,” and “healthy private working lands.” **(8059)**

**Response:** The option to limit farmer choice to use Enlist™ technology in favor of promoting organic agriculture is outside the scope of this EIS. The USDA through the the Natural Resources Conservation Service currently offers farmers incentives to pursue cover cropping through two programs: the Conservation Security Program and the Environmental Quality Incentives Program (Robinson, 2011; 2013).

**179. Comment**: We note with considerable interest the findings of the recent study by Heinemann showing that Western European non-GM agriculture outperforms North American GM production in terms of both higher yield and lower chemical use. Heinemann himself said of the study:” We analysed yield data in corn/maize, rape/canola and wheat, crops that are grown in both regions at large scales. Our findings were consistent for all three crops. Over the 50-year period we found that the ‘biotechnology package’ (which includes options in germplasm improvement and management approaches) that comes from the Western European innovation strategies in agriculture result in higher yields than those achieved in North America. The robust trends indicate that this will continue. Yield improvement was not due to higher pesticide use because countries such as France have used comparatively less of both herbicides and insecticides per area under production than countries such as the US. “An obvious difference between the two regions is that the North American innovation strategy was compatible with a switch from conventional to genetically modified (GM) crops adopted in the mid 1990s. Western Europe has and continues to raise yields and reduce the use of pesticides without GM.” The Agapito-Tenfen study also found that conventional maize is more stable, or has less variability, than GM varieties in different environments. The differences in performance are another demonstration of the failure of substantial equivalence to fully describe the nature of these crops. **(7680)**

**Response**: American farmers are free to choose their system of farming. A comparison of the merits of organic, biotech, and conventional farming is outside the scope of this EIS.

**180. Comment**: Organic agriculture offers a viable, scalable path towards a future without chemical tainted communities, fields, foods, farmworkers, air, streams, and groundwater. A 13-year Iowa State University Study released in 2011 found organic production returns about $200 per acre more than conventional agriculture, and produced comparable yields and healthier soils. A 2012 report from the American Academy of Pediatrics found that organic food provides distinct health benefits by way of reducing exposure to pesticides, especially children. **(8481)**

**Response:** American farmers are free to choose their system of farming. A comparison of the merits of organic, biotech, and conventional farming is outside the scope of this EIS.

**181. Comment:** USDA should reject proposals to regulate 2, 4-D resistant crops and instead use the agency’s authority to reduce – not expand – the use of herbicides. **(10162)**

**Response:** APHIS has no authority to regulate the use of pesticides.

**182. Comment:** Provided the lessons learned with RR crops, USDA should not deregulate the next generation of GE traits that confer tolerance to even more toxic herbicides that behave in even more dangerous ways. 2,4-D already causes costly damage for farmers who grow a variety of at-risk crops. USDA has the authority to discourage a path for American agriculture that is unsustainable, unhealthy, and shortsighted. USDA has the authority to discourage the increased exposure of more farmers and farm workers, and their communities and customers, to higher concentrations of herbicides. USDA has the authority to discourage further concentration of market power and ownership of plant genetics. Yet past decisions – USDA has deregulated more than 100 GE traits – gives us little hope that the agency will encourage a different path. We deserve better for our health and environment. Instead of supporting products that rely on harmful chemicals, USDA must devote more attention and resources to research, development, and Extension focused on safe and smart 21st century ecological approaches to weed management. We also need much more attention and resources devoted to the development of public seed varieties for low-input production systems – varieties that are adapted to diverse regions, ecologies, climates, and markets **(9716).**

**Response:** APHIS does not have the authority to regulate herbicide use. USDA policy to discourage concentration of market power, funding of agroecological approaches to weed management, funding of public seed varieties for low input production systems, are topics outside the scope of this EIS.

**183. Comment:** CCOF believes that regulatory action that promotes more herbicide use is poor policy that contributes to an ongoing herbicide treadmill. It is not sufficient for APHIS to claim that, since EPA has regulatory authority over herbicides, APHIS is unable to take into consideration greatly increased applications of a volatile herbicide that could pose significant risks to non-target crops and native vegetation. APHIS has authority to regulate GM crops to ensure they do not end up posing a plant risk. We urge APHIS to use this authority to ensure that any GM crops approved for commercial production do not amplify risks of herbicide drift or genetic pollution of non-GM crops, non-target vegetation, and seed stocks.

Organic producers have developed sophisticated cropping systems that produce good yields of high quality crops without the use of synthetic pesticides or transgene technology. Instead, they rely on integrated systems of mechanical cultivation, crop rotation, and cover cropping to control weeds. The synthetic pesticides utilized by GM crop technology packages and the GM technology itself are both prohibited in certified organic production. Organic farmers experience pesticide and transgene drift as contamination of their crops, causing economic losses and forcing them to take protective measures each growing season, which also cost valuable time and money. APHIS has the potential to reduce the unintended plant pest consequences of GM crops by ensuring that new releases are regulated in a meaningful way. We request that APHIS select Alternative 1, the No Action Alternative, and that these three petitioned crops continue to be regulated by APHIS "to ensure physical and reproductive confinement," to avoid and mitigate the damage posed by uncontrolled production of these crops. **(10152)**

**Response:** APHIS does not regulate pesticide use or make regulatory decisions based on pesticide use. Pesticide use is not a plant pest risk. American farmers are free to choose their system of farming.

**184. Comment:** We are farmers from the agricultural production states of Indiana, Illinois, Arkansas, Kentucky, Minnesota, Michigan, Missouri, Nebraska, and Ohio, who traveled from our own fields to Washington, D.C. on July 16 -17, 2013, and from July 10-12, 2012. We made the trip to represent agriculture and the needs of modern agriculture in front of the USDA, EPA, and Congressional and Senate offices to create awareness of the unnecessary delays in our herbicide and herbicide-tolerant trait regulatory processes that are currently in effect.

In these meetings, we expressed our concern about growing weed resistance issues that lead to crop loss, as well as United States agriculture losing its competitive advantage over other countries such as Canada and Brazil, which have already, or are in the process of approving these innovative technologies.

The delays in the regulatory process have not subsided since our visits, and in fact, throughout the entire regulatory review process, weed resistance has continued to increase. Our situations are not unique. We know farmers across the country are facing the same problem now, and those who are not may be soon unless you approve the new technologies we need.

We recognize that some advocate we switch to alternative practices. Some of these practices do have merit, but many are either not sustainable (such as hand weeding) or not economically viable today and probably will not be for many years, if ever. Technologies such as Enlist are here today. They are proven effective and will allow us to maintain an economically sustainable operation. This is a tool that can be safely and easily implemented as part of our diverse weed management strategies to control the current resistance problems and reduce the chance of further resistance developing.

These technologies will also provide us the opportunity to continue to move forward and provide the safe and abundant food supply that this country and the world ask us to produce, and to do so using environmentally friendly practices that allow us to continue the conservation practices we value in modern production agriculture, which protect our vital soil and water resources. **(10022)**

**Response:** APHIS acknowledges the comment.

**185. Comment**: Herbicide resistance is a major threat to food production. Herbicides are the most efficient and environmentally benign way to control weeds in crop production systems. Cultivation is highly damaging to soil structure, leading to water and wind erosion as well as increased carbon dioxide emissions; whereas hand weeding is highly inefficient and entrenches poverty in rural populations. Herbicide resistance is the inevitable result of relying on one or a small number of herbicides for weed control. To create a more robust system greater diversity in herbicide use and the incorporation of other tactics is required. **(6793)**

**Response**: The analysis in the EIS is consistent with this comment.

**186. Comment**: I am writing to respond to the USDA APHIS Environmental Impact Assessment that compared a number of scenarios evaluating the benefits (weedy plant suppression) and risks of transformed crop plants becoming a pest or creating pests through the deployment of Dow's stacked herbicide resistant corn and soybean. A great deal of the report is dedicated to an in-depth analysis of cropping regions around the country where these crops will be deployed if deregulated. The scenarios are shallow and biased in favor of deregulation. The scenarios assume weed control is very good when the new Dow traits are adopted and poor when that's not the case. The report largely ignores significant changes underway in farming where a growing number of medium to large sized farmers are expressing greater interest in practices like cover cropping. A GREAT travesty will be done to our nation's infrastructure and farming practices if this deregulation goes forward. That travesty is the opportunity cost lost when the next wave of herbicide resistant crop technology is marketed and adopted (Mortensen et al. 2012). The report so much as states this in the paragraph highlighted below under "Opportunity Cost Lost". I've highlighted the sections that are particularly disturbing to me. Imagine, a scenario (not deregulating the Dow traits) where farmers would use more practices that deliver on multiple ecosystem services, now imagine farmers adopting practices that are being aggressively promoted by the Natural Resource Conservation Service. However, the report concludes we don't need to go down that road, rather, according to the EIS, we fall back to higher herbicide use instead. That is what the report is saying, endorsing, and frankly I'm shocked and disappointed**. (9938)**

**Response:** The EIS has not ignored alternative practices such as cover cropping. American farmers have not been adopting this practice. See comment #3 and #17. The USDA through the the Natural Resources Conservation Service currently offers farmers incentives to pursue cover cropping through two programs: the Conservation Security Program and the Environmental Quality Incentives Program (Robinson, 2011; 2013).. American farmers are free to choose such incentives.

**187. Comment**: In sum, we find USDA's EIS to be lacking in rigor and scientific integrity in many critical dimensions. While hundreds of pages were filled with long descriptions of agricultural production, the EIS fails to hone in on the most critical questions at hand and to identify, explore and assess scenarios and options for action that include stepping off the pesticide treadmill and shifting U.S. agriculture towards 21st century ecologically resilient practices. We are deeply disappointed to observe throughout the EIS a great dedication to carefully circumscribing the agency's responsibility to as narrow a realm as possible (consideration of the "plant pest risk"), so as to evade its broader mandate and responsibility to protect and support the public interest and the long-term viability and sustainability of our food and farming system. This head-in-the-sands approach instead ensures what appears to be the agency's desired outcome from the get-go: a decision to approve Dow's 2,4-D corn and seed varieties. A thorough revision is required. Joining the over 400,000 other farmers, farmworkers, health professionals, scientists and concerned individuals who have voiced their concerns about Dow's 2,4-D seeds today, PAN urges USDA to reject Dow's request for deregulation of its 2,4-D-resistant corn and soybean varieties. **(10203)**

**Response:** The types of issues the commenter feels lacking from the EIS, "to identify, explore, and assess scenarios and options for action that include stepping off the pesticide treadmill and shifting US agriculture towards 21$^{st}$ century ecologically resilient practices", are outside the scope of the EIS. See response to comment #186.

**188. Comment:** Sustainable farming systems are "capable of maintaining their productivity and usefulness to society indefinitely. Such systems must be resource-conserving, socially supportive, commercially competitive, and environmentally sound." By these measures, U.S. agriculture is becoming progressively less sustainable, and genetically engineered, herbicide- resistant crops have contributed substantially to this deteriorating trend.

**Response:** APHIS acknowledges the comment. The desirability of one farming system over another is outside the scope of the EIS.

**189. Comment:** "Socially supportive" farming systems must provide a decent income and employment for farm families, a prerequisite to healthy rural communities. Technologies that facilitate increasing scale of production through reducing labor needs have been the rule in U.S. agriculture for at least a century. They have been a major factor leading to continual consolidation of farmland in ever fewer hands, accompanied by the exit of small and mid-size producers from farming (MacDonald et al 2013) and the decline of rural communities. Many now believe it is time to switch course, and implement agricultural systems such as organic farming that do a better job of providing employment rather than saving labor.

**Response**: This comment is outside the scope of the EIS. See response to comment #186.

**190. Comment**: Weed control has traditionally been one of the more labor-intensive tasks in farming. Roundup Ready (RR) soybeans have been estimated to reduce labor needs for weed control by 15% (EIS at 75). USDA economists agree that: "HT [herbicide-tolerant] seeds reduce labor requirements per acre" (MacDonald et al 2013, p. 28). APHIS regards this as a "benefit" of RR crops, in that it frees up time for off-farm employment (EIS at 75). However, it is unclear whether working two jobs rather than one is a benefit, since it may be an undesired consequence of insufficient income from farming. In any case, farmers may choose to employ their "saved labor" in other ways that APHIS fails to consider. For instance, RR crop growers may seek to farm more acres rather than seek off-farm employment, bidding up prices for land (including leases). Larger growers are generally in a better position to absorb these added costs, and so outcompete small and medium-size growers, who are thereby put at a competitive disadvantage and potentially put out of business. As USDA economists have concluded: "GE seeds may partly explain increased consolidation among field crop farmers since 1995" (MacDonald et al 2013, p. 27). APHIS has failed to assess the negative socioeconomic impacts of RR crops, and the potential for similarly adverse impacts of the Enlist crop systems designed to partially replace them. **(10202)**

**Response:** As the commenter noted, APHIS does consider reduced labor requirements from growing herbicide resistant crops a benefit because the overwhelming number of growers who have commented on herbicide resistant crops noted it as such. Growers also commented on benefits from the ease of management and greater flexibility. The harm to small farmers attributed to GE seeds favoring large farmers is still uncertain. The same reference cited by the commenter states, "Genetically engineered seeds were commercially introduced in 1995, so they cannot account for changes in farm size before that time, and so far they have been used primarily in corn, cotton, and soybeans, so they cannot account for the ubiquitous increase in farm size among many crops." (MacDonald *et al.*, 2013). Even if it were true to partly explain the increase in farm size, because the use of GE crops is not expected to change between the No Action and Preferred Alternatives, no impact on the consolidation process is expected under the Preferred Alternative.

## Cumulative impacts

**191. Comment**: APHIS states that, "No cumulative impacts are expected on organic growers because these growers do not use herbicides such as 2,4-D for weed control." This is somewhat misleading as cumulative impacts from 2,4-D drift and the economic costs of genetic drift are also experienced by organic/non-GE farmers. Additionally, nonorganic, non-GE farmers also experience the economic costs of controlling resistant weeds. While the agency believes that this new formulation of 2,4-D (EnlistTM) is 50 times less volatile than other 2,4-D formulations, without the completed EPA assessment, it is inappropriate for APHIS to underestimate the impact of 2,4-D drift **(9822)**

**Response:** EPA has concluded that the new formulation of 2,4-D is less subject to drift (US-EPA, 2014b). Genetic drift is expected to be the same between the No Action and Action Alternatives because the percentage of GE corn and soybean is not expected to differ under the various alternatives. APHIS has analyzed the socioeconomic impacts to conventional farmers for controlling 2,4-D resistant weeds in the cumulative impacts chapter.

**192. Comment**: [APHIS] emphasized that resistance to 2,4-D resulting from widespread 2,4-D usage in Enlist corn or soybean could adversely impact weed management in other crops, such as small grains or pastures. While that is true, the impact is likely less than the EIS would lead a casual reader to conclude. While there are a few exceptions, such as horseweed (*Conyza*), one needs to understand that the common weeds in small grains and pastures are seldom the same species as in corn and soybean, and vice versa. Auxin-resistant weeds could impact grain sorghum producers. A combination of atrazine and a chloroacetamide is the most commonly used program in sorghum. I have already mentioned the selection pressure on these herbicides from widespread usage in other crops. One could argue that Enlist technology could indirectly help preserve chloroacetamides and triazines for use in sorghum. **(3217)**

**Response:** APHIS acknowledges the comment. APHIS considered this point but was unable to rule out the possibility that a weed shift might occur under selection pressure from the herbicide.

**193. Comment**: The assumptions underpinning APHIS' analysis of cumulative impacts are flawed. For example, APHIS assumes that *all* pesticide applications will be made following label instructions. DEIS p. 119. This assumption vastly misstates how pesticides are used in the real world. For example, the California Department of Pesticide Regulation ("CDPR") found during the course of its inspections that, even when over 95% of the requirements of pesticide permits, of pesticide labels, and for personal protective equipment were met, thousands of violations still occurred. *See* California Pesticide Use Enforcement Statistical Profile, September 2012, p. 5.5 Even when over 80% of inspections found no violations, the CDPR noted between 1,723 and 1,850 inspections with violations from calendar year 2009 through 2011. *Id.* In Nebraska, for federal fiscal year 2013, over 20% (11 of 54) of agricultural use monitoring inspections were non-compliant; and "[v]iolations included use of a pesticide inconsistent with the label, wind drift, improper wellhead or surface water setback, unlicensed applicator, lack of notification to field workers, and lack of information exchange to field worker employers." Nebraska Department of Agriculture, Pesticide and Noxious Weed Newsletter, Winter 2013-2014, p. 2.6 Thus, APHIS' assumption that *all* pesticide labeling will be followed all the time is naive at best. Any analysis of harms or risk that fails to account for these well-documented levels of non-compliance is incomplete.

Relatedly, APHIS' assumption that "all drift from 2,4-D and other pesticide applications will be mitigated to an acceptable level by the registration requirements established by the EPA" fails to account for the manner in which farming practices have outpaced the EPA's regulatory scheme. As the Nebraska Department of Agriculture's Pesticide and Noxious Weed Newsletter discusses, the existing regulatory scheme was designed for "much smaller equipment" and often does not mesh with the larger pesticide application technology available today; thus drift is often a cause of compliance complaints. Nebraska Department of Agriculture, Pesticide and Noxious Weed Newsletter, Winter 2013-2014, p. 1. For this reason, the Nebraska Department of Agriculture "expects to see more changes to drift label language" as the EPA works to revise label language to match new rules. *Id.* APHIS' assumption that drift can be mitigated by existing labeling considerations is unfounded.

In addition, APHIS assumes that all farms growing 2,4-D resistant corn and soybean varietals will always do so under stewardship agreements with DAS, and that such agreements will "stipulate" that farmers will use DAS' new Enlist Duo™ pesticide as the only 2,4-D treatment for these crops. DEIS p. 119. This assumption ignores the likely evolution of the 2,4- D resistant marketplace: If APHIS approves the proposed action, more pesticide producers will apply to the EPA for labeling changes to allow for 2,4-D applications consistent with the timing discussed in DEIS Appendix 8, pages 8-5 to 8-9. Thus, APHIS' assumption unreasonably narrows the conditions under which pesticide application may actually occur. And while APHIS admits that any deregulated 2,4-D resistant crops "could be crossed with any currently available variety including [genetically engineered] varieties no longer regulated by APHIS" (DEIS p.119), APHIS ignores the potential impacts of such hybridization, and the related pesticide uses that could arise. For all these reasons, APHIS' discussion of the cumulative impacts of the proposed action is deficient and violates NEPA. **(10158)**

**Response:** APHIS has no discretion to regulate pesticides. EPA and not APHIS regulates pesticide use. APHIS did not analyze harms from drift in the cumulative impacts section. APHIS limited its analysis in the cumulative impacts to the socioeconomic impacts from the selection of 2,4-D resistant weeds.

APHIS disagrees that the assumptions made in the cumulative impacts section are flawed. The commenter inaccurately noted that APHIS claimed that *all* pesticide applications will be made following label instructions. The DEIS originally stated the assumption as "pesticide applications will be made following label instructions" (DEIS p. 119). APHIS has revised the assumption in the FEIS to read as "most pesticide applications will be made following label instructions." This assumption is consistent with the California Department of Pesticide Regulation (CDPR) data cited by the commenter which indicates that for the years 2009-2011, approximately 87% of all inspections had 100% compliance (California Department of Pesticide Regulation, 2012) and the Nebraska Department of Agriculture which found that approximately 80% of inspections were fully compliant (Nebraska Department of Agriculture, 2013-2014). The CDPR inspections note 15 compliance elements, one of which was "following labeling and permit conditions". The compliance rate just for following labeling and permit conditions over the three year period was 97.7% in over 63,000 instances (California Department of Pesticide Regulation, 2012).

APHIS disagrees with the commenter's assertion that farming practices have outpaced EPA's regulatory scheme and as a consequence the assumption that drift from 2,4-D applications will be mitigated to an acceptable level by the EPA registration requirements is unfounded. The commenter supports his idea with a quote from the Nebraska Department of Agriculture, "NDA expects to see many more changes in drift label language, as the Environmental Protection Agency's (EPA's) Drift Reduction Technology initiative takes hold and pesticide labels are revised to match the new rules" (Nebraska Department of Agriculture, 2013-2014). This quote refers to a revision of pesticide labels that have already been issued. In the case of Enlist Duo™, the pesticide label has never been issued. When it is issued, it will reflect the latest rules of the EPA Drift Reduction Technology Initiative. The commenter's assertion that farming practices have outpaced EPA's regulatory scheme is without merit.

APHIS acknowledges in the EIS that there may be crop damage and environmental harm from off target pesticide movement. APHIS analyzes that harm in Appendix 7 of the EIS, which includes a discussion of all reports of off-target pesticide movement reported to EPA. APHIS defers to EPA for mitigation of drift through label language. On the proposed registration for Enlist Duo™, EPA concluded, "Spray drift mitigation language on the label is intended to limit off site transport of 2,4-D choline salt in spray drift. Therefore, EPA expects that spray drift will remain confined to the 2,4-D choline treated field and that the action area is limited to this field" (US-EPA, 2014b). APHIS believes the assumption is sound that farms growing 2,4-D resistant corn and soybean varieties will do so under stewardship agreements with Dow. As described in comment #75, Dow has committed to require adopters of Enlist™ technology to keep records, use a third party auditor to verify that growers purchase and use choline formulations, and to price the choline formulation competitively to encourage growers to comply with the stewardship agreement. Although genetically engineered varieties no longer regulated by APHIS may be crossed to other varieties, Dow would still retain intellectual property rights over the resulting varieties and these varieties would still be subject to stewardship requirements.

**194. Comment**: It is arbitrary that APHIS only looked at socioeconomic impacts and not direct and indirect impacts from the herbicide use**. (10158)**

**Response:** APHIS has no discretion to regulate pesticides. (see comment #174). EPA considers direct and indirect impacts of pesticide use in its Environmental, Human Health Risk, and Acute and Chronic Aggregate Dietary Exposure and Risk Assessment ((US-EPA, 2013c; 2013b; 2013a). APHIS included an analysis of socioeconomic impacts from the selection of herbicide resistant weeds because this analysis has not traditionally been undertaken by EPA in their risk assessments. USDA and EPA are coordinating, to the extent possible, their respective reviews of Enlist corn, soybean, and the Enlist herbicide. APHIS will not issue a final determination prior to reviewing the comments submitted to EPA for the Proposed Registration of Enlist Duo™ herbicide.

**195. Comment**: The DEIS discusses the potential for "stacking" of DAS-40278-9 corn, DAS-68416-4 soybean, and DAS-44406-6 soybean with other deregulated, genetically modified events. Stacking is the process of crossbreeding two events with distinct characteristics—typically herbicide tolerance and insect resistance—through traditional methods to produce a new variety of a particular crop that expresses both of the traits introduced to the original events by way of genetic modification. Although APHIS dismisses concerns about stacking, there may be potentially significant ecological consequences associated with the practice. USDA regulations do not require that these stacked events be treated as new events that must be deregulated prior to use. Nonetheless, if stacking will have significant environmental or health impacts, the DEIS should provide a thorough analysis of those effects. In this case, APHIS's DEIS provides an inadequate analysis of stacking and the potential for significant environmental impacts associated with the release of stacked varieties developed with 2,4-D resistant crops. Following a cursory discussion of Dow's intent to stack these corn and soybean crops with corn varieties resistant to glyphosate and other herbicides, indicates that there is little difference between the stacked and unstacked crops, and does not further discuss the issue of related environmental impacts. In order to fulfill its obligations under NEPA, APHIS must account for cumulative impacts of its decisions; it must consider "impact[s] on the environment which 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*." Stacking is certainly a "reasonably foreseeable future action"; indeed, Dow AgroSciences has made explicit its intent to stack the herbicide tolerant traits from its corn and soybean with those of other genetically engineered crops. Although the APHIS DEIS provides a limited discussion of the possibility of stacking, it fails to undertake the comprehensive review necessary to adequately identify the unique risks associated with the integration of resistance to phenoxy auxin and other dangerous herbicides. **(8094)**

**Response**: APHIS disagrees with the comment. APHIS has seen no evidence that stacking the *aad*-1 or *aad*-12 trait with any other corn or soybean trait would create any significant environmental impacts. The best available data indicate that these genes encode enzymes that do not metabolize any endogenous compounds (see response to comment #105). Issues related to the use of pesticides that may result from the stacking of herbicide traits falls under EPA oversight and is outside the scope of this EIS.

## Coordination with EPA

**196. Comment:** Another issue to consider is that EPA's current standards do not cover combinations of multiple herbicides or seasonally affected concentration peaks. Therefore, there is no way to measure or regulate the effects of herbicide loading in waterways, with uncertain effects on wildlife and human health. (**6923)**

**Response:** APHIS does not regulate pesticide use. This issue is outside the scope of the EIS.

**197. Comment:** EPA has authority and responsibility to regulate the use of pesticides. That is not in question. But USDA is fully capable of including an assessment in its section on Cumulative Impacts of the likely consequences for rural communities of increased 2,4-D use resulting from a possible "yes-yes" decision by both USDA (on the seed) and EPA (on the new uses of 2,4-D to accompany the seed). This assessment should then guide the agency's decision-making. But USDA has simply *chosen* to exclude health impacts from its analysis in this section, even while it considers socioeconomic impacts of drift. If uncertain how to assess health impacts, a responsible approach would be for USDA to wait to finalize this draft EIS until after EPA concludes its review of Dow's petition for "new uses" of its new choline formulation of 2,4-D in conjunction with the 2,4-D seeds. The EIS should then be revised to include reference to EPA's findings in its own expanded section on Cumulative Impacts, and only then—with the analysis of health impacts available—will it be appropriate for USDA to draw a conclusion regarding the regulation of Dow's 2,4-D seeds. Instead, in its haste to "clear the GE Pipeline" and approve all pending petitions within 2014, as explained by one USDA official, USDA has put the cart before the horse, pushing ahead with its seed approval process and in so doing, effectively driving both processes forward towards premature approval. As stated in the EIS: If APHIS approves the three petitions for nonregulated status for Enlist™ corn and soybean, *it is reasonably foreseeable* that EPA will independently approve registration of Enlist Duo™ herbicide for use on these GE plant varieties [*emphasis added*]. As Agriculture Secretary, Mr. Vilsack, you have responsibility to ensure that USDA decisions "help rural America thrive," and that at the very least, such decisions "do no harm." Turning a blind eye to the very real health and livelihood harms that adoption of Dow's 2,4-D resistant seeds will bring to the farmers and rural communities you purport to be committed to would be unconscionable. We urge you to address the inadequacies of the draft EIS by requiring substantial revision before releasing a final version. **(10203)**

**Response**: USDA and EPA are coordinating, to the extent possible, their respective reviews of Enlist corn, soybean, and the Enlist herbicide. EPA's Human Health Risk Assessment was completed in early 2013 and they" recommended a registration for the use of 2,4-D choline on herbicide-tolerant corn and soybean." (US-EPA, 2013b). APHIS will not issue a final determination prior to reviewing the comments submitted to EPA for the Proposed Registration of Enlist Duo™ herbicide.

**198. Comment**: APHIS's DEIS relies on EPA's assessment and regulation of 2,4-D with respect to human health effects, rather than on its own assessment and the controls at its own disposal. This sidestepping presents serious concerns because, among other problems, EPA's current approval of 2,4-D does not account for the increase in 2,4-D use that is predicted to occur with the introduction of 2,4-D tolerant crops (including DAS 40278-9 corn, DAS-68416-4 soybean, and DAS-44406-6 soybean). This significant increase in the amount of 2,4-D that will be released into the environment should dramatically change EPA's determination of 2,4-D's eligibility for continued registration. APHIS must revise the DEIS to include an assessment of the risks associated with the increased exposures, including: Increased direct exposure from drift to people who live downwind of areas planted with the 2,4-D resistant corn and soybean; Aggregate impact on wildlife, water quality, and air quality from dramatic increased use of 2,4-D both on a per field basis and on a regional basis; and Risk to applicators from the increased exposure to 2,4-D due to increased application rate. Failing that, APHIS must, at minimum, wait until EPA has completed its registration review before completing its environmental review and before determining whether to deregulate DAS 40278-9 corn, DAS-68416-4 soybean, DAS-44406-6 soybean, or any other crop genetically engineered to be 2,4-D resistant. APHIS should not make its determination independent of EPA's assessment. Combining all the increased exposures that are likely to occur, the existing risk from the household exposures to weed and feed products, and the indirect exposures through residue or garden soil contamination, EPA is likely to find in registration review that the risk will be substantial. Such a finding could affect the registration of 2,4-D in many ways, including whether 2,4-D would be approved for use on DAS-40278-9 corn, DAS-68416-4 soybean, or DAS-44406-6 soybean. Further, such a finding will significantly impact APHIS' environmental review of DAS-40278-9 corn, DAS-68416-4 soybean, or DAS-44406-6 soybean. APHIS must therefore wait until EPA has completed its registration review before completing its own EIS and before determining whether to deregulate crops genetically engineered to be 2,4-D resistant.

APHIS's failure to thoroughly evaluate the likely increase in 2,4-D application, as well as its failure to undertake a searching analysis of the corresponding environmental and public health impacts discussed above, represent a glaring shortcoming and a violation of NEPA's mandate. **(8094)**

**Response**: USDA and EPA are coordinating, to the extent possible, their respective reviews of Enlist™ corn, soybean, and the Enlist™ herbicide. EPA's Human Health Risk Assessment was completed in early 2013 and they" recommended a registration for the use of 2,4-D choline on herbicide-tolerant corn and soybean." (US-EPA, 2013b). APHIS will not issue a final determination prior to reviewing the comments submitted to EPA for the Proposed Registration of Enlist Duo™ herbicide.

**199. Comment**: Going forward with the deregulation request will reduce floristic diversity on the landscape (Mortensen et al. 2012; Egan et al. 2014b) which in turn is almost certain to reduce natural enemy populations thereby releasing insect pests otherwise suppressed when broadleaf plant populations are diverse and abundant (field-edge and adjacent non-crop habitat).

The review process undertaken by USDA-APHIS is fundamentally flawed in that it is done in a piecemeal fashion. USDA-APHIS addresses the likelihood that new pests arise and EPA assesses the impact of increased herbicide use independent of one another. What is needed is a holistic, integrated assessment in which the interacting changes in cropping practices, significant increases in herbicide use at times of the year when non-target plants are particularly susceptible, the knock-on effects of not adopting cover crops on soil and water quality, the likelihood of new pests arising, the likelihood of increasing insecticide use, the likelihood that pollinators will be adversely effected etc. are addressed together. **(9938)**

**Response**: APHIS disagrees that the review process is fundamentally flawed because USDA and EPA have considered separate aspects of the review and not a holistic integrated assessment. The areas that the commenter has identified as needed, “a holistic, integrated assessment in which the interacting changes in cropping practices, significant increases in herbicide use at times of the year when non-target plants are particularly susceptible, the knock-on effects of not adopting cover crops on soil and water quality, the likelihood of new pests arising, the likelihood of increasing insecticide use, the likelihood that pollinators will be adversely effected etc. are addressed together,” include several areas of great uncertainty. We do not know what types of cropping practices will be used in the future. Similarly, there are no ways to predict the likelihood of new pests arising, nor is there any way to predict the likelihood of increasing insecticide that will supposedly result from the use of 2,4-D. The commenter appears to be alluding to his hypothesis that increased use of 2,4-D and dicamba will decrease broadleaf plants at field edges and in nearby non crop lands which will in turn lead to a decline in beneficial insects that suppress insect pests. The commenter is a coauthor on a reference offered as support for the hypothesis (Egan *et al.*, 2014). However, the results of the paper show that simulated drift leads to a decline in three insect pest species, an increase in one insect pest, and an increase in beneficial crickets that eat weed seeds. The authors conclude that “Variability across sites and taxonomic groups makes it difficult to offer general conclusions about the risks of dicamba drift to plant and arthropod biodiversity.” In the introduction to their paper they state, “Moreover, the direct and indirect effects of herbicides on arthropods are not well understood, and of the available studies, results are often variable.” Given the variability noted by the commenter in his paper and the results showing that 3 pest species decline while one pest species increases in response to simulated drift, APHIS considers it highly speculative that new pests would arise or that insecticide use would increase as a result of drift of synthetic auxins. Similarly, it is unreasonable to analyze the effects of not using cover crops on soil when hardly any corn and soybean growers are using it now (Wallander, 2013), and it is only speculative that this practice will be adopted more widely in the future. The USDA through the the Natural Resources Conservation Service currently offers farmers incentives to pursue cover cropping through two programs: the Conservation Security Program and the Environmental Quality Incentives Program (Robinson, 2011; 2013).

**200. Comment**: The second important area regarding new pests that goes completely unaddressed in the USDA APHIS EIS are the pests that result from removing many of the broadleaves in the agroecological matrix. This oversight is deeply disturbing as it comes at a time when we’re just beginning to understand the importance of plant diversity on our farmsteds. Here what I’m referring to is the natural enemies that are supported by a diverse flora (in the fields, field edges and other non-crop plant cover). I am perplexed that such things are overlooked in the EIS. There is mounting evidence that drift level doses reduce broadleaf plant cover, diversity and floral abundance (Egan et al. 2014b; Mortensen et al. 2012; Mortensen et al. in preparation). Here I'm not referring to "armchair" ecology but rather real effects that will matter to the farmer. Reducing floristic diversity or habitat heterogeneity results in an increase in pest pressure and a corresponding increase in insecticide use to address these pests. Our work along with that of Doug Landis (entomologist, MSU), Mary Gardiner (entomologist, OSU), John Tooker (entomologist, PSU), Felix Bianchi and Wopke van der Werf (entomologists, Wageningen University) and others have been quantifying the degree to which natural enemies that attack cutworm, earworm, soybean aphid (among many others) rely on field edge plants and heterogeneity in plant cover for critical life history stages. It is essential that the EIS assess these pest problems broadly in order to fully assess the impact of these Dow deregulation requests. This discussion has been focused on creation of new pests. Unfortunately, the reduction in broadleaf diversity has important implications for pollinators as well. Would expect a significant decline in the wild bee and other pollinating insect populations with a decline in floristic diversity on the landscape (Mortensen et al. 2012; Egan et al. 2014b). **(9938)**

**Response**: As stated in the response to comment #199, the commenters published work (we have not seen the manuscript in preparation alluded to above) does not demonstrate that 2,4-D drift will exacerbate insect pest problems and lead to increased insecticide use.

**201. Comment:** APHIS violates NEPA by relying solely on EPA's future assessment of the direct and indirect impacts the 2,4-D crop system, and consequent herbicide application, will have on human health and the environment. In contrast, by law federal agencies must address all "reasonably foreseeable environmental impacts of their proposed programs, projects, and regulations. Such a review must include analyses of direct, indirect, and cumulative effects. The assessment must be a "hard look" at the potential environmental impacts of its action. Despite having decided to undertake an EIS and recognizing that approval of 2,4-D crops will massively increase and change associated herbicide use in GE corn and soy, APHIS has refused to analyze these herbicide impacts.

Instead, APHIS artificially separated the GE crops from the impacts of the herbicide (i.e., 2,4-D) the plants are created and designed to be sprayed with. Indirect effects from 2,4-D crops plainly include the effects of herbicides that undisputedly will be used on the crops, since they are the crop's very purpose. Herbicide impacts are not just foreseeable, they are intended and certain. The 2,4-D crops were developed by Dow to be resistant to 2,4-D; they consequently have no value without it and thus must be sold together with it, as a cropping system. Greatly increased 2,4-D use is at a minimum, an indirect effect, of APHIS's action that must be analyzed by APHIS.

As noted, APHIS' reliance on EPA is unlawful. Two prior courts have ruled that APHIS must analyze the herbicide impacts of its herbicide-resistant crop decisions in

EISs, for Roundup Ready alfalfa and Roundup Ready sugar beets. Moreover, the courts have long and consistently rejected agencies' attempts to avoid analyzing the pesticide impacts of their actions under NEPA by arguing that EPA has purview over pesticides under FIFRA. Thus, APHIS cannot rely solely on EPA's evaluation of effects under a separate statute to adequately fulfill its own NEPA obligations. Further, FIFRA analyses and standards are different than NEPA review. "Compliance with FIFRA requirements does not overcome an agency's obligation to comply with environmental statutes with different purposes." Absent NEPA analysis by APHIS, there will be no NEPA analysis of 2,4-D herbicide impacts. This violates NEPA and the APA. **(10158)**

**Response:** APHIS does not regulate pesticide use. The authorization of Enlist-Duo™ on Enlist™ crops is solely under the discretion of EPA. As part of their decision whether to register Enlist Duo™ for use on Enlist™ crops, EPA completes an Environmental, Human Health, and Acute and Chronic Aggregate Dietary Exposure and Risk Assessments (US-EPA, 2013c; 2013b; 2013a)that thoroughly analyzes the direct and indirect effects of pesticide use on Human Health and the environment. APHIS did not analyze the direct and indirect effects of pesticide use because EPA thoroughly examines these effects in its risk assessments. APHIS did analyze the potential increase in 2,4-D use in Appendix 4, the potential for increased selection of herbicide resistant weeds and associated socioeconomic impacts in the cumulative impacts section.

APHIS believes that it has taken the requisite "hard look" at the potential environmental impacts of its regulatory action. The action that APHIS is taking is to determine whether to grant nonregulated status to two plants. In making its determination, APHIS is looking at whether or not these plants are plant pests.

APHIS decided to undertake the EIS process for the following reasons: (1) This is the first time APHIS has reviewed GE plants with these traits. (2) Soybeans and corn are among the most heavily planted crops in the United States, and the potential deregulation of these varieties could impact literally millions of acres of cropland and lead to significantly greater use of 2,4-D herbicides in agriculture. (3) The increased use of 2,4-D herbicides, combined with the fact that soybeans and corn follow each other in growing rotations, could lead to higher incidences of 2,4-D-resistant weeds in agriculture. APHIS believes that this EIS adequately acknowledges these concerns as well as others. In addition, APHIS disagrees with the commenter's characterization of the potential for increase of the herbicide.

Under the Coordinated Framework, USDA, EPA and FDA each have distinct roles in regulating biotech crops. The Coordinated Framework tasks the EPA, under FIFRA, with regulating herbicide use, and it does so through labeling instructions that the herbicide user must comply with. APHIS is tasked with looking at the plant and whether or not the plant is a "plant pest" as defined in the PPA.

As stated above, APHIS believes that it has complied with NEPA and has not only given due consideration to EPA's analyses, but has also taken an independent look at data and other analyses when warranted.

**202. Comment: Integrated Review Needed.** Currently, new genetically engineered crops go through independent reviews by USDA APHIS and the EPA. APHIS assesses the risk of gene exchange and the likelihood the transformed crop becomes a pest. The previous section details why it is essential that the definition of pest be expanded to include new herbicide resistant weeds and insect pests arisng from the decline in floristic diversity (as outlined above). At the same time, the US EPA works to determine if "threats could potentially result from proposed changes in herbicide labels" associated with the transformed crop. As the genome of the crop is manipulated in ways that directly influence pest management practices, it is essential that the review of such genetic modifications (USDA APHIS) and associated changes in pest management practices (EPA) be performed concurrently and by one integrated review panel. An integrated approach is particularly critical for herbicide resistance traits where changes in the genome result in large (5-7 fold) increases in use of the targeted herbicide. The distinction in the pest target is an important one. In the case of genetically engineered (GE) insect traits, plant incorporated protectants preclude the use of an insecticide for insect protection. GE herbicide resistance traits facilitate the use of herbicide(s) and therefore the trait is directly linked with likely increase in herbicide use. For example, in our recent BioScience paper (Mortensen et al. 2012 uploaded as a separate 'public comment') we estimate insertion of 2,4-D or dicamba resistance traits in soybean would increase auxinic herbicide use in the crop 5-7 fold. Therefore, insertion of herbicide resistance genes are inextricably linked to and positively correlated with herbicide use. In this USDA APHIS EIS review, the deregulation request for the corn and soybean traits will result in a significant increase in 2,4-D use with that increase coming in the form of increased amount applied to a particular field and in the area treated. Of equal or possibly greater importance is the fact that 2,4-D will be applied over a much broader window of time, a window during which many highly sensitive broadleaf plants are leafed out and particularly vulnerable to injury. Our assessments therefore directly contradict the general tone of the deregulation requests by Dow and are largely ignored in the USDA APHIS EIS presumably because it is not in their charge to review the corresponding increase in herbicide use that will result if deregulation is granted. This oversight underscores how badly an integrated review process is needed. Without a joint review that assesses the changes in agronomic and pesticide use practices together, it is not possible to critically assess the agronomic benefits of such a change nor is it possible to fully assess the ecological and environmental risks. (**9938**)

**Response**: APHIS disagrees with the commenter that it ignores the fact that 2,4-D use will increase and that it will be applied over a longer window of time. APHIS has thoroughly analyzed the expected increases in 2,4-D use for the No Action and Action Alternatives in Appendix 4. APHIS also discussed the fact that 2,4-D will be applied over a much broader window of time (DEIS p. 134) "Though off-target pesticide movement is expected to be lower for the Preferred Alternative than for the No Action Alternative, the use of 2,4-D may occur over a longer season under the Preferred

Alternative. This could increase exposure to sensitive plants later in the season. These offsetting impacts (less volatile formulations and potentially greater exposure) make it difficult to predict which Alternative poses the greatest risk from drift damage." EPA thoroughly analyzes the direct and indirect impacts of 2,4-D use on non-target species in the Environmental Risk Assessment. APHIS and EPA have met on a number of occasions to coordinate the review of Enlist™ corn and soybean and Enlist Duo™. Each agency has also shared their analyses with the other. APHIS believes the ecological and environmental risks have been appropriately assessed.

**203. Comment**: Another argument for an *integrated and holistic review* is found in the area of non-target effects. The deregulation requests for the three separate Dow events will have significant non-target effects they claim the "petitioner assessed the potential [of these events] to impact "non-target" organisms, included those considered beneficial to agriculture and determined that there would be no effect". Agronomically and compositionally the transformed crop varieties are not likely to adversely affect other organisms compared to other non-transformed crop varieties. The deregulation application goes on to state: "Any effects on non-target organisms that could potentially result from proposed changes in herbicide labels will be evaluated by the EPA." Obviously, the corn cultivar itself won't adversely affect other organisms; the concern is over the herbicide use that will now be possible on the transformed 2,4-D resistant corn. A careful review of the peer-reviewed environmental chemistry literature indicates that amount of herbicide use is positively correlated with the appearance of herbicides use in surface and ground water (Barbash et al., 2001). Auxinic herbicides like 2,4-D and dicamba have also been linked to a high frequency of drift injury events (see Pesticide Drift Enforcement Survey and Franklin, Barlow and Mortensen, 2014). Taken together, these spillover effects would be small in the absence of the transformed crop and associated agronomic practices. In addition to concerns about compromised environmental quality, herbicide spillover of the kind that would occur with the approval of this application will make it more difficult for fruit and vegetable farmers to coexist with grain crop farmers. Finally, large increases in 2,4-D would also potentially reduce the floristic diversity of field edges and the beneficial insects including pollinators and biocontrol organisms that rely on the flora (Mortensen et al., 2012 and Egan et al. 2014b). Therefore, a decision on deregulation of these Dow events must be weighed against the environmental consequences of such deregulation. Under the current review process, this is not possible. **(9938)**

**Response**: APHIS disagrees with the commenter that an adequate review is not possible. The issues raised by the commenter have been addressed during the review process. EPA is considering the direct and indirect pesticide effects on non target organisms. They have proposed mitigation conditions in the label to minimize off-target movement of the herbicide and impacts on non-target organisms including a 30 foot set back buffer (see response to comment #65). Dow has made commitments to fruit and vegetable farmers intended to limit crop damage from spray drift (see response to comment #75).

**204. Comment**: "[T]he registration and labeling of a substance under [the Federal Insecticide, Fungicide, and Rodenticide Act ("FIFRA")] does not exempt an agency from its obligations under [NEPA].” *Washington Toxics Coalition v. Environmental Protection Agency*, 413 F.3d 1024, 1032 (9th Cir. 2005) (citing *Oregon Environmental Council v. Kunzman*, 714 F.2d 901, 905 (9th Cir.1983), *Save Our Ecosystems v. Clark*, 747 F.2d 1240, 1248 (9th Cir.1984)). This is because “a pesticide registration under FIFRA does not require the same examination of environmental concerns that an agency is required to make under NEPA.” *Id*; *see also Calvert Cliffs’*, *supra*, 449 F.2d 1123 (“the agency to which NEPA is specifically directed” is the only agency in a position to examine the environmental costs of an action against its benefits). Further, FIFRA’s public participation requirements are significantly weaker than those provided by NEPA. *See* FIFRA, 7 U.S.C. §§ 136-136 y.

In Section 5 of the DEIS, APHIS purports to address the cumulative impact of the proposed action when taken with the EPA’s anticipated approval of Enlist Duo™. Thus, unlike the direct and indirect analysis, the cumulative analysis purports to consider the use of pesticides as a result of the proposed action. Indeed, the DEIS admits that “under the action alternatives, the increase in 2,4-D use is expected to be greater by up to three fold compared to the No Action Alternative.” DEIS p. 119. Yet the DEIS’s discussion of cumulative impacts does not address the effects of increased 2,4-D use on animal communities, special status species habitat, natural resources, or human health. *See*, *e.g.*, DEIS, pp. 134 (deferring any analysis on wildlife impacts to EPA), 135-143 (discussing plant communities only in the context of pesticide resistant weeds); 144-145 (natural resources); 146 (claiming no cumulative human health impacts for any alternatives based on lack of pesticide analysis). APHIS’ admitted failure to assess thereasonably foreseeable impacts of the proposed action on the human environment cannot be cured by the EPA’s evaluation of whether Enlist Duo™ would have “unreasonable adverse effects on the environment” “taking into account the economic, social, and environmental costs and benefits of the use of any pesticide” pursuant to FIFRA. 7 U.S.C. § 136; *Washington Toxics Coalition*, *supra*, 413 F.3d at 1032. Without the omitted information, APHIS has failed to take the requisite “hard look” at the environmental consequences of approving the proposed action.

By deferring to the EPA’s future evaluation of Enlist Duo,™ APHIS has attempted to remove the analysis of these impacts from the NEPA process altogether. *Merrell v. Thomas*, 807 F.2d 776, 778 (9th Cir. 1986) (finding that Congress did not intend the EPA to comply with NEPA when performing pesticide registration duties under FIFRA). Because the EPA has no duty under FIFRA to gather information from the public – or consider public comment – while pesticide registration applications, the EPA only solicits public comments in special pesticide registration applications, the EPA only solicits public comments in special circumstances. While Appendix 8 to the DEIS claims that such information will be available for public comment at some future point, this is not sufficient to satisfy NEPA. *Washington Toxics Coalition, supra*, 413 F.3d at 1032. APHIS’ deferral to the EPA thus stifles public participation and runs counter to NEPA’s informational mandate.

Increased pesticide use – a result of any of the action alternatives – is likely to cause significant harm to biological resources, land use, and human health, as discussed above in Section III. In addition, the action alternatives will induce the selection of

2,4-D resistant traits in targeted (and potentially non-targeted) weed species if approved. DEIS pp. 139-140. Yet, the DEIS fails to adequately address the potential for cascading impacts as resistant weeds spread from farms to open spaces, imperiling habitat for sensitive species and competing against such species for resources. *Id.* APHIS must correct these deficiencies in a revised DEIS. 40 C.F.R. § 1502.9(a). **(10158)**

**Response:** We disagree with this comment. EPA and not APHIS is taking the action to allow the use of Enlist Duo™ on Enlist™ corn and soybean. EPA is allowing ample public participation in their process. They have published their risk assessments and proposed registration and made them available for a 60 day comment period (EPA-HQ-OPP-2014-0195). EPA's risk assessments consider the issues raised by the commenter: "animal communities, special status species habitat, natural resources, or human health." APHIS did not consider how 2,4-D resistant weeds will imperil sensitive species and compete against such species for resources because, in the absence of 2,4-D, resistant weeds are no more a threat to such species as sensitive weeds. APHIS is not aware that 2,4-D is used to manage sensitive habitats and this commenter has not provided any evidence to the contrary.

**205. Comment**: APHIS rightly acknowledges the significant potential impacts of selection for 2,4-D resistant weeds, but states that it will "at its discretion, prepare an EIS to further analyze the potential for selection for 2,4-D resistant weeds and other potential impacts that may occur from making determinations of nonregulated status for these varieties." APHIS, however, must include this analysis of selection of 2,4-D resistant weeds in the final EIS, along with its review of the other impacts associate with 2,4-D resistant crops. Preparing a separate analysis, at APHIS's discretion, of an important issue will result in an incomplete final EIS, which is counter to NEPA's purposes. Further, it is important that APHIS does not limit this additional assessment to "the likely adverse socioeconomic impacts" of selection for 2,4-D resistant weeds and the associated weed-control alternatives that may arise. AHPIS must also fully explore the likely adverse environmental and public health impacts associated with the possible selection of 2,4-D resistant weeds and any resultant changes in management practices. **(8094)**

**Response**: The commenter appears to interpret the following text: [APHIS] "will at its discretion prepare an EIS") to mean that a future EIS is planned that would analyze the impacts from the selection of 2,4-D resistant weeds. In actuality, the quoted passage refers to the current EIS where impacts from the selection of 2,4-D resistant weeds were thoroughly analyzed in the cumulative impacts section. The commenter also asserts that APHIS must not limit its analysis to socioeconomic impacts but must explore the likely adverse environmental and public health impacts. As APHIS has noted in the EIS and other comments, the potential environmental and public health impacts result from changes in tillage and herbicide use. APHIS has analyzed potential impacts from tillage. EPA is analyzing potential impacts from herbicide use in its three risk assessments and proposed registration document (US-EPA, 2013c; 2013b; 2013a; 2014b).

**206. Comment**: The DEIS acknowledges that Dow AgroSciences' Enlist Duo is a 2,4-D choline salt herbicide (2,4-dichlorophenoxyacetic acid (2-hydroxyethyl) trimethylammonium salt) that will be marketed for use on DAS-40278-9 corn, DAS-68416-4 soybean, and DAS-44406-6 soybean and other crops as part of Dow's Enlist Weed Control System. The DEIS, however, contains inadequate analysis of this particular formulation of 2,4-D and its environmental impacts. APHIS once again relies on the hope that "EPA is currently reviewing the use of 2,4-D on Enlist™ corn and soybean based on the standard that the herbicide would not cause any unreasonable environmental risks so long as it was applied in accordance with its labeling instructions." This statement not only indicates that APHIS will make its decision regarding Dow's petition for determination of nonregulated status without having reviewed data regarding this specific formulation, but also reveals that potentially important and relevant information essential to determining the environmental impacts of deregulating DAS-40278-9 corn, DAS-68416-4 soybean, and DAS-44406-6 soybean will be unavailable to the public during the public comment period. **(8094)**

**Response**: USDA and EPA are coordinating, to the extent possible, their respective reviews of Enlist™ corn, soybean, and the Enlist™ herbicide. EPA's risk assessments were completed between January and August of 2013 and were shared with APHIS. "They recommended a registration for the use of 2,4-D choline on herbicide-tolerant corn and soybean." (US-EPA, 2013b). All three risk assessments as well as the proposed registration have been available for public comment between April 30 and June 30 2014 (EPA-HQ-OPP-2014-0195). APHIS will not issue a final determination prior to reviewing the comments submitted to EPA for the Proposed Registration of Enlist Duo™ herbicide.

**207. Comment**: APHIS fails to identify or analyze the environmental effects of the increased use of 2,4-D, in violation of NEPA. 40 C.F.R. § 1508.8. Instead, APHIS states in the DEIS:

> One assumption of the APHIS analysis is that EPA will establish label restrictions that will ensure the safety standards for human health and the environment associated with the use of Enlist DuoTM on these three varieties will be met. Therefore, APHIS' analysis in this section focuses on cumulative impacts associated with these varieties including the development of HR weeds due to herbicide application and changes in management practices resulting from their use. DEIS at 118.

Whether EPA conducts its own NEPA analysis is irrelevant to APHIS' responsibility to evaluate "reasonably foreseeable" effects under NEPA. APHIS cannot rely on EPA to conduct a full analysis of Enlist DuoTM impacts, as EPA is excused from conducting a NEPA analysis if the pesticide is registered under FIFRA. *Merrell v. Thomas*, 807 F.2d 776, 780 (9th Cir. 1986). This case makes clear that a FIFRA analysis falls short of the more extensive analysis required under NEPA. *See id.* at 780–81 (noting that FIFRA's standard for denying registration is "unreasonable adverse effects on the environment," while NEPA's standard for preparing an EIS is "significantly affecting the quality of the human environment"; also noting that the "basic thrust and principal responsibility of EPA are to protect the environment," while NEPA's standard evinces a compromise made by Congress in that it "reflects the need to balance environmental and agricultural impacts"). Thus, the possibility that EPA may "establish label restrictions that will ensure the safety … of Enlist DuoTM" is not a proper substitute for a NEPA anaylsis, and it certainly does not absolve APHIS of its responsibility to evaluate the reasonably foreseeable consequences of Enlist Duo™ registration, since APHIS has an independent duty to comply with NEPA. **(8097)**

**Response**: APHIS disagrees with the comment. It is EPA's action that allows the use of Enlist Duo™ on Enlist™ corn and soybean, not APHIS'. As the commenter acknowledges, EPA is tasked with ensuring there are no unreasonable adverse effects on the environment from the use of Enlist Duo™ on Enlist™ crops. APHIS relies on EPA to ensure the safe use of the pesticide to meet this standard. EPA has thoroughly assessed the direct and indirect impacts on humans and the environment from this pesticide use. APHIS properly relies on EPA for this assessment of the direct and indirect impacts of 2,4-D use.

**208. Comment:** While Enlist™ com and soybean can resist damage from the application of the Enlist Duo ™ herbicide, APHIS' s selection of a particular alternative does not in itself allow the use of Enlist Duo ™ herbicide on Enlist™ com and soybean plant varieties. APHIS has no authority to regulate herbicide use. Instead, the EPA regulates the use of herbicides under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) (7 U.S.C. §136 et seq.) and is making a separate decision which may or may not approve registration for use of Enlist Duo™ herbicide on these plants. As part of the approval process, the EPA determines how the herbicide may be used and requires that the labeling of the product contain directions and precautionary statements, which ensure that it will not cause unreasonable adverse effects on the environment when used according to its labeling. (Under FIFRA, it is unlawful to use an herbicide in a manner inconsistent with its labeling.)

The draft EIS includes a description of DAS 's proposed label language for Enlist Duo ™ addressing spray drift management™ (see Appendix 7, particularly Table 7-3). Please note that EPA has not completed its assessment of the risks posed by off-target movement of residues of Enlist Duo™, particularly via spray drift. As noted in the draft EIS, the EPA' s reviews consider additional potential impacts of using Enlist Duo ™ including risks to endangered and threatened species and their designated critical habitat, which are not addressed in the draft EIS. When the EPA completes its review and if the EPA determines that Enlist Duo TM meets the statutory standard for registration, the EPA may decide to impose limitations on the use of Enlist Duo ™ that differ from those proposed by DAS and described in the draft EIS.**(10111)**

**Response:** The analysis in the EIS is consistent with this comment.

## Mitigation

**209. Comment**: It is fundamental that an EIS must discuss not only the impacts of a proposed action and reasonable alternatives, but also measures that may be taken to reduce the action's impacts. This requirement is implicit in NEPA's provision that an EIS describe "any adverse environmental effects which cannot be avoided should the proposal be implemented." As the Ninth Circuit has emphasized, "The importance of the mitigation plan cannot be overestimated. It is a determinative factor in evaluating the adequacy of an environmental impact statement."

Mitigation measures must be described "in detail," and an analysis explaining the effectiveness of the measures is "essential." Under NEPA regulations, APHIS mitigation strategy must include:

(a) Avoiding the impact altogether by not taking a certain action or parts of an action.
(b) Minimizing impacts by limiting the degree or magnitude of the action and its implementation.
(c) Rectifying the impact by repairing, rehabilitating, or restoring the affected environment.
(d) Reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action.
(e) Compensating for the impact by replacing or providing substitute resources or environments.

Further, the effectiveness of mitigation measures must be supported by studies and analytical data in the record: "[T]he Ninth Circuit has repeatedly held that NEPA requires analytical data describing mitigation's effectiveness. A perfunctory description or mere listing of mitigation measures, without supporting analytical data, is inadequate." Finally, mitigation measures cannot substitute for actually analyzing environmental impacts.

In this DEIS, APHIS's repeated reliance on unanalyzed, uncertain mitigation violates NEPA. The agency includes various forms of mitigation it relies on to lessen the harms of its proposed action. In fact, pages 118 to 119 unabashedly include a long list of APHIS's "assumptions" for its analysis. This is exactly what the Courts have said is unacceptable: "A perfunctory description or mere listing of mitigation measures, without supporting analytical data, is inadequate.

First, as explained above, APHIS unlawfully relied completely on EPA's FIFRA process as "assumed," unanalyzed mitigation for all herbicide impacts of APHIS's proposed approval action:

One assumption of the APHIS analysis is that EPA will establish label restrictions that will ensure the safety standards for human health and the environment associated with the use of Enlist Duo™ on these three varieties will be met. APHIS assumes that drift from 2,4-D and other pesticide applications will be mitigated to an acceptable level by the registration requirements established by EPA. DEIS at 118-19 (emphases added). On page 149, entitled "mitigation measures," APHIS continues, Mitigation measures to oversee the proper usage of herbicides are determined by EPA and are disseminated to the herbicide users through EPA approved labels. Adhering to herbicide label requirements, including application rates and techniques and following industry herbicide stewardship programs, will largely minimize improper herbicide usage. The extent of herbicide drift will be mitigated by the requirement to use the Enlist ™ formulation which is at least 50 fold less volatile than other 2,4-D formulations, by conditions on the label that will require nozzles 31 that limit drift and restrictions on when and how the herbicide can be applied.

Far from analyzing labeling requirements “in detail,” APHIS includes no analysis of how EPA might accomplish this, or what levels might be acceptable or effective. Similarly, APHIS does not analyze risks from drift of 2,4-D, glufosinate, quizalofop, or glyphosate, even though these herbicides will be used as part of the Enlist crop system. This attempted mitigation reliance cannot substitute for APHIS’s duty to actually analyze foreseeable environmental impacts.

Nor it is acceptable for APHIS to claim that such impacts are uncertain: “Reasonable forecasting and speculation is thus implicit in NEPA and we must reject any attempt by agencies to shirk their responsibilities under NEPA by labeling any and all discussion of future environmental effects a ‘crystal ball inquiry.’” Consequently, APHIS’s claim that it “approve now and ask questions later is precisely the type of environmentally blind decision-making NEPA was designed to avoid.”

Second, APHIS unlawfully relied on mitigation in the form of industry’s “best practices” and “stewardship:” APHIS assumes that growers will choose management practices appropriate for the crops planted. APHIS assumes that herbicide applications will conform to the EPA registered uses for corn and soybean. In addition to corn and soybean, APHIS assumes that other approved 2,4-D uses (e.g. on pastures, wheat, oats, barley, millet, rye, sorghum, rice, cotton, sugarcane, almonds, apples, apricots, cherries, citrus, hazelnuts, nectarines, peaches, pears, pecans, plums, walnuts) will conform to EPA-registration requirements. APHIS assumes that all 2,4-D treatments made with the Enlist Duo™ formulation to corn and soybean will also include glyphosate because stewardship agreements between DAS and growers will stipulate that Enlist Duo™ products (which are a mixture of glyphosate and 2,4-D) be used. DEIS at 118. On page 149 of the DEIS, APHIS again describes its reliance and clarifies that the mitigation upon which it is relying is not enforceable: APHIS does not have the authority to regulate types of management practices or use of herbicides. Nevertheless, mitigation can occur by a number of means. First growers may voluntarily adopt best practices recommended by weed experts as described in section 5.3.2. Second, any grower who uses Enlist™ crops will be expected to follow a stewardship agreement that requires the use of a 2,4-D choline formulation mixed with glyphosate and recommends no more than two applications of this herbicide per season. APHIS assumes that there would be no binding enforcement mechanism to ensure that farmers follow the stewardship agreement but failure to do so could jeopardize a grower’s access to the technology.

Again, in violation of NEPA, APHIS fails to include analysis of the potential efficacy of these measures.

Moreover, APHIS admits that they are not enforceable; it is relying on Dow to police its own customers and sue them for any infractions, although Dow has no legal obligations or meaningful incentives to do so. Quite the contrary, Dow's financial interest in maximizing sale of its 2,4-D corn and soy seed conflicts with taking enforcement action against farmer-customers who violate its stewardship agreement. Thus, any reliance by APHIS on Dow's enforcement as a "mitigation" measure is by its nature arbitrary and capricious. APHIS provides no analysis of whether growers actually comply with stewardship provisions, nor any evidence that Dow will enforce them. "As with the question of the extent of the unremediated injury that might otherwise occur, the question of the impact of the proposed mitigation measures must be studied as part of the preparation of an EIS rather than after the injury has transpired." Therefore, APHIS's mitigation section is inadequate and violates NEPA.

Regarding transgenic contamination, APHIS states its belief that it "reasonably can be assumed" that growers of non-GE and organic corn and soy can use practices to protect their crops from transgenic contamination. DEIS at 65-66. Once again, APHIS's mitigation assumption is without analytical basis; as discussed in CFS's here *supra* and in previous CFS comments on APHIS's NEPA analyses of deregulating GE crops, and as courts have previously held, transgenic contamination is a significant risk and substantial impact to farmers and the environment that must be analyzed in an EIS; it cannot be assumed away in a few sentences. Accordingly, APHIS's cursory assumptions and complete failure to analyze mitigation violate NEPA's mandates.

Finally, regarding herbicide-resistant weed development, APHIS correctly recognizes that deregulating 2,4-D crops will cause the development of 2,4-D-resistant weeds. DEIS at 140. APHIS thus "recommends" a list of agronomic voluntary practices "to mitigate the increased selection pressure associated with the increased use of 2,4-D." *Id.* APHIS states that it is "unknown" whether farmers will follow these listed practices. *Id.* APHIS then concludes that the distribution and growth of 2,4-D resistant weeds is "impossible to predict" because the extent to which farmers will follow these practices is "unknown." *Id.* However, APHIS's reliance on this unanalyzed, uncertain "mitigation" violates NEPA. The effectiveness of mitigation measures must be supported by studies and analytical data in the record: "[T]he Ninth Circuit has repeatedly held that NEPA requires analytical data describing mitigation's effectiveness. A perfunctory description or mere listing of mitigation measures, without supporting analytical data, is inadequate." Nor can mitigation measures substitute for actually analyzing environmental impacts. **(7992)**

**Response**: APHIS disagrees with the commenter's characterization of the requirements of NEPA under the circumstances presented here and the commenter's assertion that APHIS's discussion of the mitigation measures is inadequate under NEPA The DEIS contains a thorough discussion of the known mitigation measures that are available to address impacts from the use of 2,4-D, including best management practices and mitigation measures required by EPA. APHIS has no authority to impose any mitigation measures with regard to the use of any herbicides, including 2,4-D. APHIS has complied with NEPA in discussing the available strategies and acknowledging the limitations of available data regarding effectiveness..

**210. Comment**: Under NEPA, an agency "may not 'act first and study later.'" *Western Land Exchange Project v. United States Bureau of Land Management*, 315 F.Supp. 2d 1068, 1092 (D. Nev. 2004) (quoting *National Parks, supra*, 241 F.3d at 734). NEPA requires mitigation measures to be "reasonably complete," containing "sufficient detail to ensure that environmental consequences have been fairly evaluated." *Robertson v. Methow Valley Citizens Council*, 490 U.S. 332, 352 (1989). Furthermore, mitigation measures are inadequate unless they contain "supporting analytical data." *Sierra Club v. Bosworth,* 510 F.3d 1016, 1029.

APHIS' purpose is to protect U.S. agriculture and natural resources from the spread of plant pests and noxious weeds. *See* The Plant Protection Act, 7 U.S.C. § 7701.7 APHIS assumes that, as it "does not have the authority to regulate grower management practices nor herbicide use" that it does not have the ability to prevent herbicide-resistant weeds. DEIS p. 148. However, as APHIS' approval the proposed action is likely to cause the rapid spread of plant pests (specifically 2,4-D resistant crops), APHIS should use its authority to regulate these products to impose contractual conditions between DAS and its growers to mitigate the reasonably foreseeable adverse effects of approving the proposed action. APHIS' claimed lack of authority to mitigate the environmental harms of the proposed action ignores this possibility. DEIS p. 149.

APHIS admits that "the selection of herbicide-resistant weeds is an unavoidable impact." DEIS p. 148. Yet APHIS denies it has the authority to regulate the types of best management practices that would be practically useful at addressing this impact. In its Alfalfa FEIS, APHIS investigated best management practices that would reduce these types of impacts. Alfalfa FEIS, p. 11 (preferred alternative utilized imposition of best management practices), 115 (companies agreed to adopt best management practices in contractual language). The revised DEIS must include alternatives and mitigation measures that incorporate best management practices and other grower-side polices that would mitigate the significant environmental impacts contemplated by the deregulation of these GE crops. **(10158)**

**Response**: APHIS disagrees with the commenter's premise that 2,4-D resistance alone, in crops or weeds, makes a plant a plant pest and, thus, must be regulated by APHIS. Under 7 C.F.R. part 340, APHIS regulates only "regulated articles" as defined therein. 2,4-D resistant weeds that have been selected due to exposure to 2,4-D in the environment are not considered regulated articles under part 340. Therefore, APHIS does not have authority to regulate that characteristic or to require mitigation measures to prevent the selection. While APHIS has examined best practices that would reduce the selection of herbicide-resistant weeds in the Alfalfa FEIS and in the 2,4-D DEIS (p. 138) APHIS has also stated in both documents that it does not have the authority to require such measures. APHIS has also reviewed EPA's proposed stewardship practices to manage herbicide resistant weeds. ((US-EPA, 2014b)at 19-20). EPA has proposed, as part of the 2,4-D registration decision, to require that DAS "develop a stewardship program that will aggressively promote resistance management efforts."

## Other Environmental Laws

**211. Comment**: Despite APHIS' claim otherwise, the action alternatives will impact migratory birds including bald and golden eagles. In claiming otherwise, APHIS has ignored its duties under NEPA as well as Executive Order 13 186. *See* DEIS p. 161. To the extent that the action allows an increase in single-crop mono-culture farming, it will negatively impact migratory bird species that rely on an increasingly fragmented habitat to forage for insects, their primary food source. APHIS' failure to acknowledge this connection substantially weakens its analysis of the potential environmental impacts of its decisions. Further, as mentioned above, APHIS again improperly declined to discuss the potential for increased pesticide use to impact migratory bird species, and instead relied upon the EPA to address these issues later. DEB p. 161. This is not adequate; APHIS must correct these deficiencies in its revised DEIS. 40 C.F.R. § 1502.9(a). **(10158)**

**Response:** APHIS disagrees with the comment. As described in the DEIS (p. 107) the amount of land used for corn and soybean is not expected to change under the Preferred Alternative.

## PPRA

**212. Comment**: The public has not had a full opportunity to review APHIS' PPRAs, as the studies on which APHIS relies in making its "no plant pest risk" determinations are not available in the docket. Without public access to these documents, we are unable to independently evaluate the data or APHIS' interpretation of these studies. It is possible that the public may be able to provide a different analysis of the studies and their data that APHIS was not aware of or did not consider. To that extent, while the public has been given the opportunity to comment on the PPRA, our ability to provide substantive comments that could affect the agency's decision has been substantially compromised by APHIS' failure to include the studies underlying its PPRA in the docket. **(8094)**

**Response**: The PPRAs were included in the docket. Please see docket numbers APHIS -2013-0042-0074 thru 0076 for DAS-40278-9 corn, DAS-44406-6 soybean, and DAS-68416-4 soybean, respectively. In addition the PPRAs were available for download from the APHIS website: http://www.aphis.usda.gov/biotechnology/petitions_table_pending.shtml at the times the petitions were posted beginning with DAS-40278-9 corn on December 27, 2011. All literature used in the preparation of the PPRA were cited and are publicly available. The PPRA contains an extensive reference section near the end of the document.

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