Appendix S. Economic and Social Impacts on Conventional and Organic Farmers of Deregulation of Glyphosate-Tolerant Alfalfa

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Economic and Social Impacts on Conventional and Organic Farmers of Deregulation of Glyphosate-Tolerant Alfalfa

Executive Summary

This report analyzes the potential social and economic impacts on conventional and organic farmers, and focuses on the potential changes in the demand and supply for alfalfa in domestic markets under the deregulation of glyphosate-tolerant (GT) alfalfa.

As farmers switch to producing GT alfalfa and as the demand for non-GT alfalfa falls, the impact of GT alfalfa deregulation on non-GT conventional alfalfa farmers would likely be a reduction in the market for non-GT alfalfa. The resulting final price for non-GT alfalfa is not clear, but, to the extent that GT alfalfa offers higher returns, it would be lower than it otherwise would be. During a period of adjustment to the new market segmentation between GT alfalfa and non-GT alfalfa, prices would tend to fall if demand shifted faster to GT alfalfa than farmers, or would tend to rise if farmers shifted faster than demand.

The impact of GT alfalfa deregulation on organic alfalfa farmers depends on whether there is a share of the domestic organic alfalfa market (sales) that is sensitive to products with genetic engineering (GE). With no GE sensitivity of demand (sales), the only possible impact on organic markets is the shift in demand to the left that follows the reduction in prices of conventional alfalfa, leading to a reduction in prices and quantities sold domestically of organic alfalfa. In the case of GE sensitivity of demand (sales) in organic alfalfa markets, the result of GT alfalfa deregulation depends on the extent of this GE sensitivity: the larger the GE sensitive market is, the more likely quantities sold would fall, although with unclear effect on prices. The larger the non-GE sensitive market is, the more likely prices would fall but with unclear effect on quantities.

GT alfalfa adoption by farmers, presence of GT alfalfa in non-GT alfalfa fields, and the demand response to GT alfalfa deregulation would have several distributional and social impacts: the loss and gain of businesses, potential changes in market structure, distribution of the costs of loss of production and avoidance in GE sensitive markets, and potential negative impacts on the preferred environment of organic farmers (one free of GE organisms).

1.0 Introduction

1.1 Scope of Report

This report analyzes the potential social and economic impacts on conventional and organic farmers due to the deregulation of GT alfalfa. We expand on our Technical Report *Changes in the Economics of Alfalfa Farming with Deregulation of Glyphosate-Tolerant Alfalfa* (appendix K), moving beyond changes in costs and yields within alfalfa farms, to discuss aggregate impacts on the supply of conventional and organic alfalfa.

We also incorporate domestic demand to our analysis leaving, however, foreign demand for our Technical Report *Impacts to United States Trade of Deregulation of Glyphosate-Tolerant Alfalfa* (appendix R).

Below we explain the methodology – assumptions, scenarios, and limitations – upon which this analysis is based.

1.2 Methodology

Analysis of the potential impact of deregulation of GT alfalfa on U.S. organic farming was divided in its impact on the demand for organic alfalfa and its impact on the supply of organic alfalfa in the U.S. market. When analyzing the potential impact on demand of organic alfalfa, we ignore any impacts on supply. Similarly, when analyzing the potential impact on the supply of the organic alfalfa, we ignore any impacts on demand. We then proceed to look at both demand and supply jointly.

This procedure is meant to facilitate the analysis and to improve our understanding of the sources and mechanisms of the impact of GT alfalfa deregulation. It is a conventional approach in economics, and under this approach prices and quantities are determined jointly by supply and demand. This means that in analyzing shifts in demand and supply, we will not consider how demand and supply change *in response to prices* – because prices are determined by demand and supply themselves. Rather, we look at how demand and supply change in response to other factors and draw conclusions about the resulting changes in prices and quantities. It is important to keep this in mind to understand the analysis done in this report.

We will often refer to impacts on supply and demand as “shifts,” that move the “demand curve” or the “supply curve” outward or inward, to the right or to the left. This language is best understood in reference to the conventional graph of supply and demand below. In figure S-1, an outward shift in demand is illustrated.

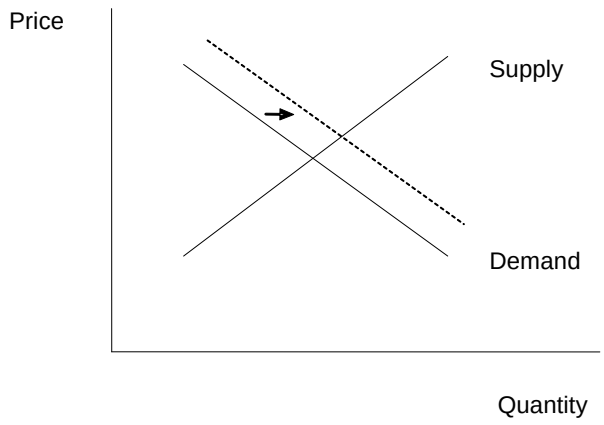

Figure S-1: Outward shift in demand

The economic analysis of shifts in demand and supply in the alfalfa market is complex because the market is segmented in various ways: domestic and international, conventional and organic, high quality and low quality, and for the purposes of this study: markets sensitive to GE products and non-GE sensitive markets. To the extent that alfalfa of various qualities and destined to various markets are substitutes, shifts in supply in one market segment could result in shifts in both supply and demand in another. We often simplify our analysis and try to be explicit about the simplifications made.

In this report we generally do not refer to forage but rather hay because more data are available for hay than for other types of forage (haylage). This has no significant impact on our analysis and we do make reference to haylage when deemed appropriate. When no distinction between seed and hay is relevant, we often refer simply to alfalfa, alfalfa stands, or alfalfa fields.

Section 2 of this report analyzes potential shifts in the demand of conventional and organic alfalfa induced by the deregulation of GT alfalfa. Section 3 does the same for the supply of conventional and organic alfalfa. In both sections we start by looking at current data and expected trends and then turn to discuss potential impacts of deregulation. In section 4 we combine our analysis of each side of the market and discuss potential impact scenarios.

No quantitative estimates of the impacts of GT alfalfa deregulation are offered in this report. We feel there is not sufficient information for such estimates. However, we describe in section 4 what lacking evidence would allow such estimates for specific impact scenarios.

In appendix S-2 of this technical report we describe our bibliographic and data search. Appendix S-3 of this technical report is a county level analysis that expands on the similar analysis done in

our Technical Report *Changes in the Economics of Alfalfa Farming with Deregulation of Glyphosate-Tolerant Alfalfa* (appendix K). It ranks alfalfa seed producing counties by acreage and the likelihood of not finding alfalfa hay with herbicides, where the latter variable is taken as an indicator of reduced losses in not producing GT alfalfa hay.

1.2.1 Assumptions

GT alfalfa deregulation is assumed to potentially affect organic and conventional alfalfa demand to the extent that it affects dairy, livestock, pet care, and human domestic demand through perception of the presence of GT alfalfa in these products. Changes in demand for alfalfa hay and alfalfa fields for human consumption reflect on changes in demand for alfalfa seed. Figure S-2 below illustrates the cause-effect links to be analyzed.

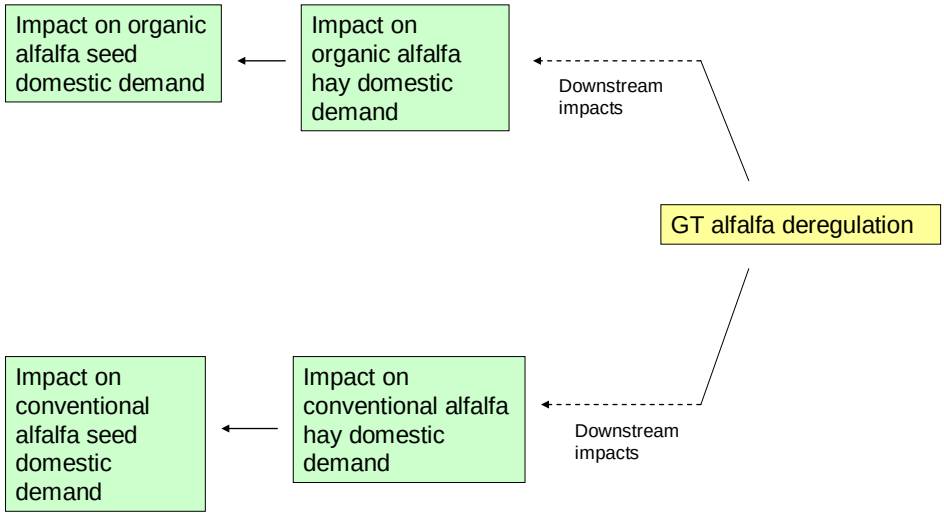

Figure S-2: Deregulation impact on demand

On the supply side, GT alfalfa deregulation will generate two sources of impacts. The first is the adoption of GT alfalfa by conventional farmers. This adoption will impact supply to the extent that GT alfalfa has its own quality and cost properties. The second is the possible comingling of GT alfalfa seeds among non-GT alfalfa seeds and gene flow from GT alfalfa fields to non-GT alfalfa fields. Figure S-3 below illustrates the cause-effect links analyzed.

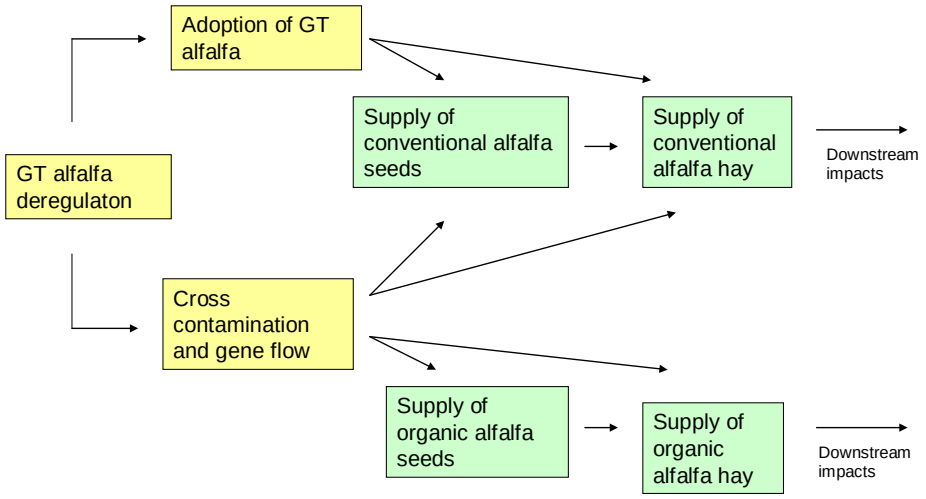

Figure S-3: Deregulation impact on supply

Comingling and gene flow could reduce the availability of seeds accepted as organic or free of GE content and could increase the costs of farmers in avoiding comingling and gene flow and in screening for GE alfalfa.

The interaction of the impacts on supply and demand will result in impacts on prices and quantities sold, and will impact differently on various segments of farmers. Some farmers could lose business with comingling and gene flow. Others – possibly depending on location – could gain, as could GT alfalfa farmers. Who gains or loses could have impacts on the market structure. It could also have an impact on perceptions of freedom of choice and on perceptions of justice associated with the distribution of the burden (among consumers of organic products as opposed to consumers of GE products, for example). Deregulation could also have social impacts, particularly on organic farmers and consumers. Figure S-4 below illustrates impacts on prices and quantities sold and social impacts.

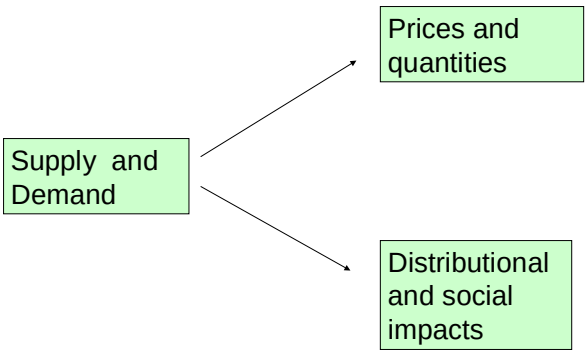

Figure S-4: Supply and demand

1.2.2 Data and Information Sources

Most of our data were obtained from United States Department of Agriculture (USDA) sources, under the assumption that these are the best quality agriculture statistics available. These data were complemented with information obtained from academic journal articles, or from Cooperative Extension services, peer reviewed whenever possible, under the assumption that

these documents are subject to standards that should help reduce if not eliminate any intentional bias.

Our primary source of data for acreage and production was USDA's National Agriculture Statistics Service (NASS). NASS collects data annually through a series of surveys based on representative samples, including area surveys and yield surveys. We also made use of data published by USDA's Economic Research Service, typically also compiled from NASS surveys. In cases where recent survey data were not available, we used the latest Census of Agriculture (2007), comparing with the previous Census of Agriculture (2002 or 1997) when this was considered informative.

In the case of organic agriculture there is less availability of data. USDA has been collecting data on acreage. As yields vary substantially, production estimates are tentative.

2.0 Impacts on Demand

2.1 Alfalfa Demand

An analysis of demand for alfalfa should distinguish between demand for alfalfa hay, demand for alfalfa seeds, and demand for alfalfa for human consumption, each with its own particular market and market characteristics. Demand for alfalfa hay (as well as products such as haylage, meal, and pellets processed from hay) derives mostly from the dairy industry, but also from the meat producing industry and from other livestock and pet care. Alfalfa is also available for human consumption in the form of alfalfa sprouts and alfalfa leaves, which can be dehydrated and used as a dietary supplement in tablets, powders, or tea.

In addition, as noted in the Technical Report *Downstream Effects to Organic Production and Marketing of Deregulation of Glyphosate-Tolerant Alfalfa* (appendix T) addressing downstream effects of GT alfalfa deregulation, the honey industry utilizes alfalfa fields for honey production. Alfalfa produces a large amount of nectar, which is attractive to some species of bees, and from which honeybees produce excellent crops of high quality honey (McGregor, 1976). The actual market "demand" for alfalfa hay fields by beekeepers appears to be small to non-existent. Alfalfa seed producers contract with bee keepers for pollination services, with honey production being sometimes a co-benefit retained by the bee keeper. Pollination services are an important interstate business. Brady-Myerov (2006) reported that 80 percent of the approximately 2.3 million commercial bee colonies that existed in the United States in 2006 needed to be trucked to California almond orchards just to meet pollination service demand. Brady-Myerov (2006) noted that the going rate for pollination services in 2006 was approximately $125 to $150 per hive for six weeks of orchard placement.

In contrast, when alfalfa is cut for hay just at the start of the flowering stage, as is normally practiced, beekeepers get little or no alfalfa honey (McGregor, 1976). Beekeepers could keep hives near alfalfa hay fields to access any blossoms prior to cutting, but we found no evidence that beekeepers engage in a commercial market exchange to purchase nectar harvesting services from hay farmers.

Demand for alfalfa seeds is derived primarily from the demand for establishing new stands of alfalfa hay, as well as much smaller demand derived from alfalfa sprout producers and from other processed alfalfa products for human consumption.

GT alfalfa deregulation will affect organic and conventional alfalfa demand to the extent that it affects dairy, livestock, pet care and various forms of human consumption domestically. These impacts are mediated by consumer concerns about consumption of GE foods, or use of GE animal feeds. The extent to which GT alfalfa deregulation will potentially affect conventional and organic alfalfa demand is also influenced by the price, availability, and comparability of substitutes.

2.1.1 Domestic Demand for Alfalfa for Forage

There seems to be no complete and systematic data on alfalfa for forage consumption in the United States (Klonsky et al., 2007). However, an approximate aggregate value of the demand for alfalfa hay can be obtained through production and trade statistics.[1]

USDA's NASS estimates the value of alfalfa hay production in the United States to have been approximately US $8 billion in 2009. This number was obtained by multiplying average prices with volumes produced and does not correspond to actual sales. Sales must have been much less. According to Klonsky et al. (2007), most of the alfalfa hay produced in the United States is consumed on farm.

If we subtract $354 million in alfalfa hay exports from the $8 billion and add $4 million in imports, we have a domestic market for alfalfa hay of approximately $7.6 billion in 2009. The same reasoning would lead to a domestic market of $10.5 billion in 2008 and $8.8 billion in 2007. Table S-1 below shows the domestic alfalfa hay market.

Table S-1. Domestic Alfalfa Hay Market (US $1,000)

	2009	2008	2007	2006	2005
Production	7,997,221	10,747,161	8,855,044	7,668,870	7,342,000
Exports	354,074	215,181	171,249	165,192	165,087
Imports*	3,848	16,079	6,800	3,613	2,430
Consumption	7,646,995	10,548,059	8,844,595	7,507,291	7,179,343

Sources: Production data from USDA NASS (2010); Trade data from USDA Foreign Agricultural Service (FAS); Consumption calculated as production – exports + imports, and assuming change in alfalfa inventories is zero. * Imports reported of Alfalfa Bales, as opposed to Alfalfa Hay.

We found no data on the national distribution of the consumption of alfalfa hay among its various uses. Putnam (2005) states that the three main domestic markets for alfalfa are dairy farms, beef farms, and horse farms, with minor uses of alfalfa hay "for small ruminants (sheep, goats), alfalfa meal for processed feeds, and alfalfa pellets for pets and rabbits." Of these, dairy farms are "by far" the main consumer. Klonsky et al. (2007) estimate dairy farms to absorb between 75-85 percent of alfalfa hay in California, with another 10-15 percent destined to horses and 5-10 percent to beef.

One indication of the role of dairy farms on alfalfa hay consumption can be found by multiplying the number of dairy cows in the United States by an estimate of alfalfa hay intake. If we follow Hoyt (2001) and estimate an intake of 15 pounds of alfalfa hay per day per dairy cow, another 7 pounds a day for milk replacement heifers, and another 3 pounds a day for dairy heifers under 500 pounds, and assume the proportion between milk cows, milk replacement heifers and heifers under 500 pounds is roughly 4:2:1, we have an estimated consumption of alfalfa hay for dairy of approximately 177 million pounds per day or 32.8 million tons a year:

9.2 million milk cows in 2007 (USDA ERS, 2008) x 15 lb = 138 million lb
4.6 million replacement heifers x 7 lb = 32.2 million lb
<u>3.2 million heifers under 500 pounds x 3 lb = 9.6 million lb</u>

[1] Assuming the accumulation of stored alfalfa hay over time is zero.

Total: 179.8 million lb per day or 65,627 million lb per year or 32.8 million tons (short)/year This corresponds to roughly 48 percent of the domestic market estimated at 69.1 million tons in 2007 (69.9 million tons produced, minus exports, plus imports).[2] These data suggest that the share of alfalfa hay demand deriving from non-dairy sources (beef production, horse care, and secondary processing into meal and pellets) is larger nation-wide than in California, the top dairy-producing state in the United States (California Department of Food and Agriculture, 2005).

The quality of alfalfa hay is guided by the low presence of weeds, by relatively low content of fiber, and high content of protein, and other factors such as color and presence of mold (Klonsky et al., 2007). Categories are classified in different ways. USDA's Agricultural Marketing Service uses the grades of supreme, premium, good, fair, and utility to regularly report average prices in various states. They describe each grade as follows:

- Supreme: Very early maturity, pre bloom, soft fine stemmed, extra leafy. Factors indicative of very high nutritive content. Hay is excellent color and free of damage
- Premium: Early maturity, that is, pre-bloom in legumes and pre head in grass hays, extra leafy and fine stemmed-factors indicative of a high nutritive content. Hay is green and free of damage.
- Good: Early to average maturity, that is, early to mid-bloom in legumes and early head in grass hays, leafy, fine to medium stemmed, free of damage other than slight discoloration.
- Fair: Late maturity, that is, mid to late-bloom in legumes, head-in grass hays, moderate or below leaf content, and generally coarse stemmed. Hay could show light damage.
- Utility: Hay in very late maturity, such as mature seed pods in legumes or mature head in grass hays, coarse stemmed. This category could include hay discounted due to excessive damage and heavy weed content or mold. Defects will be identified in market reports when using this category. (USDA AMS, 2008)

Other sources note that alfalfa hay quality grades differ to some degree from state to state (McWilliams et al. (2005), or speak of high quality alfalfa as being "dairy-quality" (Klonsky et al., 2007). According to Klonsky et al. (2007), there is no clear cut classification for alfalfa hay quality.

> *Hay quality guidelines are published by USDA Hay Market News, but quality factors are generally loosely decided by industry habit and practice, and can be freely modified by individual buyers and sellers, depending on their needs and the realities of the market.*

Dairy cattle and horses both tend to have high forage quality requirements (Van Deynze et al., 2004). Most weeds are lower in forage quality or palatability than alfalfa, and forage with high weed content can adversely affect milk production as well as animal growth and health (Van Deynze et al., 2004). Forage quality requirements for sheep and goats are not as rigorous. Beef producers in particular, facing relatively low margins, are apparently a market for lower quality (and cheaper) alfalfa (Klonsky et al., 2007).

[2] Production data from USDA ERS, 2007. Trade data from USDA FAS (online searchable database). Trade data are available in metric tons, transformed to short tons by multiplying by 1.10231.

Some states provide data on prices of different hay qualities. Table S-2 below shows some of the price differences expected of different hay qualities in some areas of California. The table also illustrates differences in prices depending upon location. As shown, prices can vary by more than 50 percent depending on quality and location. Distinctive regional alfalfa markets likely reflect the importance of transportation costs in limiting the trucking of relatively high volume, low value alfalfa hay across longer distances.

Table S-2. Price Differences of Hay Qualities, 10-Year Average, 1997-2006 (US $ per ton)

	Hay Quality Category			
Region	**Supreme**	**Premium**	**Good**	**Fair**
Southern California				
Imperial Valley	121	115.24	100.29	86.35
Blythe/Parker	120.14	114.52	99.38	82.56
Chino/LA	148.37	140.34	125.65	110.74
Mojave Desert	129.11	123.01	111.86	93.52
San Joaquin Valley				
Kern County	139.45	128.07	110.01	92.57
Tulare/ Visalia/ Hanford	163.54	149.42	129.83	109.13
Hanford/ Corcoran/ Tulare	146.25	132.62	113.75	94.08
Fresno/ Madera Counties	145.24	129.77	108.48	92.27
Los Banos/ Dos Palos	147.24	136.66	116.92	96.98
Escalon/ Modesto/ Turlock	161.69	148.94	130.23	109.20

Source: Klonsky et al. (2007)

2.1.2 Domestic Demand for Alfalfa Seed

The demand for alfalfa seed derives from the demand for establishing new stands of alfalfa hay, and to a much lesser extent from the demand for alfalfa products destined for human consumption. As in the case of alfalfa hay, the domestic alfalfa seed market can be estimated based on available data for production, exports, and imports. The last year for which complete data are available is 2007, the year of the last Census of Agriculture.

Table S-3. Domestic Alfalfa Seed Market (US $1,000)

	2007	**2002**	**1997**
Production	93,173	66,724	104,492
Exports	66,094	25,963	50,372
Imports	36,363	10,864	14,521
Consumption	63,442	51,625	68,641

Sources: Production data from USDA Census of Agriculture (2007, 2002, 1997); Trade data from USDA Foreign Agricultural Service (FAS); Consumption calculated as production – exports + imports, and assuming change in alfalfa inventories is zero.

Table S-3 suggests the domestic demand for alfalfa seeds in 2007 was approximately US$ 63 million, up from US$ 52 million in 1997. Imports represented some 64 percent of domestic demand, although it is possible that some of these imports were re-exported.

2.1.3 Domestic Demand for Alfalfa for Human Consumption

Some alfalfa seed is used to produce sprouts for human consumption. Seed for sprouting is produced throughout the world, but the major suppliers are in the US, Canada, and Australia. Approximately 80 million pounds of alfalfa seed are produced each year in the United States. Of that, 85 percent is produced in five western states – California, Idaho, Oregon, Washington, and Nevada. The balance is from Arizona, Utah, Montana, Wyoming, and other states. The primary market for that seed is planting stock to produce forages to support the livestock industry in the United States and throughout the world. Only a small fraction of the seed produced is used for sprouting (Mueller, Undated).

There does not appear to be any publicly available sales data for alfalfa sprouts. In testimony given in a public meeting convened by the U.S. Department of Health and Human Services' Food and Drug Administration (1998), sprout industry expert Dr. Earl Hauserman noted that as of 1998 there were about 350 sprouters in the United States. He noted that green sprouts (alfalfa, broccoli, clover, mustard, onion, radish, sunflower, and other sprouts) amount to about $80 million a year in sales. Hauserman also stated that alfalfa sprouts account for about 75-80 percent of the green sprout market, or $60-$64 million in annual sales. Hauserman stated that U.S. sprouters utilize approximately 125,000 to 150,000 pounds of alfalfa seed a month to produce about 5 to 6 million 4-ounce packages a month. On an annualized basis, Hauserman's testimony would imply that 1998 alfalfa sprouters purchased 1.5-1.8 million pounds of alfalfa seeds, and produced 15-18 million pounds of alfalfa sprouts. Hauserman estimated that between 5 and 10 percent of U.S. residents consume sprouts of various kinds.

Dehydrated alfalfa leaf is commercially available as a dietary supplement in several forms, such as tablets, powders, and tea. Alfalfa is also believed by some to be useful as an herbal or homeopathic medicine (Foster and Johnson, 2006). Once again there does not appear to be any publicly available sales data for alfalfa produced for dietary supplements, herbal remedies, or homeopathic medicines. Nelson (2008) reports an estimate that the total U.S. alfalfa supplement market could be satisfied with 10 tons of alfalfa hay production, which could be produced on 1-2 acres.

2.1.4 Domestic Demand for Organic Alfalfa for Forage

As in the case of non-organic alfalfa for forage, organic alfalfa also faces a derived demand, mainly from the demand for organic dairy and beef (Butler, 2002) but also for use as a fertilizer in the form of alfalfa meal. The higher price of organic hay (described later in this section) will generally deter conventional livestock producers from using organic alfalfa when it is not necessary to do so.

To be sold as organic in the United States, alfalfa hay must meet standards established by the Organic Foods Production Act of 1990 and the National Organic Program (NOP) that became effective in 2001. According to these standards, to be sold as organic, dairy and meat products must come from dairy cows and livestock fed 100 percent with organic feed, with the exception of vitamin and mineral supplements (USDA NOP, 2008). NOP standards also state that dairy animals must be managed organically for at least 12 months in order for milk or dairy products to be sold, labeled, or represented as organic. Dairy producers could use land that is

transitioning during its third year of transition to organic certification to provide crops and forage for dairy animals during this 12-month period prior to the sale of dairy products as organic (USDA NOP, 2008). For the use of GT alfalfa meal as a soil additive, NOP standards do not currently disallow the use of GE plant material in fertilizers (USDA NOP, 2010).

Information on organic alfalfa hay acreage is available from USDA Economic Research Service for 2005 (we cover this in section 3 on alfalfa supply). However, we found no publicly available information on trade in organic alfalfa, making estimates of domestic demand impossible. If domestic demand for organic alfalfa follows the same trend of organic alfalfa hay production, it is a growing demand. As shown in section 3, organic alfalfa hay represented in 2005 0.92 percent of total alfalfa hay harvested acreage, up from 0.51percent in 2000.

There is likely a GE-sensitive segment of the market for most organic products. The first version of the NOP published by the USDA in 1997 did not exclude GE organisms. After the over 270,000 comments received to this first version, this was one of the main aspects changed (Hubbard, 2006), even though there are not set tolerance levels for the presence of unintended genetically engineered content (the organic certification standard focuses on the process rather than the product). We found no information on the possible size of the GE sensitive segment of the market for organic products in the United States. We argue further below, however, that opposition to genetic engineering within the organic market might not translate to reduced demand in the case of alfalfa hay.

Prices and quality requirements are significantly different between organic and non-organic alfalfa hay. In its *Organic Alfalfa Hay* report, the University of California found that prices for organic alfalfa hay will vary depending on season, the market, and quality, but will be approximately 20 percent greater than prices for conventional hay (Long et al., 2007).

Table S-4 below shows how prices differ between organic and conventional alfalfa hay in Escalon, Modesto, and Turlock counties in California in 2008. The average premium reported in this particular data set is slightly less than 12 percent.

Table S-4. Prices for Organic and Conventional Alfalfa Hay; Escalon, Modesto, Turlock, California, 2008 (US $ per ton)

	JAN	FEB	MAR	APR	MAY	JUN
Alfalfa (Organic) Domestic Cattle						
Supreme	270.00					
Premium					270.00	
Good						
Alfalfa Domestic Cattle						
Supreme	249.28	248.52	255.07	256.74	258.56	261.55
Premium	238.62	246.15	253.29	245.47	250.18	251.22
Good	231.67	242.60	237.50	232.91	238.33	245.93
Difference						
Supreme	20.72					
Premium					19.82	
Good						

Table S-4. Prices for Organic and Conventional Alfalfa Hay; Escalon, Modesto, Turlock, California, 2008 (US $ per ton)

	JUL	AUG	SEP	OCT	NOV	DEC	AVG (year)
Alfalfa (Organic) Domestic Cattle							
Supreme	305.00	293.81		295.00			295.71
Premium		278.80	278.40	273.00			277.90
Good		261.25	265.00	260.00			262.81
Alfalfa Domestic Cattle							
Supreme	271.65	271.70	263.48	266.09	236.32	247.45	260.34
Premium	256.90	257.55	246.96	243.29	208.70	219.52	247.98
Good	247.76	242.82	240.90	220.18	186.25	162.50	239.87
Difference							
Supreme	33.35	22.11		28.91			35.37
Premium		21.25	31.44	29.71			29.92
Good		18.43	24.10	39.81			22.94

Source: USDA, AMS (2008).

2.1.5 Domestic Demand for Organic Alfalfa Seeds

Demand for organic alfalfa seeds derives from the demand for organic alfalfa hay, as the NOP requires the use of organic seeds to establish organic alfalfa stands (CFR Title 7, §205.204). However, an exception is made to the requirement of using organic seeds in cases where these are not available.[3] In these cases, untreated conventional seeds or seeds treated with substances included in the National List of synthetic substances allowed for use in organic crop production are typically allowed.

We were not able to estimate the demand for organic alfalfa seed, due to the lack of data on production of organic alfalfa seed as well on organic seed trade. It is possible that the fact that non-organic seeds are allowed for the production of organic alfalfa hay has reduced the demand of organic alfalfa seed and incentives for production.

However, some demand is likely to exist and it could be currently supplied by either domestic or imported production (imported seeds in 2002 were approximately 21 percent of domestic consumption, in 2007, imported seeds were 64 percent of domestic consumption). The Organic Materials Review Institute (OMRI), a nonprofit managed by the organic industry that self-regulates allowed substances in organic production, reports nine suppliers of organic alfalfa seed its seed database (OMRI, 2010). Some of this seed is imported from Canada.

Baker (2008) notes that the main reason reported by organic certifiers to accept farmers claims that organic seeds are not available is the claim that available seeds are not “equivalent” to non-organic available seeds in their desired qualities. When asked what crop was most claimed to not have available organic seeds, certifiers identified alfalfa. This could be an indication of an unfulfilled demand that, given the growth rates in organic alfalfa seed production, is likely to stimulate the development of “equivalent” organic varieties that are now possibly not available. The supply to satisfy this demand could come from domestic or foreign sources.

[3] This exception is not made for production of organic edible sprouts.

2.1.6 Domestic Demand for Organic Alfalfa for Human Consumption

As noted in section 2.1.3 above, some alfalfa seed is used to produce sprouts for human consumption. Seed for sprouting is produced throughout the world, but the major suppliers are in the US, Canada, and Australia. The primary market for alfalfa seed, however, is planting stock to produce forages to support the livestock industry in the United States and throughout the world. Only a small fraction of the seed produced is used for sprouting (Mueller, undated). There does not appear to be any publicly available sales data for organic alfalfa sprouts. Using data drawn from the U.S. Department of Health and Human Services' Food and Drug Administration (1998), it is estimated in section 3.1.3 that 1998 alfalfa sprouters purchased 1.5-1.8 million alfalfa seeds, and produced 15-18 million pounds of alfalfa sprouts. Presumably organic sprout production in 1998 was some fraction of total sprout production.

As noted in section 2.1.3 above, dehydrated alfalfa leaf is commercially available as a dietary supplement in several forms, such as tablets, powders, and tea. Alfalfa is also believed by some to be useful as an herbal or homeopathic medicine (Foster and Johnson, 2006). Once again there does not appear to be any publicly available sales data for alfalfa produced for dietary supplements, herbal remedies, or homeopathic medicines. Nelson (2008) reports an estimate that the total U.S. alfalfa supplement market could be satisfied with 10 tons of alfalfa hay production, which could be produced on 1-2 acres.

2.2 Impact of GT Alfalfa Deregulation

2.2.1 Shifts in Demand

The quantity of alfalfa hay demanded depends on its price and quality. Quality is mostly influenced by the presence of weeds. The impact of GT alfalfa deregulation on price (and quantities) will be the result of its impact on the remaining determinants of demand and supply. We focus here on the possible impact of GT alfalfa deregulation on the demand for alfalfa hay quality and leave the joint analysis of supply and demand impacts on prices and quantities for section 4.

The main possible impact of GT alfalfa deregulation on the domestic demand for alfalfa hay, conventional or organic, depends on the existence of a GE sensitive market among domestic consumers of alfalfa hay. If GT alfalfa is seen as an undesirable quality of alfalfa hay by some, these consumers could seek to substitute their purchases by: a) seeking imported non-GT alfalfa hay; b) seeking some form of GE-free certification; c) using GE-free hay based on other crops. In the case of GE sensitive consumers of conventional alfalfa hay, a fourth alternative might be to shift to organic alfalfa hay, or to certified conventional seeds that are able to guarantee that any presence of GT alfalfa is kept below certain levels.

In the case of alfalfa seed production, the impact of GT alfalfa deregulation on domestic demand would depend mainly on the impact of GT alfalfa deregulation on the demand for alfalfa for hay, since this is by far its main use.

Throughout our analysis of potential shifts in demand, we assume that presence of non-GT alfalfa occurs or is perceived to occur at a level considered relevant by the markets analyzed. If there is no presence or perception of presence of conventional and organic alfalfa by GT alfalfa, there is no impact on demand.

As demand for alfalfa hay is a derived demand from that for dairy, meat and other animal products, we first summarize the results of our analysis on the impact of GT deregulation on the demand for those products in downstream markets. This analysis is done in our Technical Report *Downstream Effects to Organic Production and Marketing of Deregulation of Glyphosate-Tolerant Alfalfa* (appendix T).

2.2.2 Impact on Downstream Demand

In the above mentioned report, we analyze the impact of GT alfalfa deregulation on the demand for dairy, meat and other animal products, since alfalfa hay is used as an input in the production of these products, as well as in the production of nutritional supplements for human consumption, in minor quantities.

The conclusions reached are summarized below.

In the case of downstream demand for conventional products:

- There is an ongoing trend of slow to moderate growth in demand for dairy products, driven mostly by population growth;
- In surveys, U.S. consumers often suggest a preference for non-GE foods;
- However, other GE crops (e.g., corn, soybeans, canola) have been deregulated in the United States for a number of years with no substantial drop in demand for conventionally produced dairy products or meat;
- Domestic markets for conventional alfalfa are less likely to be sensitive to GE content than export markets (not dealt with in this appendix), although privately developed standards and labels for food free of genetically engineered content reveal a nascent domestic market.

In the case of downstream organic products we found that organic dairy represents nearly 90 percent of the total sales value of the combined U.S. organic dairy and meat market in 2006. Thus, the dairy market is likely to be a more important downstream market for organic hay than is conventional dairy for conventional hay:

- Consumer preference for GE-free foods could be particularly strong among consumers of organic products and have contributed to strong growth in the organic sector;
- Current organic standards do not prevent the presence of unintended genetically engineered content in organic products and parallel labels have been developed by the private sector to address existing demand for products free of genetically engineered content;

- However, demand for organic products could or could not decrease with GT alfalfa deregulation and there is actually a possibility of an increase in the demand for organic products;
- To the extent that organic consumers do move away from domestic organic products the demand could be fulfilled by imported products or by products guaranteeing absence of genetically engineered content, under privately developed "non-GMO" labels.

We analyze other potential impacts in section 4.3.

2.2.3 Impact on Conventional Alfalfa Hay and Seed Domestic Demand

Based on the findings summarized in section 2.2.2 above, we expect no to minor reductions in the demand for conventional alfalfa hay *that derive from no to minor declines in the demand for conventional dairy, meat, eggs, and other animal products*. Due to the minor nature of any negative impact, it is more likely to manifest as a slowing of domestic demand growth, if at all.

As noted in section 2.1.2 above, the demand for alfalfa seed derives from the demand for establishing new stands of alfalfa hay, and to a much lesser extent from the demand for alfalfa products destined for human consumption. It is reasonable to conclude that there would be no substantial impact on domestic conventional alfalfa seed demand *that is derived from shifts in demand for alfalfa for forage.*

There would, however, be shifts in demand for conventional alfalfa seed and conventional alfalfa hay induced by shifts in supply of high quality hay. This will be analyzed further below when we consider the impact of GT alfalfa deregulation on supply.

2.2.4 Impact on Organic Alfalfa Hay and Seed Domestic Demand

To the extent that the demand for organic alfalfa hay is a derived demand, mainly from the demand for organic dairy, we found no evidence to suggest the demand for organic alfalfa hay would decrease with deregulation of GT alfalfa, *as a consequence of shifts in demand for organic downstream products*.

Given the disproportionately large share of organic dairy in the derived demand for organic alfalfa and the importance of alfalfa hay in dairy production it seems reasonable to expect that the demand for organic alfalfa hay would continue growing at a considerable pace, accompanying the growth in the demand for organic dairy.

There are, however, some possibilities of shifts up or down of the domestic demand of organic alfalfa hay. Given that the choice to produce organic products could not only be guided by market incentives but also by personal views of farmers, it is possible that some share of organic farmers could chose to abandon organic production if they feel that GE alfalfa has occurred in their seed or hay, or could potentially occur at levels they consider unacceptable. In this case, the demand for organic alfalfa hay would shift to the left. On the other hand, if there is any domestic GE sensitive market for conventional alfalfa, GT alfalfa deregulation could lead consumers in this market to shift to organic alfalfa (as argued in section 1.1.1). This would shift the demand curve outward. As long as economic incentives prevail in the choice or producing

alfalfa organically or not and as long as the GE sensitive domestic market among conventional alfalfa is small, neither of these possibilities should considerably alter the growth trend of the demand for organic alfalfa hay. As in the case of conventional alfalfa, there would likely be some shifts in demand caused by shifts in supply of conventional high quality alfalfa hay. We address this shift in section 3.

As previously noted, the demand for organic alfalfa seeds derives from the demand for organic alfalfa hay. Although the NOP requires the use of organic seeds to establish organic alfalfa stands, it is apparently common to use conventional seeds, given the often lack of organically grown seeds available. In this case, as the organic market is small relative to the conventional market, the impact of shifts in demand in the organic hay market would be likely minimal to non-perceptible in the market for conventional seeds.

The potentially existing unfulfilled demand for organic alfalfa seed could be reinforced by GT alfalfa deregulation and could translate into greater pressure for the growth of organic varieties considered "equivalent" to the presently used conventional ones.

2.3 Summary of Findings

The domestic market for alfalfa hay was estimated to be approximately $ 7.6 billion in 2009. The domestic market for alfalfa seed was roughly $ 63 million in 2007. Alfalfa demand is a derived demand from that for dairy, meat, pet care, and human consumption. Some sources indicate dairy is by far the main source of demand for alfalfa. We estimated dairy to be responsible for approximately half of the domestic demand, with meat production presumably consuming much of the rest. The demand for organic alfalfa seems to rely more heavily on dairy. While most of the seed used in organic alfalfa hay production is likely not organically produced, demand for organic alfalfa seeds, whether domestically produced or imported, is likely to grow in the near future.

We found no evidence that consumer sensitivity to GE products would necessarily translate into reduced demand for conventional or organic alfalfa hay with GT alfalfa deregulation. There is currently an unfulfilled demand for organic alfalfa seeds. This demand could increase further if GT alfalfa deregulation leads to an increased pressure for organic or non-GE certification of alfalfa seeds for organic production.

3.0 Impacts on Supply

3.1 Alfalfa Supply

In this section we focus on domestic production. Imports are more important for the domestic supply of alfalfa seed (imports have increased from 16 percent of domestic production in 1997 to 64 percent in 2007) than for alfalfa hay (0.1 percent of domestic production). Domestic production of hay is almost all destined to the domestic market, although the same cannot be said of seeds (roughly a third to a half are exported). We consider trade in our Impact on Trade Technical Report (appendix R).

3.1.1 Domestic Production of Alfalfa for Forage

Production of alfalfa hay in the United States in 2008 was approximately 70.2 million tons, reaching 71.0 million tons in 2008 (USDA NASS, 2009).[4] This corresponds to almost half the production of hay in 2007 and 2008 (approximately 145 million tons for both years). Production statistics for haylage are not available for all states for 2007, but based on the 2002 and 2007 Agricultural Census and more recent USDA NASS data available for 18 states, haylage production adds another 10-15 percent in alfalfa acres grown for forage.

Harvested acreage of alfalfa hay was in 2008 approximately 21 million acres (NASS, 2009) for an average yield of 3.3 tons per acre. See table S-6 below for alfalfa hay harvested acreage.

The alfalfa share of total hay production has been falling in the recent past, as has absolute production of alfalfa hay. In 2007 alfalfa production was at its lowest (69.6 million tons) compared to a high of 84.4 million tons in 1999. See table S-5 below for hay production data.

[4] Including alfalfa hay mixtures.

Table S-5. Hay Production (1,000 tons)

Year	Alfalfa Hay	Other hay
1990	83,413.00	62,799.00
1991	83,319.00	68,754.00
1992	79,140.00	67,763.00
1993	80,115.00	66,584.00
1994	81,130.00	69,006.00
1995	84,138.00	70,101.00
1996	79,139.00	70,640.00
1997	78,535.00	74,001.00
1998	81,992.00	69,395.00
1999	84,405.00	75,177.00
2000	81,520.00	72,083.00
2001	80,354.00	76,062.00
2002	73,014.00	76,453.00
2003	76,098.00	81,292.00
2004	75,375.00	82,747.00
2005	75,610.00	74,851.00
2006	70,548.00	70,235.00
2007	69,880.00	77,021.00
2008	70,180.00	76,090.00
2009	71,030.00	76,412.00

Source: USDA ERS, 2007

Alfalfa farming has also declined in terms of harvested acres, from as much as almost 24 million acres in 1999 to just over 21 million acres in 2009.

Table S-6. Alfalfa Hay Harvested Acreage (1,000 acres)

	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Acre-age	24,055	22,077	23,822	22,923	23,527	21,697	22,359	21,138	21,126	21,060	21,227

Source: USDA NASS, Various Years.

Regarding geographic distribution, as seen in table S-7 below, although alfalfa hay is grown most everywhere across the United States, it is most concentrated in the Midwest and Northwestern States. South Dakota has consistently devoted the most acres to alfalfa hay, with as much as 3 million acres of alfalfa hay in 2001.

Table S-7. Alfalfa Hay Harvested Acreage by State (1,000 Acres), 2008

State		State		State	
South Dakota	2400	Wyoming	530	Virginia	90
North Dakota	1660	Ohio	420	Maryland	45
Montana	1600	Oregon	420	Vermont	30
Wisconsin	1500	Washington	410	West Virginia	25
Minnesota	1350	New York	350	Tennessee	20
Iowa	1150	Missouri	350	New Jersey	20
Idaho	1130	Illinois	350	Arkansas	15
Nebraska	970	Oklahoma	310	Connecticut	9

Table S-7. Alfalfa Hay Harvested Acreage by State (1,000 Acres), 2008					
State		State		State	
California	950	Indiana	300	Maine	8
Colorado	820	Nevada	270	North Carolina	8
Michigan	770	Arizona	260	Massachusetts	8
Kansas	700	New Mexico	250	Delaware	6
Pennsylvania	550	Kentucky	240	New Hampshire	5
Utah	550	Texas	130	Rhode Island	1

Source: USDA NASS, 2009

As seen in table S-8 below, in terms of value of production, California has been the largest producer, thanks to high yields and over-average prices.

Table S-8. Alfalfa Hay Production by State, 2008

State	Harvested Acres	Yield (tons)	Production (tons)	Price per Unit (/ton)	Value of Production
California	950,000	7.0	6,650,000	204	1,470,840,000
Idaho	1,130,000	4.4	4,972,000	201	999,372,000
Iowa	1,150,000	3.8	4,370,000	135	589,950,000
South Dakota	2,400,000	2.30	5,520,000	97	535,440,000
Minnesota	1,350,000	3.1	4,185,000	130	544,050,000
Colorado	820,000	3.3	2,706,000	164	443,784,000
Nebraska	970,000	3.95	3,832,000	92	352,544,000
Washington	410,000	4.4	1,804,000	223	402,292,000
Pennsylvania	550,000	3	1,650,000	198	326,700,000
Utah	550,000	4.2	2,310,000	170	392,700,000
Kansas	700,000	4.1	2,870,000	127	364,490,000
Arizona	260,000	8.6	2,236,000	185	413,660,000
Nevada	270,000	4.8	3,832,000	188	243,648,000

Sources: columns 2-4 from USDA NASS, 2009; columns 5-6 from USDA NASS 2010.

Table S-9 shows the number of farms and tons of output broken down by alfalfa hay acreage and table S-10 shows the share of the total number of farms and tons of alfalfa hay for each group.

Table S-9. Farms per Acreage Size of Farm

Alfalfa acreage	Number of farms	Production (tons)
1-14.9	92,193	1,719,486
15-99.9	148,668	17,079,793
100-999.9	48,331	35,723,978
>1,000	1,534	10,825,845

Source: Census of Agriculture, 2007

Table S-10. Share of Farms/Production per Acreage Size of Farm

Alfalfa acreage	Percentage of farms	Percentage of Production
1-14.9	31.71%	2.63%
15-99.9	51.14%	26.14%
100-999.9	16.62%	54.67%
>1,000	0.53%	16.57%

Source: Census of Agriculture, 2007

Approximately 83 percent of farms grew fewer than 100 acres of alfalfa hay and less than 18 percent of the farms accounted for 71 percent of the alfalfa production in 2007. Many farms could grow relatively small plots of alfalfa as an input for dairy or other farm industries, particularly for own consumption.

Intermediation between alfalfa hay growers and dairy farms seems to be done largely by individual brokers (often the hay or dairy farmers themselves) or by farmer associations, at least in California (Klonsky et al., 2007)

3.1.2 Domestic Production of Alfalfa Seed

The latest complete information on alfalfa seed production comes from the 2007 Census of Agriculture. In 2007, approximately 62 million pounds of alfalfa seeds were produced compared to almost 58 million pounds from the previous Census in 2002. Table S-11 below shows how this reflected largely in an increase in acreage of harvested alfalfa for seeds.

Table S-11. Alfalfa Seed Production and Acreage

	2007	2002
Production (pounds)	62,115,239	58,020,460
Acreage	121,467	110,617

Source: Census of Agriculture, 2007, 2002.

More frequent data are available for some states that report voluntarily to the NASS.

Table S-12. Alfalfa Seed Acreage by State (1,000)

	California	Idaho	Montana	Nevada	Washington	Wyoming
2009		11	7			
2008		12	9		14	
2007	36	15	12	6	17	11
2006	36	15	11		14	6
2005		16	6		13	6
2004	32	22	6	5	13	4
2003	26	15	6	5	13	2
2002	26	18	7	6	14	4
2001	39	27	9	10	15	7
2000	75	46	19	14	17	
1999	100		20	13	19	
1998	67	39	18	13	18	
1997	49	39	14	12	13	
1996	46	33	12	13	13	
1995	44	35	12	12	15	

Source: USDA NASS, Various Years, Statistics by State. Numbers are rounded.

The data in table S-12 also show a fall in acreage dedicated to alfalfa seeds until 2002-2004 with some recovery in some states in recent years.

Mueller (2008) attributes recent reduction in alfalfa seed acreage in California to "changes in economics, environmental constraints, and regulatory issues." Mueller (Undated a) lists among difficulties of alfalfa seed farming in California scarcity of water for crop irrigation and lack of development of new chemicals for insect control due to high registration costs

Production of seeds is largely concentrated in the Northwest. The top eight producing states are from that region, as seen below in table S-13.

Table S-13. Alfalfa Seed Production by State (1,000 tons)

	2007		2002	
	Acres	**Production (tons)**	**Acres**	**Production (tons)**
California	36,625	19,083,458	27,160	15,543,144
Washington	17,127	10,860,608	14,161	11,887,387
Idaho	12,788	9,346,709	17,126	13,910,135
Wyoming	10,548	5,915,816	4,049	2,400,315
Nevada	6,498	4,237,101	(D)	4,695,737
Montana	10,338	3,729,635	6,824	2,024,033
Oregon	4,959	3,183,375	5,605	3,783,887
Utah	3,803	2,077,813	2,596	830,889
Arizona	5,206	1,902,669	2511	574020

Source: Census of Agriculture, 2007, 2002.

Mueller (Undated a) suggests California's share of production has fallen in recent years and a larger share is coming from the Northwestern states. In 2007, U.S. production of alfalfa seed came from 806 farms, about 70 percent from farms with over 250 acres of alfalfa seeds and 90 percent from farms with over 100 acres of alfalfa seeds.

Alfalfa seed constitutes a small portion of total alfalfa production in all of these states, though it appears to be more significant in California and Washington, making up between 3 and 7 percent of total alfalfa acreage from 2000-2007.

3.1.3 Domestic Production of Organic Alfalfa for Forage

There are no publicly available sources of data on U.S. organic alfalfa production, so an estimate is derived here for illustrative purposes only. The USDA Economic Research Service reports that there were 411,342 acres on which organic hay (all types) was produced in 2005. According to the USDA NASS, 61,729,000 acres were in hay (all types) in 2005, of which 22,439,000 acres were in alfalfa hay in 2005. Thus alfalfa hay acreage is 36.35 percent of total hay acreage in 2005. In 2005 the national average yield per acre for alfalfa was 3.39 tons.

If we assume that the proportion of alfalfa hay to total hay acreage is the same for organic as for conventional, then we can estimate that 411,342*0.3635 = 149,526.2 acres were in organic alfalfa hay in the United States in 2005. Based on differences in organic and conventional alfalfa yield from Long et al. (2007), we get total US organic hay production in 2005 of 149,526.2*3.39*0.875 = <u>443,532.1</u> tons. By way of comparison, if instead one assumes that two-thirds of all organic hay is alfalfa (perhaps driven by demand from organic dairies requiring alfalfa rather than grass or some other type of hay), then we get total U.S. organic hay production in 2005 of 274,242*3.39*0.875 = <u>813,470</u> tons. Based on these estimates, organic alfalfa hay

production tonnage in 2005 could represent between 0.58 percent and 1.07 percent of total alfalfa production. These estimates are rough, however, and should only be used for illustrative purposes.

As shown in table S-14 below, in terms of acreage, the number of acres devoted to growing organic alfalfa hay increased every year between 2001 and 2008, except for 2003 and 2006. The share of all alfalfa hay acres that grew organic hay increased from 0.49 percent in 2000 to 1.22 percent in 2008.

Table S-14. Organic Alfalfa Hay Harvested Acreage

	2000	2001	2002	2003	2004	2005	2006	2007	2008
Acreage	113,157	116,608	155,437	135,717	175,260	204,380	188,911	223,234	256,554
Share of Total Acreage	.49%	.49%	.68%	.58%	.81%	.91%	0.89%	1.06%	1.22%

Source: USDA ERS, 2005; USDA NASS, 2007

Organic alfalfa hay production is distributed geographically similarly to conventional hay. However, production of organic alfalfa hay is more significant in proportion in some states than others. In 2005, for example, of all alfalfa hay acreage in Idaho, more than 4 percent was organic, compared to a national proportion of 0.92 percent. Table S-15 below shows the geographic distribution of organic alfalfa hay acreage.

Table S-15. Geographic Distribution of Organic Alfalfa Hay Acreage

State	**Organic Acreage**			
	2005	2006	2007	2008
Idaho	49,497	49,388	60,756	62,670
Wisconsin	29,389	21,344	8,649	9,416
Minnesota	21,339	14,426	14,203	16,773
North Dakota	20,614	12,815	22.536	25,094
South Dakota	13,930	13,261	18,427	22,622
California	13,246	11,920	12,187	18,800
Iowa	9,193	7,277	6,328	8,213
Colorado	8,943	9,704	9,946	11,893
Nebraska	8,192	4,875	7,940	10,910
Oregon	6,592	11,127	26,089	29,210

Source: USDA ERS, 2005

Organic alfalfa also seems to be grown in pockets, with 72 percent of organic acreage being found in just six states: Idaho, Wisconsin, Minnesota, North Dakota, South Dakota, and California (these six states only account for about 41 percent of total acreage).

3.1.4 Domestic Production of Organic Alfalfa Seed

There are no publicly available sources of data on U.S. organic alfalfa seed production. To the extent that conventional alfalfa seeds are used in organic production (NOP permits in the lack of available organic seeds) a rough estimate of the production of seeds for the organic market follows. In section 3.1.3 it was estimated that U.S. organic hay production in 2005 could range between 0.58 percent and 1.07 percent of total alfalfa hay production. If stand establishment

demand for organic alfalfa seed (expressed as a percentage of total alfalfa seed demand from section 2.1.2) is roughly in the same proportion, then U.S. consumption of alfalfa seed for organic production in 2002 would range between $300,700 and $551,500. These demand estimates are rough and should only be used for illustrative purposes.

In section 2 we suggested that the production of organic alfalfa seeds could lag behind demand. This could be due to difficulties in producing organically the preferred varieties for organic alfalfa hay production, given the evidence we previously presented on complaints of non-availability of organic alfalfa seeds "equivalent" to the conventional ones used.

According to the OMRI's Organic Seeds Database, there are currently nine certified suppliers of organic alfalfa seed, providing for a total of twenty-six varieties of seed (OMRI, 2010). Although some of this seed is imported, it is likely that some was produced domestically. In the Fourth National Organic Farmers' Survey, 138 organic farmers reported producing a total of 15,169 acres of organic hay, 1% of which was then sold as seed or propagation stock (OFRF, 2004)

3.2 Impacts of GT Deregulation

3.2.1 Shifts in Supply

GT alfalfa deregulation will introduce a new cultivar that will compete with others in the conventional alfalfa seed and forage markets. As the main economic characteristics of the GT alfalfa cultivar are its reduced use of herbicide with potentially improved quality of alfalfa forage (reviewed in Technical Report *Changes in the Economics of Alfalfa Farming with Deregulation of Glyphosate-Tolerant Alfalfa* in appendix K) GT alfalfa will likely compete with the high quality alfalfa forage market. The domestic supply of conventional alfalfa for forage and conventional alfalfa seeds in the domestic market will then be impacted by GT alfalfa deregulation to the extent that the availability of GT alfalfa changes costs and returns to alfalfa farmers that choose to plant GT alfalfa.

The Technical Report *Changes in the Economics of Alfalfa Farming with Deregulation of Glyphosate-Tolerant Alfalfa* (appendix K) argued that, at least in the short run (during the planning horizon of the life of a stand), and under farming conditions typical of specific areas of two different regions of the country (Wisconsin and the San Joaquin Valley, California), GT alfalfa hay could offer higher returns when compared to conventional alfalfa hay, given potentially lower herbicide costs and potential high quality (low weed content). This would not always be the case, and the likelihood of GT alfalfa offering higher returns to any specific farmer would depend on the current farming practices. To the extent that the conditions presented in the two studies are sufficiently prevalent to impact the overall supply of alfalfa, the effect of the introduction of GT alfalfa in the market could be a shift outward in the supply of alfalfa. This would be caused by the reduction in average costs necessary to produce alfalfa of a given quality. This is represented in figure S-5 below and would imply a decrease in prices and increase in quantity of alfalfa sold, as dairy and meat farmers substitute alfalfa for other feeds. The less prevalent the conditions under which GT alfalfa would offer higher returns, the smaller the impact of deregulation would be on the supply of alfalfa.

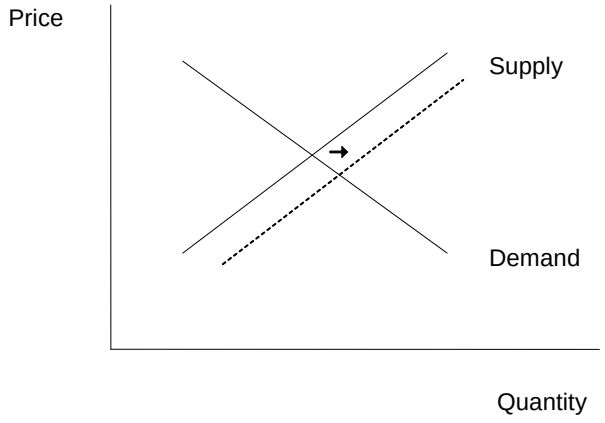

Figure S-5: Overall impact on supply of introduction of GT alfalfa

Within the alfalfa market, however, there are segments: conventional and organic, domestic and international, high and low quality alfalfa, and possibly GE sensitive and non-GE sensitive. The impact of GT deregulation on each of these segments will not be the same. There are two main possible sources of shifts in supply introduced by GT alfalfa deregulation:

1) Changes in production costs for those adopting GT alfalfa
2) Changes in production costs for those not adopting GT alfalfa and that are associated with presence of GT alfalfa in non-GT alfalfa (cross-pollination or gene flow).

Organic alfalfa growers cannot adopt GT alfalfa because GE crops cannot be certified as organic. However, organic alfalfa growers could be affected by deregulation of GT alfalfa in several ways. First, to the extent that conventional and organic alfalfa are substitutes, a decrease in the price of conventional alfalfa would affect the demand of organic alfalfa. Second, the unintended presence of GT alfalfa in non-GT alfalfa fields could affect producer costs and returns, given an existing demand for GE-free alfalfa, through avoidance costs (including testing) or loss of production.

Shifts in domestic production might or might not be partially offset by imports. We leave any analysis of impacts on imports for another report and assume for now that there is no change in imports of alfalfa.

Throughout this section we do not analyze shifts in demand, but assume there is some demand for GE-free alfalfa.

We analyze the impact of each possible source of shifts in supply below.

3.2.2 Impacts on Supply from Adoption of GT alfalfa

To the extent that GT alfalfa adoption allows for a reduction in production costs of alfalfa hay of a given quality or, alternatively, improvements in quality of alfalfa hay with no increase in costs, the supply curve for alfalfa would shift outward, reducing prices and increasing output. The extent to which this would happen depends on how prevalent in the United States are the farming conditions under which GT alfalfa would offer increased returns. As noted, however, the alfalfa market is segmented in various ways and the impact on producers of various alfalfa varieties and for various markets would not be the same.

We analyze the impact of shifts in supply in the various alfalfa market segments below. In doing so, we should not lose sight of the fact that the sum of the supply of alfalfa in the various markets will add to the total alfalfa supply. Thus, shifts in supply in one segment are likely to be compensated by shifts in supply in another to the extent that they add up to the total supply shift suggested in section 3.2.1.

In the case of those adopting GT alfalfa for forage, a reduction in costs of production of GT alfalfa as compared to conventional alfalfa, or an equivalent improvement in quality of alfalfa forage for a given production cost would have the impact of an outward shift in the supply curve in the market for high quality alfalfa forage with reduction in prices and increases in quantities bought and sold in the market. This is represented in figure S-6 below.

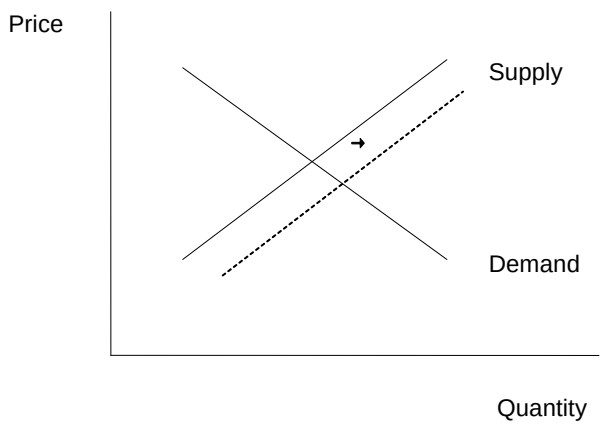

Figure S-6: Impact of adoption of GT alfalfa on the market for high quality alfalfa forage

Despite no shift in the demand curve, the quantity of alfalfa forage of high quality demanded in the market would increase given the lower prices induced by the production of GT alfalfa and its consequential shift in the supply curve. How much the price would fall and how much the quantity of high quality alfalfa sold would increase, we do not know. This depends on the extent to which the demand curve is sensitive to decreases in prices, that is, the inclination of the demand curve portrayed in figure S-6 (price-elasticity of demand).

The reduction in the price of high quality alfalfa hay would likely have an impact on the demand for alfalfa hay of lower quality, as well as on the demand for alfalfa hay of high quality that is only available at higher costs (non-GT alfalfa). To the extent that high quality and low quality (or higher cost) alfalfa hay are substitutes, a reduction in the price of high quality alfalfa hay would reduce the demand for low quality alfalfa hay, shifting the demand curve to the left.

Supply of low quality alfalfa hay could decline, depicted as a leftward shift of the supply curve. If only farmers already producing high quality alfalfa adopt GT alfalfa, there would be no change in the supply curve of low quality alfalfa. However, if adoption of GT alfalfa were widespread, farmers currently producing low quality alfalfa might also adopt GT alfalfa and the supply curve of low quality alfalfa would shift to the left.

Figure S-7 illustrates these movements. The result is clearly a reduction in the quantity of low quality alfalfa hay in the marketplace. The impact on prices, though, is undetermined and would depend on the magnitude of change of each factor described above, as well as on the sensitivity of the demand and supply curves to prices (price elasticities of supply and demand).

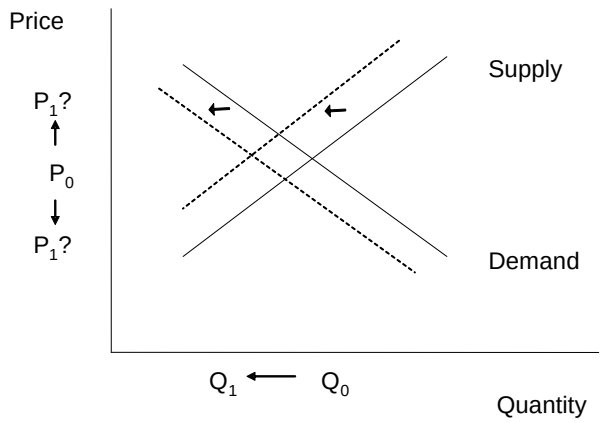

Figure S-7: Impact of adoption of GT alfalfa on the market for low quality alfalfa forage

The organic alfalfa hay market could suffer a similar decline in demand. This would happen under two possible scenarios.

(1) If organic dairy and meat farmers consider shifting to conventional farming in the face of the decreased costs of high quality conventional alfalfa (and presumably increased returns);
(2) If the decreased costs of high quality conventional alfalfa are transmitted to conventional dairy and meat costs, increasing the price differential between conventional and organic dairy and meat, stimulating organic dairy and meat consumers to purchase conventional products.

We have no evidence on the likelihood that the first scenario would occur. To the extent that organic farmers have chosen organic production out of philosophical values, the economic incentive to switch to conventional farming should not have an impact. The likelihood of the second scenario is also not clear. In our Technical Report *Downstream Effects to Organic Production and Marketing of Deregulation of Glyphosate-Tolerant Alfalfa* (appendix T), we argue that governmental intervention in the pricing of milk and the low share of alfalfa in total meat production cost suggest the transmission of lower alfalfa costs to prices of conventional dairy and meat should be minor.

The remaining analysis in this chapter considers the case in which a decline in demand for organic alfalfa does occur to some extent, since this is a scenario of particular concern to organic farmers. Figure S-8 reflects the shift in demand for organic alfalfa.

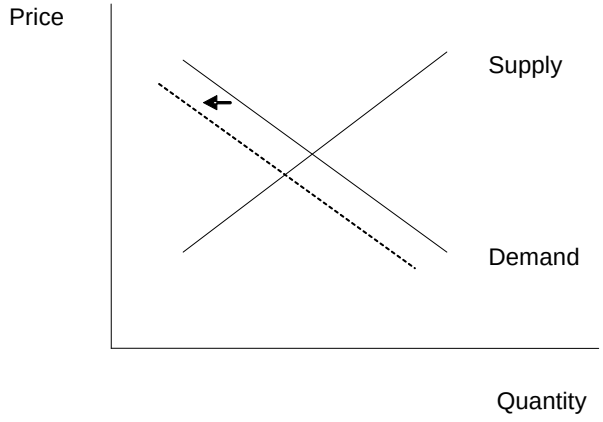

Figure S-8: Impact of GT alfalfa adoption on organic alfalfa for forage

In the case of alfalfa farmers producing GT alfalfa for seed, we were not able to find sufficient information on the returns in the production of conventional alfalfa seed as compared to the production of GT alfalfa seed in our Technical Report *Changes in the Economics of Alfalfa Farming with Deregulation of Glyphosate-Tolerant Alfalfa* (appendix K). It is likely that, given sufficient time, there would be no distinction in market returns to alfalfa seed producers for those agreeing to produce GT varieties or other varieties, and that any monopolistic rents would benefit the plant breeding company that has the property right to those varieties. However, there could be transitory effects, if there is demand for GT alfalfa seeds from alfalfa forage producers that is not being met by a corresponding increase in GT alfalfa seed production. In this case, returns to GT alfalfa seed producers could be higher than for producers of other varieties during a period of adjustment in the market.

The companies who produce Roundup Ready® seeds in the National Alfalfa & Forage Alliance (NAFA) agreed jointly to adopt, as a minimum, best management practices for Roundup Ready® alfalfa seed production in the United States. These production practices meet or exceed Association of Official Seed Certifying Agencies standards for the seed production of Foundation Class alfalfa seed production. Compliance to the guidelines is required under a separate and binding agreement (NAFA, 2008). To the extent that stewardship initiatives increase the requirements on producers of either GT or conventional alfalfa seed, or both, production costs could increase, although this need not be the case, particularly where local seed producers establish GE free seed production zones, a possibility recognized in the NAFA best management practices for Roundup Ready® alfalfa. Because demand for alfalfa seed is relatively inelastic to prices, the impact on demand of any increased costs is likely small. However, an increase in the share of the domestic conventional seed market supplied by

imported seed is possible. In a recent report by The Organic Center, Benbrook (2009) argues that prices of GE seeds have increased substantially in recent years, negatively impacting farm income; however, this report has not been peer reviewed.

If adoption rates of GT alfalfa are high, alfalfa seed farmers would face increased demand for GT alfalfa seed and would shift to production of this variety. This could lead to increased market concentration in the supply of alfalfa seed technology. To the extent that this leads to market concentration in the production of alfalfa seeds, service providers to seed production could face increased concentration of demand for their services. Services providers to the seed industry include providers of pollination services and that often also produce honey based on alfalfa fields. However, it is not clear that this would be the case. On one hand, increased use of GT alfalfa seeds could imply in stricter management of flowering and less use of on-farm produced seeds. On the other, licensing of the GT technology trait to seed producers and the possibility of stacking this trait with those of other proprietary varieties would reduce the likelihood of market concentration in seed production.

3.2.3 Impacts on Supply from Presence of GT alfalfa

Changes in production costs and returns for those not adopting GT alfalfa are associated with the presence of GT alfalfa in non-GT alfalfa fields, hay or seed. Non-GT alfalfa farmers could be a subset of either the high or low quality alfalfa segments considered above, or a subset of both these segments.

Changes in costs associated with the presence of GT alfalfa in non-GT alfalfa must assume there is some market for GE-free alfalfa, whether domestic or foreign, whether having zero tolerance or accepting some degree of presence. If there is no such market, GT alfalfa stands treated as conventional or organic would perform similarly to other varieties and we would expect no impact on costs and returns.

By presence of GT alfalfa in non-GT alfalfa, we mean both comingling (no exchange of genetic material, e.g. same equipment used for GT and non GT alfalfa and equipment was not properly cleaned) or gene flow (through cross-pollination). The literature we found focuses on gene flow and we understand this reveals a lesser concern for comingling. Van Deynze et al. (Undated) argue that "best practices in the cleaning and management of seed harvesting and processing equipment are effective in managing admixtures between GE and conventional alfalfa seed."

The extent of presence – number of acres or tons of non-GT alfalfa hay and seed that will be contain GT alfalfa every year in a scenario of GT alfalfa deregulation – would depend on:

a) *Gene flow*. Gene flow is defined as "the incorporation of genes into the gene pool of one population from one or more other populations" (Putnam, 2007). We review the current U.S. research on gene flow in alfalfa in a separate Technical Report (appendix Q). Gene flow depends on many factors including stewardship. In that report we conclude that Forage Genetics International's Best Practices are expected to maintain the presence of GT alfalfa at a rate considerably below 0.5 percent, within some distance from the areas

of adoption of GT alfalfa[5], although the role of feral alfalfa as a possible reservoir for the GT trait and its role in GT alfalfa population dynamics could require further exploration;

b) *Geographic distribution of adoption of GT alfalfa*. If adoption rates were high but concentrated in certain regions of the country, this would increase the possibility that locations would be available for production of GE-free alfalfa that would be beyond the reach of gene flow from GT alfalfa. In the case of hay, this is highly unlikely. As previously noted, alfalfa hay production is distributed throughout much of the country. On the other hand, gene flow to alfalfa hay is considered relatively unlikely. In the case of alfalfa seed, the likelihood of gene flow is greater. However, production is not dispersed throughout the country, but rather concentrated in areas where the climate is favorable, mostly in Western States. The feasibility and benefits of isolating areas for production of non-GT alfalfa seed are thus likely to be greater for seeds. If this were possible, however, it would come at a cost. The cost would be either that of creating extended buffer zones or of relocation of alfalfa seed production. These costs would translate into higher land rents. As shown in our Technical Report *Changes in the Economics of Alfalfa Farming with Deregulation of Glyphosate-Tolerant Alfalfa* (appendix K), land rents are a considerable cost of seed production;

c) *Geographic distribution of non-GE production*. Of particular interest is the geographic distribution of production for GE sensitive markets. If the location of alfalfa production for forage and for seed destined to GE sensitive markets is concentrated, it would be presumably easier to distance this sensitive production from that of GT alfalfa. In our review of the domestic demand for alfalfa in section 2 we found no evidence that some portion of it is likely to be sensitive to GT alfalfa. Sensitivity to GE traits in export markets has not yet been analyzed and will be considered in depth in our Technical Report *Impacts to United States Trade of Deregulation of Glyphosate-Tolerant Alfalfa* (appendix R).

In addition, the rate of adoption of GT alfalfa would have an impact on the number of years it will take for the level of GT alfalfa in the marketplace to reach the levels anticipated in non-GT alfalfa.

There are two ways in which presence of GT alfalfa in non-GT alfalfa could affect producer costs and returns, given an existing demand for GE-free alfalfa:

a) *Loss in production*. If producers cannot avoid the presence of GT alfalfa above those levels found acceptable by the market, any alfalfa seeds or forage previously destined to those markets would have to be shifted to salvage markets that could pay a lower price.

b) *Avoidance costs*. If producers can avoid the accidental presence of GT alfalfa, whether through adopting buffer zones, relocating to non-deregulated areas (if deregulation was not done on a national level), or requiring testing for GT alfalfa traits in alfalfa seeds used for production, there is a cost of avoidance that would have to be incorporated into its production costs.

[5] Forage Genetics International's validation study of its own Best Practices, used isolation distances from 900 feet (the minimum isolation distance in their Best Practices) to "more than 10 miles" (Forage Genetics International, 2007) during the 2006 growing season. The longest distance in which gene flow was observed in that study was 2.75 miles from a GT alfalfa seed field where 0.008% of conventional seed fields presented GT traits (standard error of 0.006).

In either case, the impact on supply is best understood by imagining two separate market segments: a GE sensitive market and a non-GE sensitive one. In analyzing shifts in these separate market segments, we should keep in mind that the sum of supply in these segments will add up to the supply of non-GT alfalfa that is in turn a share of total alfalfa supply.

If there is loss in production destined to the GE sensitive market or an increase in costs of supplying that market, supply would decline, as indicated by a leftward shift of the supply curve. If non-GT alfalfa hay or seed containing GT-alfalfa is then destined to the non-GE sensitive market (loss in production) or if some farmers are not able to continue supplying the existing market given the increased costs and shift to the non-GE sensitive market (avoidance costs), the supply for that market would expand, as indicated by a rightward shift of the supply curve. These shifts are illustrated in figure S-9 below.

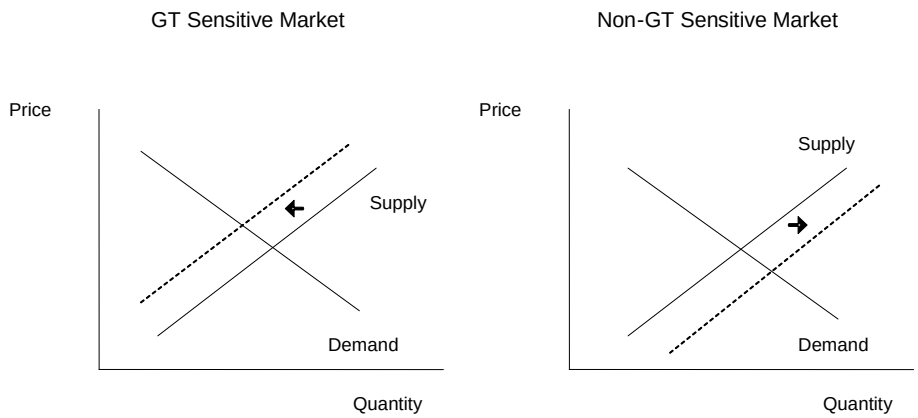

Figure S-9: Impact of unintended presence of GT alfalfa

The impacts illustrated above assume domestic production is unable to guarantee the low-level presence of GT alfalfa in non-GT alfalfa below those levels found acceptable by GT sensitive markets. The acceptable levels of unintended presence of genetically engineered content in non-GT alfalfa seeds or hay are typically determined by the market and the industry has typically adopted self-governing processes to meet market demands. In a scenario of GT alfalfa deregulation, avoidance costs in the production of non-GT alfalfa hay and seed could result when catering to domestic (or export) GT sensitive markets, as a means of guaranteeing the presence of GT alfalfa is below a desired threshold. As discussed in the Technical Report *Presence of Glyphosate-Tolerant Alfalfa in Human Food and Animal Feed* (appendix Q), gene-flow is much more likely to occur to non-GT alfalfa seed fields than to non-GT alfalfa hay and avoidance costs is likely to include testing of seed (could also include testing of hay).

The testing of seeds has increasingly been part of the process for attesting varietal purity in seed production. Protein based tests could be sufficient to attend organic alfalfa demands and could be increasingly demanded in seed selection for organic alfalfa production. These tests are relatively inexpensive and, as explained in our Technical Report *Changes in the Economics of Alfalfa Farming with Deregulation of Glyphosate-Tolerant Alfalfa* (appendix K), seed costs are a small share of alfalfa production costs.

However, protein tests can guarantee considerably high levels of seed purity (e.g., 99.9 percent) typically above levels required for certified seed. If domestic organic markets demand low-level presence of GT alfalfa below levels the domestic seed industry is willing to produce for (and establish stewardship programs for), and if testing of seeds is increasingly required for use in organic programs, domestically produced seeds for the organic market could become unavailable and supply would need to be provided by imports.

3.3 Summary of Findings

Production of alfalfa hay in the United States was approximately 69.9 million tons in 2007, while that of seeds was in 2007 approximately 62 million pounds Production of alfalfa hay is distributed in much of the United States while seed is highly concentrated in Northwestern states. The alfalfa share of total hay production has been falling in the recent past, as has been the absolute production of alfalfa hay. Organic alfalfa hay acreage was quickly approaching 1 percent of total alfalfa hay acreage in 2005. Domestic production of organic alfalfa seed seemed to be lagging behind.

GT alfalfa deregulation would likely impact the supply of conventional alfalfa in at least two ways. First, there would be a reduction in the supply of conventional low quality/high cost (non-GT) alfalfa hay as producers adopt GT alfalfa. Second, the potential for GT alfalfa to be present in non-GT alfalfa would tend to reduce the supply of alfalfa for GE sensitive markets; this effect would be partially compensated by the supply of alfalfa by these producers to non-GE sensitive markets.

In the case of organic alfalfa, assuming some GE sensitivity in domestic organic markets, presence of GT alfalfa in non-GT material could reduce the supply of organic alfalfa for GE sensitive organic markets with a possible increase in supply for non-GE sensitive organic markets. The current provision of domestically produced seed for organic alfalfa markets is likely quite small. GT alfalfa deregulation could increase the dependency of organic alfalfa production on imported seed.

4.0 Impacts on Conventional and Organic Alfalfa Farmers

4.1 Impacts on Non-GT Alfalfa Farmers

In section 2 we argued that GT alfalfa deregulation would likely have little to no impact on domestic demand of conventional alfalfa, *derived from downstream demand*. However, in section 3 we noted that GT alfalfa deregulation would likely have a negative impact on the demand of low quality or high cost (non-GT) alfalfa to the extent the increased supply of GT alfalfa with high quality forage and lower costs reduces the demand for substitute varieties. The result would be a shift in demand for non-GT alfalfa to the left.

On the supply side, there are at least two different effects. First, there would be a reduction in the supply of conventional low quality/high cost (non-GT) alfalfa hay as producers adopt GT alfalfa. Second, potential presence of GT alfalfa in non-GT alfalfa would reduce the supply of alfalfa for GE sensitive markets even further, while it would bring some supply back to the non-GE sensitive market, only partially compensating for initial reduction in supply. The results are shown in figure S-10 below. The leftward movement of the supply curve would be larger for GE sensitive markets than for non-GE sensitive ones.

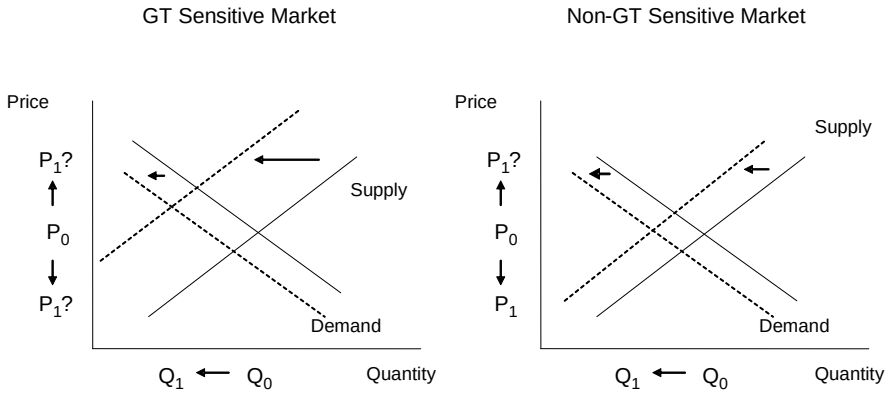

Figure S-10: Impact on non-GT alfalfa farmers

What figure S-10 shows is that non-GT farmers producing for GE sensitive markets would likely lose more markets than non-GT farmers producing for non-GE sensitive markets. In either case, whether the resulting market prices for non-GT alfalfa would be higher or lower than pre-deregulation prices for low quality alfalfa, we cannot say, but prices in GE sensitive markets would likely be higher than in non-GE sensitive markets.

In section 2 we found little evidence of a domestic GE sensitive market for conventional alfalfa. In this case, the resulting impact would look like the non-GE sensitive market in figure S-10. The market for non-GT alfalfa would be reduced as farmers switch to producing GT alfalfa and demand for non-GT alfalfa falls. The resulting final price for non-GT alfalfa is not clear but it would likely be lower than it otherwise would, pushed down by the lower cost of its substitute: GT alfalfa. During a period of adjustment to the new market segmentation between GT alfalfa and non-GT alfalfa, prices would tend to fall if demand for non-GT alfalfa shifted faster than the reduction in supply, or would tend to rise if the reduction in supply occurred faster than the shift in demand.

A numerical estimation of the impact of GT alfalfa deregulation on the non-GT alfalfa market under this scenario would require being able to estimate:

a) What the level of adoption of GT alfalfa is;
b) What is the sensitivity of the demand curve to increases in prices (the price-elasticity of demand) since this would determine how much the price of non-GT alfalfa would increase as producers shift to GT alfalfa reducing supply;
c) The sensitivity of low quality alfalfa demand with respect to a reduction in price of high quality alfalfa (cross-elasticity) since this would determine how much the demand curve for low quality alfalfa would shift to the left; and
d) What is the sensitivity of the supply curve to increases in prices (the price-elasticity of supply) since this would determine how much the price of alfalfa would fall as demand shifts to GT alfalfa.

We do not have sufficient information to provide any reliable numerical estimate.

The market for seed would likely follow the tendency of the market for alfalfa hay, since it is a derived demand. In the case of seeds, reductions in supply would likely raise prices considerably since the price-elasticity of demand seems to be very low. Myer et al. (1998) use panel data from seven states and conclude that the demand for alfalfa seed is highly inelastic. This is to be expected given the importance of appropriate seed choice for alfalfa hay yields and quality and the relatively low share of total production costs represented by seeds.

4.2 Impacts on Organic Alfalfa Farmers

In section 2 we explain that we found no evidence that GT alfalfa deregulation would directly cause a shift in the demand for organic alfalfa hay. However, in section 3 we argued that the demand for organic alfalfa could shift to the left with the reduction in costs of conventional hay, to the extent that organic and conventional farming are substitutes or to the extent that the reduction in conventional alfalfa hay costs are transmitted to prices of conventional dairy and meat..

On the supply side, unintended presence of GT alfalfa in non-GT alfalfa would have the effect shown in figure S-9: a reduction in supply for GE sensitive organic markets with a possible increase in supply to non-GT sensitive organic markets. This result relies on the assumption that

sales in domestic organic markets are sensitive to some degree to the possibility of low-level presence of GT alfalfa.

As it is not necessarily the case that the demand for organic products would decrease with the possibility of low-level presence of GT alfalfa in feed, we first consider the case in which the only impact of GT alfalfa deregulation is the demand reduction that follows the reduction in prices of conventional GT alfalfa. We also consider what the impact would be in case there actually was GT sensitivity of sales of organic products.

With no GT sensitivity of demand (sales), the only impact on organic markets would be the shift in demand to the left that would follow the reduction in prices of conventional alfalfa. This is portrayed in figure S-8 and reproduced again below in figure S-11.

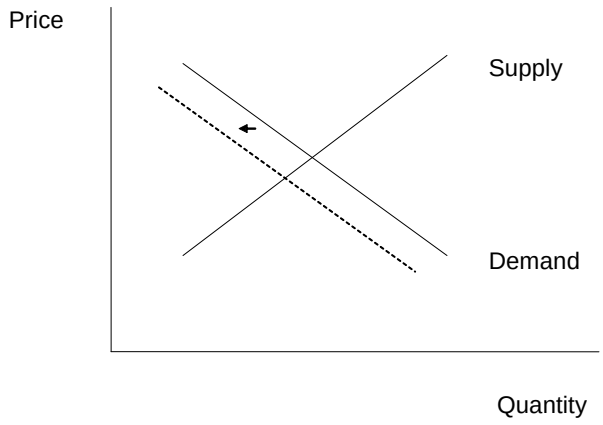

Figure S-11: Impact of GT alfalfa adoption on organic alfalfa for forage with no GT sensitive domestic markets

To estimate numerically the impact for organic farmers under this scenario, we need to know:

a) The magnitude of the decrease in prices expected of conventional alfalfa;
b) The cross-elasticity of demand between conventional and organic alfalfa. This would tell us how much the demand for organic alfalfa would fall in response to the decrease in prices of conventional alfalfa;
c) The price-elasticity of supply of organic alfalfa. This would tell us how much organic market quantities and prices would fall in response to the shift in demand to the left.

We do not have sufficient information to provide any reliable numerical estimate.

In the case of any GT sensitivity in the domestic organic sales, the reduction in demand would be complemented by the shifts in supply shown in figure S-9. The result of these shifts is shown in figure S-12 below.

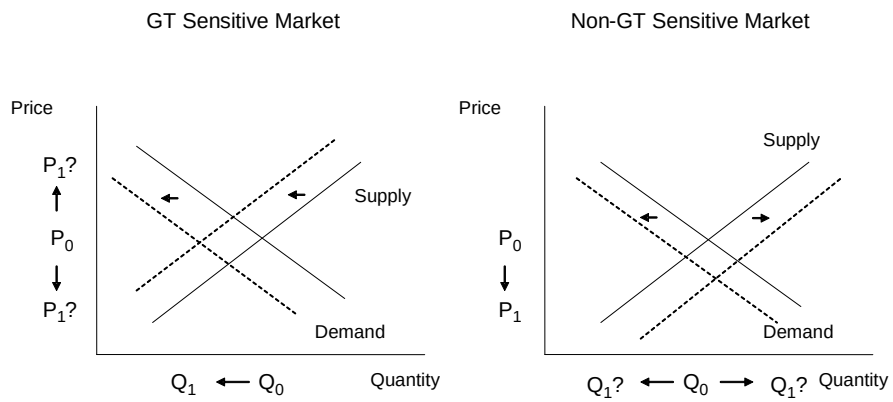

Figure S-12: Impact of GT alfalfa adoption on organic alfalfa for forage in GT sensitive and non-GT sensitive domestic markets

The result of GT alfalfa deregulation under this scenario depends on the extent of the GT sensitive sales within the organic market. The larger the GT sensitive portion of sales is, the more likely quantities sold would fall, although with unclear effect on prices. The larger the non-GT sensitive portion of sales is, the more likely prices would fall but with unclear effect on quantities.

Once again, we do not have enough information to estimate numerically the impact for organic farmers under this scenario. In addition to the elasticities of supply and demand we would need to know the share of the organic market that is GT sensitive and the magnitude of the decrease in prices expected for conventional alfalfa.

4.3 Distributional and Social Impacts

GT alfalfa adoption by farmers, presence of GT alfalfa in non-GT alfalfa fields, and the demand response to GT alfalfa deregulation would have several distributional and social impacts:

Businesses Lost and Gained. In our above discussion we mentioned that farmers adopting GT alfalfa could face decreased costs or improved markets while organic farmers could face a reduction in demand. Early GT alfalfa adopters could gain markets while conventional non-GT

alfalfa farmers producing high quality alfalfa could lose, due to potentially higher costs when compared to GT alfalfa. Organic farmers most affected by the presence of GT alfalfa could lose markets while organic farmers less affected could gain, if there is GT sensitivity of organic sales under the possible low-level presence of GT alfalfa in feed.

Market Structure. In our Technical Report *Changes in the Economics of Alfalfa Farming with Deregulation of Glyphosate-Tolerant Alfalfa* (appendix K) we showed that land costs are a major factor in generating economies of scale in alfalfa grown for forage, and we also showed that land costs are a major cost factor in alfalfa seed production. To the extent that GT alfalfa deregulation leads alfalfa hay or seed farmers to increase the use of buffer zones to reduce the likelihood of gene flow, increased land costs would be more easily absorbed by larger alfalfa farmers. In addition, to the extent that organic farming is more suitable for small farms than conventional farming (less economies of scale related to greater dependency of labor), a reduction in the demand for organic products could favor larger farmers. However, because gene flow to alfalfa hay fields is considered relatively unlikely and because there are other methods available to minimize the presence of GT alfalfa in GT sensitive alfalfa fields, it is not clear that any increased expenses with land would actually occur in conventional alfalfa hay production. In the case of alfalfa for seed, any increase in land cost for seed production would likely be mitigated by the fact that the demand for seed seems to be highly inelastic with respect to prices. In other words, as seed quality is important for alfalfa forage producers and seed costs are a small part of their total production costs, increases in seed costs should not significantly affect sales of seed. It is therefore unclear whether the deregulation of GT alfalfa would have any impact on farm size.

If adoption rates of GT alfalfa are high, alfalfa seed farmers would face increased demand for GT alfalfa seed and would shift to production of this variety. This could lead to increased market concentration in the supply of alfalfa seed technology. To the extent that this leads to market concentration in the production of alfalfa seeds, services providers to seed production could face increased concentration of demand for their services. Services providers to the seed industry include providers of pollination services and that often also produce honey based on alfalfa fields.

Distribution of Costs of Loss of Production and Avoidance. To the extent that there is presence of GT alfalfa in the organic market, we argued that producers would bear a cost in either loss of production or measures (typically land costs) to reduce the likelihood of unintended presence of GT alfalfa.

Organic certification typically requires producers to take measures to avoid pesticide contamination or the unintended presence of GE content from conventional farming. However, who should bear the costs of preventing the unintended presence of GT alfalfa in non-GT alfalfa is debatable. Movement of GT alfalfa into non-GT alfalfa fields would be considered an externality in economics: a cost to third parties of producing GT alfalfa that is not being internalized in the cost of production of GT alfalfa.

Social aspects of organic farming. In section 2 we noted that it is unclear whether domestic sales of organic products would decrease with the low-level presence of GT alfalfa in feed. This does

not mean that GE products are welcome by organic consumers, but rather that any sensitivity to GE products would not necessarily translate into a decrease in sales of organic alfalfa. Organic producers (and consumers) could still be unhappy with the outcome, to the extent that organic farming involves broader life choices related to philosophical attitudes; this discontent would be a negative impact.

This situation could conceal a market for GE-free products in need of development, and private certification standards have been developed in the United States to explore the potential demand for such products (for an example, see Non-GMO Project (2010))

4.4 Summary of Findings

The impact of GT alfalfa deregulation on non-GT conventional alfalfa farmers could be a reduction in the market for non-GT alfalfa as farmers switch to producing GT alfalfa and as the demand for non-GT alfalfa falls. The resulting final price for non-GT alfalfa is not clear but it could be lower than the present prices, pushed down by the lower cost if its substitute: GT alfalfa. During a period of adjustment to the new market segmentation between GT alfalfa and non-GT alfalfa, prices would tend to fall if demand for non-GT alfalfa shifted faster than the reduction in supply, or would tend to rise if the reduction in supply occurred faster than the shift in demand..

The impact of GT alfalfa deregulation on organic alfalfa farmers depends on whether domestic sales of organic products are sensitive to the possible low-level presence of GT alfalfa in feed. With no GT sensitivity of demand (sales), the only impact on organic markets is the shift in demand to the left that follows the reduction in prices of conventional alfalfa, leading to a reduction in prices and quantities sold domestically of organic alfalfa. In the case of GT sensitivity of demand (sales) in organic alfalfa markets, the result of GT alfalfa deregulation depends on the extent of this GT sensitivity: the larger the GT sensitive market is, the more likely quantities sold would fall, although with unclear effect on prices. The larger the non-GT sensitive market is, the more likely prices would fall, but with unclear effect on prices.

GT alfalfa adoption by farmers, presence of GT alfalfa in non-GT alfalfa fields, and the demand response to GT alfalfa deregulation would have several distributional and social impacts: the loss and gain of businesses, potential changes in market structure, distribution of the costs of loss of production and avoidance in GT sensitive markets, and potential negative impacts on the environment preferred by organic farmers (one free of GE products).

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Appendix S-2. Literature Search

1.0 Literature Search Strategy

Most data were obtained from USDA Web sites.

Much of the remaining information was obtained from university (and cooperative extension) linked alfalfa portals and alfalfa symposium proceedings such as:

- The California Alfalfa Workgroup: http://alfalfa.ucdavis.edu/
- The University of California Alfalfa Seed Production Homepage: http://alfalfaseed.ucdavis.edu
- University of Wisconsin Forage Research and Extension: http://www.uwex.edu/ces/forage/
- 2007 37th California Alfalfa and Forage Symposium: http://alfalfa.ucdavis.edu/2007AlfalfaConference
- 2006 Western Alfalfa and Forage Conference: http://alfalfa.ucdavis.edu/2006AlfalfaConference
- San Joaquin University of California Cooperative Extension: http://cesanjoaquin.ucdavis.edu/Agriculture/Publications,_Research_Reports.htm

Other papers were obtained from internet searches; others from academic journals such as *Agronomy Journal* and *Agribusiness*.

Some of the conclusions are based on our Technical Report *Downstream Effects to Organic Production and Marketing of Deregulation of Glyphosate-Tolerant Alfalfa.*

Direct personal communication with extension experts was also used and is detailed in the References.

Appendix S-3. Probability of Alfalfa Seed Acres Using Herbicide

One policy option to address the impacts of presence of GT alfalfa material in non-GT alfalfa is to guarantee the possibility of producing non-GT alfalfa seeds at a distance from GT alfalfa sufficient to reduce the likelihood of unintended presence to virtually zero.

In this appendix we build on the exercise constructed in our Technical Report *Changes in the Economics of Alfalfa Farming with Deregulation of Glyphosate-Tolerant Alfalfa* (appendix K). By listing U.S. counties that currently produce alfalfa seed by acreage and multiplying this acreage by the likelihood of an acre in that county not having alfalfa grown for forage with herbicides, we obtain a ranking of counties that could produce alfalfa seeds while losing relatively little by not being able to adopt GT alfalfa hay. The process for obtaining this ranking was as follows:

1. We listed all U.S. counties for which alfalfa seed is grown and ranked them by alfalfa seed acreage. The ranking by acreage is taken as an indicator of economic interest in producing alfalfa seed.
2. We listed our ranking of counties growing alfalfa for forage with herbicide, as presented in the Technical Report *Changes in the Economics of Alfalfa Farming with Deregulation of Glyphosate-Tolerant Alfalfa* (appendix K), and subtracted the values from that ranking from 1: this gives us the likelihood of randomly selecting an acre in a county that does not have alfalfa grown for forage with herbicide use.
3. We multiplied the two lists above to obtain a ranking of counties with economic interest in producing alfalfa for seed, while relatively little in producing alfalfa for forage with herbicide.

The ranking is presented below.

The top counties are also counties that actually do produce considerable acreage of alfalfa for forage under herbicide. This reflects the fact that there are counties that produce both seed and forage with intense use of herbicide. Other counties with relatively low likelihood of alfalfa grown for forage under herbicide could find it in their interest to give preference to growth of alfalfa seeds under special conditions, if these conditions generate particularly high returns, as those that could be obtained by the exploration of specialized niche markets.

Table S-16. Probability of Acres in Alfalfa Seed not in Hay with Herbicide

Geographic area	Harvested Acres of Alfalfa Seed	Acres in Farm	% of Seed Acres to Total Farm Acres	% Acres low-alfalfa, low herbicide use	% High rates alfalfa seed w/ low rates alfalfa hay and herbicide use
California\Imperial	25848	427349	6.05%	85.0851%	5.15%
Idaho\Canyon	7018	260247	2.70%	93.2410%	2.51%
Washington\Walla Walla	10759	682350	1.58%	99.0729%	1.56%
California\Kings	5779	680662	0.85%	95.5090%	0.81%
Nevada\Pershing	1960	244249	0.80%	98.5559%	0.79%
Arizona\Yuma	1723	210480	0.82%	92.3251%	0.76%
Nevada\Humboldt	4206	756313	0.56%	99.6056%	0.55%
Wyoming\Park	4560	881736	0.52%	99.7311%	0.52%
Washington\Grant	4249	1087952	0.39%	95.4597%	0.37%
Idaho\Jerome	707	188753	0.37%	87.0995%	0.33%
Oregon\Malheur	3565	1170664	0.30%	99.6496%	0.30%
Idaho\Payette	496	166179	0.30%	98.1103%	0.29%
Utah\Cache	580	251550	0.23%	95.9822%	0.22%
Idaho\Owyhee	1179	569305	0.21%	99.2854%	0.21%
California\Fresno	3287	1636224	0.20%	98.1028%	0.20%
Utah\Millard	1118	566692	0.20%	98.5740%	0.19%
Arizona\Maricopa	776	485469	0.16%	94.8906%	0.15%
South Dakota\Dewey	2113	1449585	0.15%	99.6978%	0.15%
Montana\Powder River	2187	1620068	0.13%	99.9531%	0.13%
Idaho\Gem	233	190757	0.12%	99.5692%	0.12%
Nevada\Churchill	162	131448	0.12%	98.4587%	0.12%
South Dakota\Bennett	759	753263	0.10%	99.3163%	0.10%
California\Lassen	377	459126	0.08%	99.7695%	0.08%
Michigan\Mecosta	74	114715	0.06%	95.1494%	0.06%
South Dakota\Marshall	324	534178	0.06%	98.3376%	0.06%
Idaho\Twin Falls	258	439537	0.06%	94.1855%	0.06%
Minnesota\Stearns	404	708284	0.06%	94.4371%	0.05%
Washington\Franklin	311	609046	0.05%	94.8114%	0.05%
Missouri\Adair	126	279855	0.05%	99.8259%	0.04%
Oklahoma\Grady	275	608373	0.05%	99.1076%	0.04%
Washington\Yakima	713	1649281	0.04%	99.7611%	0.04%
Montana\Carter	560	1698363	0.03%	99.8857%	0.03%
Idaho\Washington	130	417092	0.03%	99.5383%	0.03%
Montana\Rosebud	749	2714024	0.03%	99.9732%	0.03%
Nebraska\Dawes	204	848753	0.02%	99.6518%	0.02%
Arizona\Graham	304	1345629	0.02%	99.9980%	0.02%
Montana\Big Horn	619	2899620	0.02%	99.8683%	0.02%
New York\Yates	27	126118	0.02%	95.6047%	0.02%
Nebraska\Merrick	46	247927	0.02%	98.3646%	0.02%
Oklahoma\Alfalfa	96	542813	0.02%	99.0123%	0.02%
South Dakota\Tripp	175	1014336	0.02%	98.0914%	0.02%
California\Kern	367	2361765	0.02%	99.1788%	0.02%
California\Modoc	65	597740	0.01%	99.5080%	0.01%
Washington\Okanogan	129	1205229	0.01%	99.9259%	0.01%
Montana\Fallon	105	978818	0.01%	99.6674%	0.01%
Utah\Duchesne	60	1076470	0.01%	99.9718%	0.01%