Flaws in the draft Environmental Impact Statement for Roundup Ready Alfalfa

Cultural Practices when Raising Alfalfa Forage and Seed

Good Cultural Practices

Good cultural practices by many alfalfa forage growers make herbicides unnecessary. (78-83% of alfalfa forage growers don't use herbicides.) Alfalfa, when grown in the correct environment, will outgrow most weeds and with a cutting schedule of 28 to 35 days, most weeds, including deep rooted perennials like Canada Thistle, will die away.

The first good cultural practice in alfalfa forage production is to choose a field that alfalfa will grow well in. If the soil pH is low, lime should be added to correct it. Soil fertility should be checked and fertilizer should be added (including micro nutrients) so alfalfa has the optimum nutrients available. The grower should understand and be able to identify the disease and pest problems in his own field and then buy alfalfa varieties that have built-in resistance to these problems. Choosing the alfalfa with the correct dormancy for his area and management goals is important.

When a farmer buys blends or brands, he will not know what disease and pest resistance is bred into the alfalfa seed. With blends or brands, the seed tags are usually labeled VNS (Variety Not Stated). When you buy varieties, you can be reasonably assured the seed will have disease resistance as advertised. Varieties have to be approved by the National Alfalfa Variety Board or be approved for PVP (Private Variety Protection).

Next, if the field has a high and varying water table, it should be tiled to stabilize it and lower the water table. If the field is badly infested with deep rooted noxious weeds that have been allowed to go to seed, the weeds should be controlled before alfalfa is planted. A heavy application of glyphosate, tank mixed with other chemicals and coupled with deep cultivation over one or more years, is a possible way to control them. (Generic glyphosate and 2,4-D are inexpensive and effective.)

Russian Knapweed is very resistant to herbicides. It may be necessary to use harsh, long term soil sterilants to control it. One option might be to plant corn for several years and use the maximum rate of Atrazine. If you own land like this and have allowed it to get into this condition, you should consider some other vocation. If you are looking for ground to raise alfalfa hay on and you find land like this, just turn around and walk away. If you think you can clean up this ground with RR alfalfa, you are dead wrong. The low rates of glyphosate (.75lbs per acre/per application, 1.50 lbs per acre total per year, Table J9, page J29) will only help the weeds develop higher resistance to glyphosate.

Planting RR alfalfa and spraying with glyphosate will not correct problems that are caused by poor cultural practices.

Herbicides that Control Weeds in Conventional Alfalfa

Herbicides that give long term control of weeds are: Sinbar, Treflan, Diuron, Prowl, Eptam, Velpar, etc... These herbicides kill weeds as the seeds germinate and therefore give long term and even season long weed control. Some of these pre-emergent herbicides can be incorporated in the alfalfa seedbed before the alfalfa seed is planted because the alfalfa seed is not affected by the herbicide. They are cheap, effective, and give long term weed control of the germinating weed seeds and even of the noxious perennial weeds that glyphosate will not control after emergence or establishment.

Some herbicides used in established alfalfa stands are applied when alfalfa is dormant. These herbicides are inexpensive because their patent has expired. They are easy to apply, and will not damage or stunt the alfalfa.

There are broadleaf weed herbicides that can be sprayed on growing established alfalfa: 2,4-DB, Buctril, or Raptor. Some of these herbicides will cause minor stunting. The use of herbicides is rarely needed in forage production because of the frequent cutting schedule. Some herbicides can be used if the alfalfa is planted with a cover crop of oats or with a companion grass crop. These broadleaf herbicides are more often used in alfalfa seed production fields in which some stunting does not affect the yield of seed.

Some herbicides kill only grass and do not stunt alfalfa: Poast, Select, and Fusilade. Some of the broadleaf and grass herbicides can be tank mixed for control of both broadleaf and grass weed at the same time. Table J6, on page J-22, is only a partial list of the herbicides that are labeled for use on conventional alfalfa.

Glyphosate use in GT Alfalfa

Glyphosate kills weeds that have emerged. It does not kill or control weeds that emerge even one day after application. Therefore, many repeat applications may be required to control weeds in alfalfa, particularly if there is a large weed seed bank in the soil. The recommended rates are low and will not control many weeds on the restricted or noxious weed lists. (Table J9, page 129)

Weed Transfer Problems in RR Alfalfa

Weed Seed Transfer

The transfer of weed seed across the country is a very serious problem. State and Federal seed laws try to restrict the transfer of weed seed via crop seed. Large seed, like corn and bean seed, is usually not much of a problem because weed seed is usually small and can be screened out easily. Alfalfa seed, however, is small like most weed seeds and seed laws allow for rather high amounts of weed seed in alfalfa. Certified alfalfa seed is allowed to have as much as 0.2% common weed seed, a very small amount of restricted weed seed and no noxious weed seed.

Nevertheless, there could be a small amount of noxious weed seed in a lot of seed because only a 50 gram sample of seed is checked to determine the presence of noxious weed seed.

If glyphosate is used with RR alfalfa seed production, the glyphosate will kill only the weeds that are highly susceptible, because of the low rates that are allowed on RR alfalfa. Any weed that has resistance or some tendency to have resistance, will survive and the progeny of these plants will likely develop higher levels of resistance to glyphosate.

Alfalfa seed production takes a full season with no forage cutting, therefore the glyphosate resistant weeds will have the chance to mature and make seed that will be harvested with the alfalfa seed. Seed cleaning will not clean out the glyphosate resistant weed seed but some seed lots might still be able to pass the 50 gram test. These seed lots will then be shipped across the country and distributed to alfalfa forage growers for planting.

Glyphosate will not control Dodder, a noxious weed in most states. Dodder is a parasitic plant that germinates from seed after the alfalfa is growing and attaches to the stems of alfalfa (and many other plants) and sucks nutrients and moisture from the plants. Every time the soil surface is moistened by a rain event or irrigation, a new flush of Dodder seeds germinate and attach to the alfalfa. In late July and August, when daylight is shortening, Dodder can make viable seed within a few weeks after it has attached to the alfalfa. RR alfalfa seed growers have found that they can't spray glyphosate on blooming alfalfa because glyphosate prevents alfalfa from making seed after it is in blossom. Seed growers now understand or should understand, that they will have to continue the use other herbicides, as they have in the past, to control weeds like Dodder. The use of glyphosate on RR alfalfa will have a very limited value in alfalfa seed production.

RR Technology is in Jeopardy

Farmers that are using RR corn, soybeans and other RR crops, that consider this technology an important tool in their operation, **should be very concerned** about the spread of weeds that are resistant to glyphosate. RR alfalfa seed will likely spread glyphosate resistant weeds rapidly throughout all of the locations where RR alfalfa might be used.

The low rates of glyphosate allowed on RR alfalfa for seed and forage production will increase the likelihood of weeds developing resistance to glyphosate.

RR Alfalfa Will Become a Serious Weed Pest

RR alfalfa will likely become a serious weed pest in other RR crops such as soybeans, sugar beets, cotton and other RR crops that don't develop a high canopy and that take a full season to mature. RR alfalfa will survive the glyphosate treatment, thrive and make copious amounts of seed, some of which will be hard seed that will lay in the soil and emerge in subsequent crops years later.

Will alfalfa forage farmers who are not interested in using RR alfalfa, and are using other RR crops in rotation with alfalfa, be willing to buy conventional alfalfa seed that is contaminated with the RR gene? Forage Genetics and Monsanto are proposing that 0.5-1% contamination is ok in conventional alfalfa seed. It should be noted here there is no practical test to determine the percentage of contamination in conventional alfalfa seed. Therefore, tolerances or standards for allowable contamination are meaningless.

Stand Take-Out of Conventional Alfalfa

At stand take-out of conventional alfalfa, a burn down at a high rate of generic glyphosate is an inexpensive and widely used cultural practice because not only alfalfa but other weeds, such as quack grass, are killed. Crops can be immediately planted in fields sprayed with glyphosate but, not with other herbicides.

If the conventional seed planted by the farmer was contaminated with only a slight amount of RR seed, the surviving alfalfa plants, after a burn down application, that are GT, will have to be removed by some other method. If they are not removed and RR soybeans or cotton are planted, the GT alfalfa plants will survive, mature, and make copious amounts of seed, some of which will be hard seed and will emerge years later.

Herbicides other than glyphosate have serious problems with soil residues and volatility. 2,4-D and Dicamba, for example, are volatile and in warm temperatures, the vapor can drift for miles, causing serious stunting to crops such as sugar beets, dry beans, grapes, and other desirable plants. Herbicide residues will cause delayed planting dates and prevent some crops from being planted for years. Spring burn down applications of any herbicide, other than glyphosate, is very risky.

When glyphosate is used for burn down, high rates can be used (generic glyphosate is economical) and then all crops can be immediately planted. A useful technique, that only glyphosate can be used for when establishing a new crop, is to prepare the seed bed, bed it out and then irrigate. After the weed seeds in the soil seed bank have germinated and have started to emerge, seed the intended crop with the least soil disturbance possible. Just before the new crop emerges, spray with a light application of glyphosate. Even weeds that are resistant to glyphosate in the mature stage are easily killed in the cotyledon stage.

Glyphosate is the preferred herbicide of canal companies, road districts, and private land owners because it is a non-restricted use chemical. Anyone can buy and apply it and it kills a wide spectrum of weeds, broadleaf, and grasses. Glyphosate is non-restrictive because it is relatively safe, non-volatile and has no soil activity. No other herbicide can be used this way.

Gene Flow Considerations

Factors Increasing the Probability of Gene Flow

See pages 104 & 105 EIS

The factors listed demonstrate how easily gene flow between alfalfa populations can occur. At the conclusion of this section, the authors state the following:

> “If alfalfa farmers take these factors into consideration and employ measures to counter these factors, such measures should also help alfalfa farmers effectively reduce or prevent

gene flow between neighboring alfalfa crops. Combined with the measures discussed above that can be employed to decrease the probability of gene flow between alfalfa fields and crops, we do not believe that the potential flow of genes and traits between alfalfa populations in the United States should amount to a significant impact on the human environment."

"If" is a very big word here. Measures to counter the gene flow of the RR trait would be expensive, must be mandatory and would change common farming practices. Changing farming practices would require the cooperation of nearby landowners and farmers who would have no benefit from them, only additional work and expenses. Furthermore, if there are no penalties for not following these changed farming practices, any suggestion or thought that these practices would occur or continue over any length of time is totally false. Even with a small amount of RR contamination there would be a huge impact on the export of US produced alfalfa seed.

Voluntary rules that cause a lot of extra expense to RR hay growers will not be followed. Controlling alfalfa around the borders of fields, was not practiced when RR alfalfa was deregulated and will not be practiced. Asking honey bee keepers to keep their bees 3-5 miles away from RR alfalfa fields is ridiculous. Bee keeping sites are coveted by bee keepers as a valuable asset to their operation and they won't give them up voluntarily just because they are asked to. Most bee keeping sites are not on the seed grower's property and the seed grower has no authority to tell bee keepers to take their bees away...…particularly within 3-5 miles of his operation.

Farmers who are not interested in planting RR alfalfa and who wanted to avoid contamination of their non-GM crops, (according to the impact statement, page S-30, Avoidance costs) could plant barriers around their fields ("buffer zones'), move to another location ("relocating to non-deregulated areas"), or have their crops tested for contamination levels ("requiring testing for GT alfalfa traits in alfalfa seeds used for production").

The arrogance of Monsanto, Forage Genetics and the USDA authorities supporting Monsanto is unbelievable! It is unjust and impoper for them to suggest that conventional seed growers should move their farming operation to another location so Forage Genetics and Monsanto can raise RR alfalfa anywhere they want.   Rather, if they want to commercialize this crop they need to require it be done in a manner that allows all farmers can continue to grow the crop of their choice, without risk of contamination. The EIS refuses to even consider such any scenarios where such measures are required, let alone recommend they be required.

Feral Alfalfa

From the EIS, page V 87 "Feral plants are crop plants that grow and reproduce outside of cultivation. Feral alfalfa plants can sometimes be found on road edges, in fence lines and in abandoned fields. In the US, feral alfalfa populations have occurred through unintentional plantings of cultivated varieties ("escapes" from cultivation) or, in some cases , they originated from intentional planting of the abandoned fields, roadsides or marginal lands. Feral alfalfa occurs at very low density and scale relative to cultivated alfalfa grown for seed or hay. Biogeographic survey data from six states indicates that for most agricultural areas feral alfalfa plants do not occur or they are sparse (Kendrick et al., 2005). In a 2001/2002 multi-state survey, feral plants were found as dispersed plants or patches within 1.25 miles (2 km) of cultivated alfalfa at only 22% of the survey sites (Kendrick et al., 2005). Feral alfalfa plants are sometimes managed on roadsides by clipping, either with hay being harvested or simply left on the ground along with the other roadside vegetation. Feral plants are sometimes completely unmanaged and given adequate moisture and timely presence of pollinators, can flower and set seed. Feral plants are susceptible to the environmental (e.g. drought in the irrigated West) and insect (e.g. Lygus bugs in the West and potato leafhopper in the East) stresses common to the local area. Although alfalfa was introduced to North America more than 200 years ago, it is not considered weedy, noxious or invasive in cultivated or feral settings."

The survey sites were 500 square meters (or approximately 75 feet by 75 feet square). There are approximately 8000 potential sites within 2000 meters of an alfalfa field. If 22% contained a feral alfalfa population, there would be over 1700 feral alfalfa populations within 2000 meters of the alfalfa field. This is a significant number of alfalfa plants. Control of these plants would be difficult, if not impossible, particularly when the land within 2000 meters is not controlled by the seed grower. The way this report was written the reader would get a false idea as to how much feral alfalfa is growing in a farming area.

Page V 85 EIS 5.12.5.3 " Gene flow from the four large fields to the very small (1 square meter) pollen traps was notably higher, with 25% to 35 % out-crossing measured at 1000 meters. Data is presented for percent out-crossing, but the gross number of seeds produced on each trap or trap plant (the sample size) was not reported." The large number of feral alfalfa plants in the farming areas and the high percent of gene transfer in just one season, guarantees the RR gene will be spread throughout the environment.

Common use of Glysophate in these feral alfalfa areas will soon result in all of the feral alfalfa populations contain the Roundup Ready gene, because glyphosate will kill non-GE alfalfa seed leaving the contaminated GE feral alfalfa to flourish. In just a few years, the Roundup Ready gene will leapfrog over the entire landscape. Because of alfalfa's production of hard seed, it will be impossible to recall this GMO plant.

The EIS fails to adequately assess the risks from feral alfalfa as a pollen bridge for contamination and USDA must do further study on this important issue.

The GT trait will impart a significant fitness advantage in feral alfalfa

On page 101 of the EIS it is stated, "The GE trait is not expected to impart an increase fitness in feral alfalfa". Glysophate is the most widely used herbicide in the world. Anyone can buy and spray it without an applicators license, therefore, it is the most widely used herbicide by road districts, home owners, railroads and on other non-farm ground. This wide spread use will give GT alfalfa a huge fitness advantage. GT feral alfalfa will become much more widespread and will become the dominant plant in these areas.

In the study by Bob Hammon at Fruita, CO in 2006 titled, "Pollen Movement From Alfalfa Seed Production Fields" The conclusions state "Bees are capable of moving the RR gene at least 1.7 miles. The farthest distance they can move pollen cannot be determined because we found the

RR gene at our most distant site from the pollen source." Bob Hammon has also concluded that it would require a 5 mile distance to prevent contamination completely.

Hammon reveals RR alfalfa was grown for seed production in 2004, **one year before the 2005 deregulation of RR alfalfa.** Why wasn't this study included in the EIS statement

For more information see
http://www.informaworld.com/smpp/content~content=a909102716&db=all

Economic Impact of RR Alfalfa

Loss of the Export Market

The economic impact on the alfalfa seed industry by the release of RR Alfalfa was not adequately analyzed in the environmental impact statement.

The executive summary states: "To the extent that GT Alfalfa deregulation reduces foreign demand for US exports, alfalfa hay and seed production previously destined to foreign markets may be channeled to the domestic market." Page R2 E15

This is really a round about way of saying that the export market for US alfalfa seed will be lost and since more that 50% of the US alfalfa seed production has been for export this will be a huge loss for alfalfa seed producers and the alfalfa seed industry. Excess supply will only serve to drive the price down in the domestic market.

And; "As the domestic market for non-GT alfalfa hay and seed is expected to decrease with GT alfalfa deregulation, US production is likely to substitute imports."

What does that mean?

US alfalfa forage producers who are sensitive to RR contamination will import seed from other sources than the U.S. This will further reduce the demand for US produced alfalfa seed.

Why don't they just say that instead of using these unintelligible statements?

Why didn't they list the countries that won't accept GM contaminated seed? Some countries will accept GE feeds and food, but they will not except seed that has even a trace of GMO. (see table V7 on page V35)

Economics of Alfalfa Farming with Deregulation

Appendix K.

Changes in the Economics of Alfalfa Farming with Deregulation of Glyphosate-tolerant Alfalfa are presented in appendix K. Table K-8 "Comparative Variety Trial Yields Results" for RR alfalfa varieties show that six of the seven locations show RR varieties to be lower yielding. The seventh location shows the RR varieties to be considerably above the trial mean. A quick check of the internet source shows that unlike the prior 6, it does not come from the University research site, but rather is from an University extension site that does not compare RR alfalfa varieties with the trial average, but rather a comparison of RR varieties treated with Roundup compared with the same varieties treated with a conventional herbicide. This internet site also presents data from another location showing smaller differences that the presenter of this data apparently chose to ignore. This is inadequate and inaccurate analysis.

There are other problems with this data as well. The comparison should have been RR varieties with recent commercial varieties. Alfalfa yield trials always have older check varieties, one of which is usually Vernal, now 60-years old and almost always at the bottom of the test. Some trials often contain varieties that were not selected for yield, such as pasture types and HQ varieties bred for quality. Lastly, the comparison should not contain the same RR varieties to which the RR varieties are being compared. That is the lower yielding RR varieties included in the total, bring this average down. A proper comparison would increase the difference between RR varieties and non-RR varieties and in 7 of 7 comparisons the RR varieties would be lower yielding. This is pretty good evidence that the RR varieties are lower yielding.

In summary the report states: “As revealed in table K-8 above, variety trial results do not indicate any systematic hay yield advantage or disadvantage for GT alfalfa hay cultivars.” (Quoted on page K-13.) It is not true; the GT varieties have a yield drag over 2.4% and possibly as high as 10%.

The executive summary states that: “Alfalfa forage farmers aiming at maximizing returns during the time horizon of an alfalfa field stand life would likely benefit financially from the adoption of GT alfalfa due to potential improvements in forage quality with reduced herbicide costs.” (Page K2) Their own data does not support this conclusion.

Differences in Quality

Differences in quality are discussed but it is stated that “…one cannot systematically attribute higher quality to GT alfalfa over conventional alfalfa, since sometimes conventional weed control systems can be quite effective.” And, “limited evidence presented here suggests that while there is the potential for higher quality forage from GT alfalfa, one cannot systematically assume higher quality attributable to GT alfalfa over conventionally produced alfalfa”. Again, quoted from the impact statement page K-15

In table K-10 ”Scenarios for GT Alfalfa”, the total operating costs/acre for conventional alfalfa is shown to be $685 per acre. This number ($685) was lifted from table K3 and apparently from table K1 “other cultural costs” (the cost for seed is figured at a seeding rate of 30 lbs per acre @ $3 per pound). The total operating cost for GT alfalfa was $619 per acre. Why are the total operating costs for GT alfalfa less than conventional alfalfa? Apparently the seed cost used for the GT alfalfa seed was figured at a 12 lbs per acre seeding rate! Table K3 that shows herbicide cost at $71 per acre, figuring $71 per acre herbicide cost for conventional alfalfa is extremely high considering that only 17-22% of alfalfa is EVER treated with an herbicide. If the table was corrected, conventional alfalfa would have the profit advantage over GT alfalfa every time even, if you give the GT alfalfa a quality advantage.

Table K11 shows the seeding rate at 12 pounds per acre. The total operating costs for GT alfalfa is $3 more per pound. At 30 pounds per acre the tech fee alone would be an additional $90. If these numbers were corrected table K-10 would always show that conventional alfalfa gives a greater return than GT alfalfa.

If this is the case, all of the statements made throughout this environmental impact statement that say GT alfalfa will increase profits for hay growers are false.

Conclusion

When one considers all of the adverse effects of GT alfalfa, and the fact that it cannot be recalled, its release is not justified as an important part of American agriculture. USDA's job is to protect America agriculture and the EIS's recommendation does the opposite, endangering farmers like me. Further the adoption is not good for American farmers, only Monsanto. The environmental impact statement has failed to show an advantage for RR alfalfa. The high seed costs and technology fee of RR alfalfa, together with a lower yield in these studies, make conventional alfalfa more profitable. The disadvantages and problems of Roundup Ready alfalfa far outweigh the advantages. There is no justification for the release of Roundup Ready alfalfa and it should not be deregulated again.

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You can view the complete EIS at
http://www.regulations.gov/search/Regs/home.html#documentDetail?R=0900006480a6b7a1

This is also where you can submit comments, and read other comments. The USDA considers comments that are addressed to issues in the EIS.
If you would like more information on how to make comments you can refer to
http://ceq.hss.doe.gov/nepa/Citizens_Guide_Dec07.pdf

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Glyphosate-Tolerant Alfalfa Events J101 and J163: Request for Nonregulated Status

Draft Environmental Impact Statement—November 2009

This means there could be a 0.01 percent cross-fertilization between non-GT alfalfa and a GT variety, which is one seed in 10,000, or one plant in 667 square feet at a stand density of 15 plants per square foot.

Because of alfalfa seed purity concerns, FGI has expanded the required isolation distances typically used in States that follow the AOSCA standards when growing GT and non-GT alfalfa for seed production. FGI changed the isolation distances for contractors growing alfalfa seed based on scientific studies examining the travel distance of different alfalfa pollinators. FGI's Best Practices, described in more detail below and are a part of the mandatory stewardship program for licensed GT alfalfa seed growers (alfalfa hay growers follow the mandatory stewardship program as decribed by the Monsanto Technology/Stewardship Agreement), states that when farmers contract with FGI to grow and produce alfalfa seed and use leafcutter bees for pollination, the distance between GT and non-GT alfalfa seed production fields must be greater than or equal to 900 feet. When using Alkali bees, the isolation distance must be greater than or equal to 1 mile, and when honey bees are used as a pollinator, the isolation distance must be greater than or equal to 3 miles. FGI has validated their Best Practices for seed production and believes they can produce non-GT alfalfa seed reliably with >99.5 percent purity (FGI, 2007). To put this in context, one seed in 200 could be from an off-variety, such as GT alfalfa seed in conventional alfalfa seed.

4. Gene Flow to Other Alfalfa Crops and Wild Relatives

Gene flow (the movement of genes from one population to another) occurs naturally among alfalfa in hay fields, seed fields, feral and other alfalfa populations via bees and secondary seedlings. Potential environmental impacts due to gene flow from GT alfalfa to cultivated or feral (free living) alfalfa are considered by APHIS to be no different from cultivation of conventional alfalfa and the resulting potential for gene flow from conventional alfalfa. In the event that GT alfalfa plants were no longer regulated under 7 CFR part 340, we do not believe that the natural flow of genes and traits between alfalfa populations in the United States amounts to a significant impact on the human environment for the following reasons:

- No *Medicago* species are native to the Western Hemisphere; hence, there will be no impact on the natural genetic resources of these species from release in the United States (Sinskaya, 1961; Lesins and Lesins, 1979; Ivanov, 1988).
- If GT individuals did arise through intraspecific hybridization (between two sub-species of the same species), tolerance to glyphosate would not confer any competitive advantage to these plants unless exposed to glyphosate. This would only occur in managed ecosystems where glyphosate is applied for broad-spectrum weed control or in

plant varieties developed to exhibit glyphosate tolerance and in which glyphosate is used to control weeds.

- As with GT alfalfa volunteers, these individuals, should they arise and where they require control, could be controlled using other available chemical and/or mechanical means. Undesired crosses, if they developed, would not be controlled by the use of glyphosate and control would require use of non-glyphosate vegetation management practices. Currently, glyphosate is not widely used to control unwanted alfalfa vegetation (Rogan and Fitzpatrick, 2004).

The following section discusses the factors that influence gene flow between alfalfa fields and potentially increase or decrease the chances of gene transfer between alfalfa plants.

As previously discussed (see chapter 3), there is no evidence for existence of any sexually compatible, free-living or cultivated relatives of *Medicago sativa* in the United States or North America. Thus, possible movement of the transgene via pollen from GT alfalfa events J101 and J163 to other members of the *Medicago* genus would not occur in the United States, or it would only occur following the introduction and establishment of a reproductively compatible, non-native species near GT alfalfa events J101 and J163. It is reasonable to predict that hybridization between rangeland *falcata* subspecies and GT alfalfa varieties with mostly *sativa* parentage would result in hybrids with more rangeland hardiness than the original GT alfalfa, but less rangeland hardiness than the *falcata* parent.

The three alfalfa populations discussed in this section are defined as follows (based partly on Bagavathiannan and Van Acker, 2008):

- *Hay field population*: agricultural field that is intentionally planted with alfalfa and is harvested for hay (may also include some grazing).
- *Seed field population*: agricultural field that is intentionally planted with alfalfa and is harvested as seed stock.
- *Feral and other alfalfa:*
    - o *feral*—alfalfa growing on any non-agricultural land (including roadsides, fences, waste lots) that reproduces without intentional human inputs, including reseeding. This is considered the "naturalized" population in the United States because alfalfa was introduced to the continent at least 200 years ago (Putnam et al., 2001).
    - o *habitat/rehabilitation/erosion control*—alfalfa that is intentionally sown (most likely in a seed mix), but is not managed after planting.
    - o *rangeland*—seed may be sporadically sown for grazing, but land is not mowed for regular hay harvest, populations are mostly self sustaining.

Table 4-3. Relative Potential for Gene Flow Between Populations of Alfalfa (requires that viable seed is produced).

Pollen Donor	*Pollen Acceptor* Seed field	Hay field	Feral and other alfalfa
Seed field	Between adjacent fields with synchronous flowering, gene flow would be expected to exceed 1% which is not acceptable for foundation or certified seed. The largest data set collected under actual seed production conditions using FGI Best Practices found a range of gene flow from 0.00 to 0.18 percent. Thus, FGI Best Practices that include distance between fields can manage cross-fertilization to below 0.5 percent which is FGI's goal.	Lowest risk of gene flow because hay is cut before seed is produced.	Feral populations should be controlled near seed fields to preserve seed purity. However, if feral plants are present, they will likely be cross-pollinated by seed field pollen.
Hay field	Less likely than seed to seed gene flow. The percent bloom at harvest will influence how much pollen could potentially be transported to seed fields. Mowing hay prior to 10 percent bloom and distance (350 to 600 feet) from seed fields can manage cross-fertilization to below 0.01 percent.	Lowest risk of gene flow out of the nine scenarios. Even in fields that bloom, hay is cut before seed is produced.	The percent bloom at harvest will influence how much pollen could potentially be transported to feral populations. Mowing hay prior to 10 percent bloom can reduce pollen availability. Seed farmers will need to be aware of seeding practices in neighboring rangelands because falcata (yellow-flowered alfalfa) may become increasingly adopted for rangeland forage improvement and the Falcata seed is available commercially[1].
Feral and other alfalfa	Feral populations need to be controlled near seed fields, or purity of GT and non-GT varieties can be compromised. (Or the seed field edges can be harvested as a separate crop.) Seed farmers will need to be aware of seeding practices in neighboring rangelands because falcata (yellow-flowered alfalfa) may become increasingly adopted for rangeland forage improvement and the Falcata seed is available commercially.	Lowest risk of gene flow because hay is cut before seed is produced.	Gene flow between feral individuals that are close to each other is likely. Gene flow between feral populations depends on proximity, pollinators, flowering timing, and environmental stresses. The GT trait is not expected to impart increased fitness in feral alfalfa.

Source: Van Deynze et al. (2008)

[1] http://www.windriverseed.com/15212%20-%20Falcata.pdf

Thus, there are realistic measures that non-GE alfalfa farmers can employ that will effectively reduce or prevent gene flow from neighboring GE alfalfa crops. As stated by Van Deynze et al. (2008):

> "Growers who wish to avoid gene flow (e.g., those who produce hay for markets that reject GE crops) should pay attention to flowering habits (avoiding simultaneous flowering) and harvest schedules, and disallow or remove commercial beekeepers' hives. Although the hay harvest date can be delayed a week or more by wet weather or equipment failure, harvesting before the ripe seed stage is possible in all but the most extreme circumstances."

In those extreme weather circumstances, rainfall or snow during the ripening time will cause decreased seed yield and reduces seed quality (e.g., reductions in seedling vigor and reduced percent germination because of fungal pathogen infection of the seed, or seed will sprout prematurely and die while it is still in the pod) (Rincker et al., 1988), further reducing the likelihood of gene flow. Additionally, viable alfalfa seeds that fall near adult alfalfa have a harder time growing because they must compete for nutrients with the already established adults, and adult alfalfa plants secrete an autotoxic substance into the soil that inhibits root growth in seedlings (Xuan et al., 2005). In fact, reseeding fields to fill gaps from dead plants is not recommended, as the new plants do not compete efficiently enough to survive (Orloff et al., 1997).

Feral alfalfa is a concern if it is not managed near seed fields. Feral alfalfa near GT alfalfa hay fields may receive the GT trait, but the trait's survival in the feral population depends on whether there is pressure from the environment to select for plants that maintain the trait, or chance. The GT trait is not expected to enhance feral alfalfa fitness; there is no difference between GT and non-GT alfalfa in terms of alfalfa's ability to reproduce or persist in an environment (USDA-APHIS, 2009).

Rangeland alfalfa (*falcata* subspecies) populations may be growing as ranchers intentionally seed *falcata* into rangeland to increase forage quality and soil nitrogen (Waggener, 2007; High Plains Midwest Ag Journal, 2008). The potential for gene flow between GT alfalfa and *falcata*, as well as the effect of hybridization between GT alfalfa and the *falcata* subspecies is unstudied.

Factors Decreasing Probability of Gene Flow

FGI and Monsanto have developed mandatory stewardship programs to address concerns regarding gene flow (FGI, 2007).[20] Seed growers

[20] The stewardship programs also address other concerns such as weediness potential and glyphosate-resistant weed formation.

undergo training and have to be licensed to grow GT alfalfa seed. Any farmer who purchases GT alfalfa seed for producing hay is required to sign a Monsanto Technology/Stewardship Agreement (MTA). The FGI (Forage Genetics International) Best Practices for alfalfa seed growers is the primary mechanism for limiting gene flow. Features of the MTA and FGI Best Practices are as follows (FGI, 2007):

- GT alfalfa seed producers may not sell seed to any party other than FGI and growers may not save seed for any purpose.
- Bee hives cannot be moved out of GT alfalfa fields until pollination is finished for the year. This prevents pollen being carried via hive between GT and non-GT alfalfa. Grower must indicate main pollinator species on the FGI Seed Grower Contract.
- Isolation through distance from other alfalfa fields is required. For pollination with leafcutter bees the distance must be greater than or equal to 900 feet, for Alkali bees greater than or equal to 1 mile, for honey bees greater than or equal to 3 miles.
- FGI reports seed field location and planting date to local seed certifying organizations, which GE-sensitive farmers can refer to in order to certify isolation distances.
- Stand removal and volunteer management must be sufficient to allow seed certification inspectors to validate stand removal. Stand removal date and method must be reported to FGI and verified.
- Cleaning requirements for equipment are included in the FGI Best Practices.
- The Monsanto MTA requires alfalfa hay growers to harvest at or before 10 percent bloom.

Additional factors that could further decrease the potential for gene flow include:

- *Barriers between fields*—Types of barriers can include bodies of water, or other, more attractive plants for bee foraging in between fields. A border of plants at field edges has the benefit of being a buffer zone, as pollen would be deposited in the border population before leaving a GT alfalfa field. If the border were also alfalfa, this would ensure that pollinators would not preferentially avoid the border area. However, the border would need to be treated as GT alfalfa, and if it starts out as non-GT alfalfa, then the spread of genes from that population to the GT alfalfa could adversely affect the cultivation of GT alfalfa seeds by reducing seed purity. If the border were not alfalfa, but a different plant, this would prevent bees from traveling far from the field, and fewer GT genes would be spread. However, this could be difficult if the border plant has different growing and management requirements from the alfalfa, or if it is an attractive plant to pollinators, which would discourage the alfalfa pollinators from

pollinating the alfalfa, and could encourage distant bees to forage there, increasing long-distance pollen flow. Seeds produced by a non-alfalfa plant could also contaminate the purity of the alfalfa seed crop (Amand et al., 2000; Rogan and Fitzpatrick, 2004).
- *Competition for resources*—Volunteer alfalfa plants must establish themselves and compete for nutrients against adult plants.

Given proper adherence to FGI Best Practices and Monsanto's MTA, the risk of cross-fertilization is well below FGI's goal of less than 0.5 percent (unintended or unplanned presence of GT alfalfa).

Factors Increasing Probability of Gene Flow

Certain factors have the potential to increase gene flow between alfalfa crops, as has been discussed in the technical report, *Glyphosate-Tolerant Alfalfa Presence in Human Food and Animal Feed* (appendix Q). If GT alfalfa is deregulated, there would be no restrictions or permits required to grow GT alfalfa. Factors that may increase gene flow between alfalfa populations include, but are not limited to the following:

- *Feral alfalfa creates gene flow corridors*—If feral alfalfa grows between fields of GT alfalfa and non-GT alfalfa, then it could provide a corridor for gene flow, or a strip of growth that can serve as a reservoir for the GT gene, between these fields. It could act as a stepping stone for pollinators that would be more likely to travel between flowers that are closer together than between distant fields.
- *Pest management strategy*—Some farmers use a pest management strategy which allows for a strip of uncut alfalfa during hay harvest. This alfalfa strip can act as a reserve for insect predators. If these alfalfa strips are not harvested at the same time as the rest of the field, they would have the chance to flower, receive pollinators, and set seed. If the strip was GT alfalfa, this would result in a low risk of pollinators mediating the distribution of the GT trait, potentially including feral populations if they occur nearby (Mueller, 2005).
- *Seed field proximity can increase gene flow between the fields*—The seed fields are generally found in a compact geographic area, and with pollinators that have the potential to forage over miles (honey bees, for instance), this creates the potential for cross-pollination in non-GT alfalfa seed fields (Hubbard, 2008).
- *Presence of volunteer alfalfa*—As with any agricultural crop, there is the possibility of volunteer alfalfa growing in the field during other crop rotations. If these volunteer plants were GT, normal glyphosate-based herbicide routines would not eradicate them, creating a possibility that the volunteer plants would flower, set seed, and be a source of pollen for gene flow (Altieri, 2000). Also, alfalfa produces "hard seeds", which have hard coatings that prevent moisture from

germinating the seed. It is possible that these seeds can remain dormant through growing seasons and germinate at a later time, creating the possibility of adventitious presence even after alfalfa is no longer produced in a field (Hubbard, 2008).

- Movement of honey bees from crop to crop could increase the chance of transferring pollen from one field to another.
- If farmers release too many bees to pollinate one alfalfa seed field, this can lead to unintended and wide dispersal of the bees. This is because bees respond to the competition at one field, and if there are too many in one field, they will forage to find nectar and pollen or to establish nests at alternate sites where there is less competition. This might happen before they visit any flowers of the target field, or they might visit the target field before traveling, increasing the potential of gene flow from the target field (which may be GT alfalfa) to other fields (possibly non-GT alfalfa) (Bosch and Kemp, 2005).

If alfalfa farmers take these factors into consideration and employ measures to counter these factors, such measures should also help alfalfa farmers effectively reduce or prevent gene flow between neighboring alfalfa crops. Combined with the measures discussed above that can be employed to decrease the probability of gene flow between alfalfa fields and crops, we do not believe that the potential for flow of genes and traits between alfalfa populations in the United States should amount to a significant impact on the human environment.

5. Weediness and Increased Glyphosate Resistance

Weed management is an important aspect of alfalfa production. Some of the negative effects of weeds include the following (Canevari et al., 2007; Canevari et al., 2006; Van Deynze et al., 2004; Loux et al., 2007; Miller et al., 2006; Orloff et al., 1997):

- competition with weeds can reduce yield and cause thinning in the stand;
- weeds can lower the nutritional quality of alfalfa hay because many weeds are lower in protein (50 percent less protein than alfalfa) and higher in fiber compared to alfalfa;
- poisonous weeds containing toxic alkaloids (a type of chemical) can make alfalfa hay unmarketable (e.g., common groundsel, fiddleneck, yellow starthistle, and poison hemlock);
- under some conditions weeds can accumulate toxic nitrate concentrations (e.g., lambsquarters, kochia, and pigweed);
- some weeds with a spiny texture can cause mouth and throat ulcerations in livestock (e.g., foxtail, wild barley, cheatgrass, and bristlegrass);
- weeds that are unpalatable to livestock result in less feeding and, therefore, less productivity (of either beef or milk);

any listed or proposed T&E species or any designated critical habitat from directly contacting, consuming, or hybridizing with GT alfalfa events J101 and J163 and/or its progeny (http://ecos.fws.gov/tess_public/pub/listedAnimals.jsp; http://ecos.fws.gov/tess_public/pub/listedPlants.jsp; http://crithab.fws.gov/; all accessed January 2009).

- GT alfalfa events J101 and J163 are not expected to become more invasive in natural environments or have any different effect on critical habitat (designated by the Endangered Species Act) than their parental non-GT line in the absence of glyphosate selection. This conclusion is based on results of more than 150 field trials conducted over a 5-year period in 33 different states (Rogan and Fitzpatrick, 2004). The data show GT alfalfa events J101 and J163 are essentially equivalent to non-GT variations in form and shape, such as growth habit, vegetative growth, and flower and pollen morphology (USDA-APHIS, 2009). Several agronomic traits were evaluated and no biological differences between GT and non-GT alfalfa were noted for traits that may influence weediness, including seed dormancy, seed germination, seedling emergence, seedling vigor, winter survival, spring vigor, seed yield, vegetative growth, plant dormancy, survival, and relationship with symbiotic organisms (USDA-APHIS, 2009).
- Analysis of forage samples from several locations demonstrates that it is compositionally and nutritionally equivalent to other alfalfa varieties currently on the market except for the expression of the transgene protein, and therefore is not expected to have nutritional effects on any T&E species that feeds upon it (technical reports, *Presence of Glyphosate-Tolerant Alfalfa in Human Food and Animal Feed* (appendix Q), and *Character and Quality of Glyphosate-Tolerant Alfalfa Traits* (appendix U), (FDA, 2004) [appendix P], (Rogan and Fitzpatrick, 2004).
- The transgene protein does not have toxic or pathogenic effects that would affect T&E species or their critical habitat. The EPSPS protein from plants and from the CP4 *Agrobacterium* strain are not known for pathogenic or toxic effects on human, animal, or plants based on numerous laboratory and field studies with these purified proteins or plants expressing these proteins (technical reports, *Presence of Glyphosate-Tolerant Alfalfa in Human Food and Animal Feed* (appendix Q), and *Character and Quality of Glyphosate-Tolerant Alfalfa Traits* (appendix U), (FDA, 2004) [appendix P], (Rogan and Fitzpatrick, 2004). Nor do the proteins dispose plants to become more susceptible to disease (USDA APHIS, 2009). The same CP4 EPSPS enzyme is expressed in numerous glyphosate-tolerant crops already grown on millions of acres across the United States.
- GT alfalfa events J101 and J163 are not expected to form hybrids with any State or federally listed threatened or endangered species of plants

> "Organic crops must be protected from contamination by prohibited substances used on adjoining lands (for example, drifting pesticides, fertilizer-laden runoff water, and pollen drift from genetically engineered…)"(NCAT, 2003).

Typically, more than one method is used under organic practices to prevent unwanted material from entering their fields including; isolation of the farm, physical barriers or buffer zones between organic production and non-organic production, as well as formal communications between neighboring farms (NCAT, 2003). Farmers using organic methods are requested to let neighboring farmers know that they are using organic production practices and request that the neighbors also help the organic farmer reduce contamination events (NCAT, 2003; Krueger, 2007). The organic plan used as the basis for organic certification should also include a description of practices used to prevent or reduce the likelihood of unwanted substances, like GE pollen or seed, at each step in the farming operation, such as planting, harvesting, storing and transporting the crop (Riddle, 2004; Krueger, 2007; Kuepper et al., 2007). Organic plans should also include of how the risk of GE pollen or seed co-mingling will be monitored (Kuepper et al., 2007). Practices that help organic farmers minimize the risk of unintended GE presence in their field include: (1) Use seed that is from a known, non-GE stock (lists of organic seed suppliers can be found at www.attra.org); (2) Use temporal buffers such that alfalfa being produced using organic methods is receptive to pollen at a different time of year than when the neighboring alfalfa flowers; (3) Harvest alfalfa at 10 percent bloom to reduce the number of flowers available for pollination (however, harvesting alfalfa prior to formation of seed (approximately 4 weeks after bloom) will also minimize the potential of gene flow into an organic alfalfa forage field; see table 4-3); (4) remove bee hives surrounding alfalfa fields prior to alfalfa blooming period (5) Maintain physical isolation from GT alfalfa (either through distance or natural barrier (e.g., tree rows)); (6) Plant alfalfa at the edge field to act as a trap for GE pollen and harvest these buffer rows separately.

Thus, commonly used production practices for alfalfa, and the practical methods typically used by alfalfa farmers using organic methods to protect their crop and maximize their profits and price premiums granted to alfalfa under organic production, currently provide many effective measures that greatly reduce the likelihood of accidental gene flow between GT and non-GT alfalfa. APHIS assumes that organic farmers are already using, or have the ability to use, these common, reasonable practices to minimize gene flow between GT and non-GT alfalfa, because organic alfalfa growers have not informed APHIS to the contrary, and because USDA organic certification requires measures to minimize unintended presence to GT alfalfa. Recommended organic production practices for alfalfa are also readily available (Guerena and Sullivan, 2003). It is important to note deregulation increases organic production costs associated with isolation, buffer zones, or relocation, this growth may be slowed.

Deregulation of GT alfalfa could imply losses in exports of conventional alfalfa seed and hay to the main U.S. clients (Saudi Arabia and Japan, for each product respectively). If GE content in animal feed becomes increasingly rejected by international markets, much of this market could be lost. If GE content becomes increasingly accepted, the United States may benefit from the increased competitiveness of GT alfalfa in a market where international competitors are currently gaining ground.

The analysis of the direct and indirect effects of the deregulation of GT alfalfa to human health and safety concludes that under present and expected conditions of glyphosate use, GT alfalfa or the glyphosate herbicide are unlikely to pose a health risk to humans. In terms of herbicide use in conjunction with deregulating GT alfalfa, the cumulative impacts related to the past deregulation of other GT crops increases glyphosate use, and decreases in the use of other, more toxic and persistent herbicides. With more GT crops, there is a greater chance that crops grown for human consumption will be found planted near GT crops, which could result in a greater chance for unintentional glyphosate applications on food crops and a subsequently greater chance for the general public to be exposed. This chance would increase with the deregulation of GT alfalfa. However, glyphosate has been shown to replace more toxic herbicides, so the overall risk to human health, cumulatively, would likely decrease with the deregulation of GT alfalfa. Additionally, glyphosate is currently a widely-used herbicide, and in numerous applications other than agricultural. The additional incremental increased use of glyphosate that would occur with the deregulation of GT alfalfa, along with the current use as described here, would minimally increase exposure to the general public.

Past actions contributing to impacts on surface water pollution include agriculture, industry, resource extraction, urban, suburban, and rural development, and other human activities. Glyphosate will be found in surface water runoff when erosion conditions lead to the loss of surface soil particles. However, deregulation of glyphosate-tolerant alfalfa would likely lead to an increase in conservation tillage and no tillage systems, which could mitigate the increased application of glyphosate by decreasing sedimentation of glyphosate-laden soil particle in surface water runoff (Wiebe and Gollehon, 2006). The quality of surface water may also be improved by conservation tillage, as it reduces erosions and decreases the amount of sediments in rivers and streams.

office expenses and taxes. Non-cash costs are capital recovery costs for land, the irrigation system and the equipment. The seeding rate is assumed to be 30 lbs/acre. We show the line items for seeds and herbicides, more details are found in the publication.

Table K-1. Establishment Costs, $/ acre

Seeds	90.00
Herbicides	32.00
Other	314.00
TOTAL CULTURAL COSTS	436.00
Interest on operating capital @ 6.75%	10.00
TOTAL OPERATING COSTS/ ACRE	446.00
Cash overhead costs	85.00
CASH COSTS/ACRE	531.00
Non-cash costs/ acre	294.00
TOTAL COSTS/ACRE	825.00

Source: Frate et al., 2008

Table K-2 shows how establishment costs per acre vary with changes in seed and herbicide costs. The first column shows the increase assumed for seed costs or for herbicide costs. The second and third columns show the impact on establishment costs when it is seed costs that increase 10%, 20%, 30% or 40%, and the fourth and fifth columns show the impact on establishment costs when it is herbicide costs that face a similar increase.

Table K-2 shows that seed costs have a greater weight than herbicide costs in determining total establishment costs, under the conditions of the US Cooperative Extension Study.

Table K-2. Sensitivity of Establishment Costs to Changes in Seed and Herbicide Costs

Percent increase in input costs	Establishment costs when seed costs increase		Establishment costs when herbicide costs increase	
	$	% change	$	% change
0	825.0		825.0	
10%	834.0	1.09%	828.2	0.39%
20%	843.0	2.18%	831.4	0.78%
30%	852.0	3.27%	834.6	1.16%
40%	861.0	4.36%	837.8	1.55%

Source: based on previous table

Table K-3 incorporates establishment costs into total costs of producing alfalfa by assuming annual cost recovery of cash establishment costs spread over a 4 year life of stand. Cultural costs now include herbicides, insecticides, fertilization and irrigation. Income from alfalfa hay sales is also incorporated and seven harvests are assumed in a year. The UC Cooperative Extension study assumed a yield of 8 tons/ acre, average of yields between 5 and 11 tons/ acre obtained under these conditions in the San Joaquin Valley. The table shows positive returns over operating costs, but negative returns when overhead and capital costs are included.

Table K-3. Total Production Costs and Returns, $/ acre

Sales (8 tons/acre at $185/ton of premium)	1,480
Herbicides	71.00
Other cultural costs	294.00
Harvest costs (7x)	310.00
Interest on operating capital @ 6.75%	10.00
Total operating costs/ acre	685.00
Return over operating costs	795.00
Cash overhead costs	165.00
Annual cost recovery: alfalfa establishment	147.00
Annual cost recovery: other	549.00
Total costs/acre	1,546.00
Return over total costs	-66.00

Source: Frate et al., 2008

Table K-4 shows how returns per acre vary with changes in seed and herbicide costs, as well as changes in yields or hay prices. As in table K-2, the first column represents the percent increase assumed if a given factor is affecting returns. In this case: seed costs, herbicide costs or the yield multiplied by the price of alfalfa hay. The remaining columns show the impact on returns when the percent increase assumed is applied to seed costs, herbicide costs, yields or the price of alfalfa hay.

The table shows that the influence of herbicide costs now surpasses that of seeds on total costs, since now herbicides are also used during production. The table also shows, however, that under the conditions of the US Cooperative Extension Study, yields and hay prices are far more important than seed and herbicide costs in determining returns.

Table K-4. Sensitivity of Returns to Changes in Costs, Yields and Hay Prices

Percent increase	Seed costs		Herbicide costs		Yields or Hay prices	
	$	% change	$	% change	$	% change
0%	-66		-66		-66	
10%	-68.49	3.77%	-73.99	12.11%	82	224.24%
20%	-70.49	6.80%	-81.97	24.20%	230	448.48%
30%	-73.48	11.33%	-89.96	36.30%	378	672.73%
40%	-75.97	15.11%	-97.94	48.39%	526	896.97%

Source: based on previous table

The Integrated Pest and Crop Management Portal of the University of Wisconsin Plant Sciences outreach programs posts a "Roundup Ready Alfalfa Calculator" elaborated by Dan Undersander (http://ipcm.wisc.edu/WCMNews/tabid/53/EntryID/208/Default.aspx). Table K-5 shows the results of this calculator for conventional hay, as presented on the website. We include the results for Roundup Ready alfalfa further below. Values are those that the portal feels "are accurate estimates of the costs, use patterns, and yield throughout Wisconsin." However the numbers are not supposed to be representative of every farmer, and the calculator is offered so that each farmer can plug in their numbers and see the results.

Table K-5. Establishment and Production Cost of Conventional Alfalfa, units/acre

Seed cost/ 50 lb bag ($)	$200.00
Pounds of seed per acre	12
Technology fee/bag ($/bag)	$0.00
Yield in seeding year (t/a DM)	3.50
Herbicide cost ($/acre/application)	$20.00
Herbicide application cost ($/acre)	$10.00
Number of herbicide applications	1
Value of ease of roundup use ($/acre)	$0.00
Yield depression from pursuit/raptor (t/a DM)	0.30
Expected stand life (yrs including seeding year)	3
Value of hay (per ton DM)	$100.00
Fixed costs per acre per year	$180.00
Harvesting costs per acre per harvest	$35.00
Number of harvests	2
Seeding Year Production Costs/Results	
Seed cost (prorated + tech fee) per acre*	$16.00
Total seed and herbicide cost per ton of hay	$14.38
Total cost per ton of hay seeding year	$85.80
Profit per acre - seeding year	$49.69

Source: Integrated Pest Crop Management, University of Wisconsin

The University of Wisconsin portal also presents some sensitivity analysis. We extend their analysis to include herbicide costs and the price of alfalfa hay, since these variables may potentially differ between conventional and GT alfalfa, as argued in section 2.2 below. We use the numbers for the seeding year above to have an idea of the changes in profit for percent changes in seed costs, herbicide costs and the price of hay. Table K-6 shows the results for a conventional alfalfa hay field. The first column represents the percent increase assumed in a given factor affecting returns. The remaining columns show the impact on per acre profit when the percent increase assumed is applied to seed costs, herbicide costs or the price of alfalfa hay.

Table K-6. Sensitivity of Profit per Acre to Costs and Prices

% increase	seed costs	herbicide costs	price of alfalfa hay
0	49.69	49.69	49.69
10	47.94	47.50	84.69
20	46.19	45.31	119.69
30	44.44	43.13	154.69
40	42.69	40.94	189.69

Source: Elaborated from numbers in table above.

While a 40% increase in seed costs and herbicide costs have a less than proportional impact on profit, a 40% increase in alfalfa hay prices will more than triple the profit per acre. What this means is that reductions in the costs of herbicides are less important in the farmer's choice of adopting GT alfalfa or conventional alfalfa for hay than the possibility of obtaining higher quality alfalfa hay.

additional reports, including that of possible increase in yields (due to lesser stunting caused by use of other herbicides) and reduction in herbicide costs.

Reduced seeding rates or increased life of stands would have relevant impacts on costs because establishment costs would be reduced (per year of production). Van Deynze et al. (2004) suggested GT alfalfa could potentially increase the life of alfalfa stands but we have not found studies verifying this.

Given the economic relevance for alfalfa farming of yields and alfalfa hay quality evidenced in the cost studies reviewed above, we reviewed the literature for evidence of differences in those particular traits between GT alfalfa and non- GT alfalfa.

2.2.1 Differences in Yield

Alfalfa hay yield is influenced by a wide range of factors, including seed variety, proper planting and establishment, climate, soil and moisture conditions, and weed and insect control (Dixon et al. 2005). Hundreds of alfalfa varieties have been developed for use in North America. These varieties are adapted to the various major alfalfa production zones, and contain genes selected for high yield and resistance to diseases, insects, and nematodes (Van Deynze et al. 2004).

The focus here is on evaluating any systematic differences in yield between GT and conventional alfalfa varieties, holding constant the other factors that may influence yield. Rigorous assessment of the yields of different alfalfa varieties under actual farming conditions is generally not available. Instead, forage agronomists usually evaluate different varieties in the context of controlled variety trials at agricultural experiment stations (Mueller 2008).

Comparative yield data from a number of variety trials across the United States are given in Table K-8. These results were selected for illustrative purposes, and do not necessarily represent the yield outcomes that would result from individual cultivar comparisons, or other locations and growing seasons.

Table K-8. Comparative Variety Trial Yield Results

Variety Trial Location and Date	Average Annual Yield, All GT Alfalfa Varieties (Tons/Acre)	Average Annual Yield, All Varieties (Tons/Acre)
Illinois (Freeport), 2007[1]	6.10	6.17
Iowa (Ames), 2007[2]	4.61	4.64
Kansas (Thomas Co.), 2007[3]	8.22	8.41
Nebraska (Havelock), 2006[4]	5.04	5.12
New York (Cobleskill), 2006[5]	2.6	2.9
South Dakota (Brookings Co), 2006[6]	3.81	3.86
Wisconsin (Lancaster), 2006[7]	4.77	4.07

1. Source: http://vt.cropsci.uiuc.edu/forage.html
2. Source: http://www.croptesting.iastate.edu/alfalfa/results/2007-alfalfa.xls
3. Source: http://kscroptests.agron.ksu.edu/07/07alf/7a-thi6.asp?Loc=thi6
4. Source: http://varietytest.unl.edu/alfalfa/2006/Roundup-Havelock2006table06.xls
5. Source: http://plbrgen.cals.cornell.edu/programsandprojects/departmental/foragetest/alfalfa06.htm
6. Source: http://plantsci.sdstate.edu/forages/Alfalfa%20Trials/SD_Alfalfa_Trials.html
7. Source: http://www.uwex.edu/CES/crops/RRAlfalfa07.htm

As revealed in table K-8 above, variety trial results do not indicate any systematic hay yield advantage or disadvantage for GT alfalfa hay cultivars. Dr. Daniel Putnam, a leading alfalfa

Taken together, the evidence suggests that there is no intrinsic yield advantage in GT alfalfa cultivars over conventional cultivars. The evidence suggests a potential yield advantage for GT alfalfa using the glyphosate weed management system, particularly during stand establishment.

2.2.2 Differences in Quality

The forage quality of alfalfa is based on a large number of factors that are ultimately linked to its utility as an animal feed (Baker and Ball 1998). Federal quality guidelines currently use percentage of crude protein and acid detergent fiber, relative feed value, and an evaluation of color, molds or weeds present (McWilliams et al. 2005). Alfalfa is then placed in five quality categories: supreme, premium, good, fair and low. Some states have adopted additional quality grading regulations. 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).

As noted in the preceding subsection, Van Deynze et al. (2004), Dillehay and Curran (2006), and Rankin (undated) all report better weed control in GT alfalfa using the glyphosate weed management system. Glyphosate controls a broader spectrum of weeds and is more efficacious than most currently available herbicides and herbicide combinations during the critical stand establishment stage of alfalfa production (Van Deynze et al. 2004; Dillehay and Curran 2006), and induces less crop injury in established stands (Van Deynze et al. 2004).

Conventional alfalfa hay varies in terms of weed content, and so it is difficult to make direct comparisons between GT and conventional alfalfa hay from a weed content standpoint. Quality grading assigns penalties based on weed and other contaminant content. Cummings et al. (2004) utilized an alfalfa hay pricing system in which each 15 percentage point increase in weed content above a benchmark 5 percent level resulted in a 10 percent reduction in the price of the alfalfa hay. Van Deynze et al. (2004) note that pure alfalfa hay is usually worth 20 to 50 percent more than weedy hay. Putnam (2008) argues that while the relative weed-free nature of GT alfalfa tends to give it a quality edge over conventional alfalfa, one cannot systematically attribute higher quality to GT alfalfa over conventional alfalfa, since sometimes conventional weed control systems can be quite effective.

The limited evidence presented here suggests that while there is the potential for higher quality forage from GT alfalfa, one cannot systematically assume higher quality attributable to GT alfalfa over conventionally produced alfalfa.

2.2.3 Scenarios

Based on the review above, we use the cost studies previously mentioned and ask what would happen under the same assumptions but with the use of GT seed, glyphosate, and under various scenarios of alfalfa hay quality. No differences in yield are assumed between GT alfalfa and non-GT alfalfa, and no additional differences in management systems are assumed.

These scenarios should not be interpreted as likely differentials in costs and returns between conventional and non-GT alfalfa in any particular setting, since the differences in management systems between the two varieties are likely to involve other factors not taken into consideration in the scenarios (such as the time spent by farmers with weed control) and the impact of the deregulation of GT alfalfa on the prices paid for alfalfa of various qualities is ignored (this will be analyzed in a future Technical Report, since it is not part of the scope of the present report). However, given the importance of differences in seed, herbicide use and potentially in alfalfa forage quality between conventional and GT alfalfa, we feel these scenarios provide a useful illustration of what the potential cost and return implications may be of adoption of GT alfalfa for forage.

A note on removal costs: removal of GT alfalfa stands can be done both through mechanical and chemical methods and one source describes plowing as possibly the most common method for alfalfa stand removal (Orloff and Putam, No Year). When herbicides are used for removal, glyphosate seems to be the most common (Canevari 2004). However, glyphosate cannot be used to remove GT alfalfa stands.

Differences in removal costs of alfalfa stands are not considered in this exercise, because they are also not included in the cost studies used as comparison. Glyphosate as an herbicide in the removal of alfalfa stands apparently can be substituted by other herbicides. One study done by Mark Renz at the University of Wisconsin with various herbicides found that "all herbicides were effective at limiting resprouting of alfalfa at the appropriate rate and timing" (Renz, 2007). Canevari et al (2004) suggest a combination of 2,4-D and Banvel (dicamba) was particularly effective. Miller et al (2006) suggest various options while alerting to the restrictions of these herbicides for future crop rotation.

Based on the existing literature, we consider the following values (sometimes ranges) for the scenarios.

a) GT alfalfa seed costs

GT alfalfa seeds were sold at US$6-7.50/lb during its deregulation period, according to various sources (http://www.purdue.edu/UNS/x/2007a/070323NeesAlfalfa.html; http://ipcm.wisc.edu/WCMNews/tabid/53/EntryID/208/Default.aspx; http://www.roundupreadyalfalfa.com/home.aspx?page=valuecalculator)[40], including its technology fee (trait premium). The technology fee for areas "east of the Rocky Mountains[41]" (http://www.farmandranchguide.com/articles/2005/08/31/ag_news/regional_news/news11.tx; http://www.soils.wisc.edu/extension/wfapmc/2006/pap/Undersander2.pdf) is US$125 per 50/lb bag, that for those areas west of the Rocky Mountains US$150 per 50/lb bag.

Seeding rates are those of the conventional alfalfa farming cost studies used as comparison.

b) Glyphosate costs

[40]One commenter to APHIS EIS NOI gives the value of US$6.50 (comment tracking # 803a981a).

Glyphosate prices used in the scenarios area based on those reported by USDA NASS for the same year of the non-GT study being used:

Table K-9. Glyphosate Prices, 1998-2008, $ / gallon

1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
56.30	45.50	43.30	44.50	43.50	43.30	39.70	33.80	29.30	28.90	40.50

USDA, NASS, Agricultural Prices, various years.

In 2008, prices of glyphosate seem to have rebounded from a few years of reduced prices.

The number of glyphosate applications used in the scenarios is one or two per year at 22 ounces/acre. One application a year would then require 0.172 gallons and two applications would require 0.344 gallons. These volumes correspond to those used by several of the trials previously reviewed.

c) Weed content

In this exercise, we assume no glyphosate resistance and only glyphosate is used as a herbicide. We leave considerations regarding the potential need for additional herbicides for section 4, where we consider the impact of herbicide resistance to glyphosate. With one or two applications of glyphosate at 22 ounces/acre there is a range of possible results in terms of weed content in the final product, as reviewed above. Improvements in weed content are built into the scenarios as increases in the quality of hay (for example, from good to premium or to supreme) with reflections on prices, according to USDA available alfalfa hay prices for the relevant locality and year. We consider a range of scenarios, from no improvement at all in quality to improvements to supreme alfalfa hay quality.

Table K-10 is intended as an illustrative exercise regarding the possible impact of using GT alfalfa and is not applicable to all situations. It is based on the same circumstances assumed by the UC Cooperative Extension study, while altering seed prices, herbicide use and hay prices.

Table K-10. Scenarios for GT Alfalfa

		1 glyphosate application		2 glyphosate applications	
	Conventional	**GT (l)**	**GT (h)**	**GT (l)**	**GT (h)**
Sales (8 tons/acre)	1480	1560	1480	1560	1480
Total operating costs/ acre	685.00	619.16	620.88	624.32	627.76
Return over operating costs	795.00	940.84	859.12	935.68	852.24
Cash overhead costs	165.00	165.00	165.00	165.00	165.00
Annual cost recovery: alfalfa establishment	147.00	164.48	177.41	165.91	179.32
Annual cost recovery: other	549.00	549.00	549.00	549.00	549.00
Total costs/acre	1,546.00	1,497.64	1,512.29	1,504.23	1,521.08
Return over total costs	-66.00	62.36	-32.29	55.77	-41.08

Source: column two from Frate et al., 2008; other columns added.

Columns three and four assume one glyphosate application during the establishment year, columns five and six assume two. Low cost scenarios (l) assume seeds cost US$6/lb and glyphosate US$30/ gallon, while the high cost scenarios (h) assume seeds cost US$7.50/lb and glyphosate US$40/ gallon. Seed prices already incorporate the technology fee (trait premium) of US$ 150 per 50 lb bag. Each glyphosate application is assumed to use 22 ounces/acre. The high cost scenario also assumes GT alfalfa generated no benefits in terms of alfalfa quality. The low cost scenario assumes GT alfalfa improved alfalfa quality. Alfalfa that in the UC Cooperative Extension study was assumed to be sold as premium quality will be sold, under the low cost scenario, as supreme quality. Prices are based on those of the USDA AMS, 2007 California Market Summary, where prices for alfalfa hay in the San Joaquin Valley averaged around US$185/ ton for premium and US$195/ ton for supreme qualities.

This result depends on the assumptions made regarding the use of herbicides. One way of relaxing these assumptions is by increasing the use of glyphosate applications. Six applications alfalfa in years following that of the seeding year. In the remaining scenarios, in two of the three cases, GT alfalfa increased profits in the seeding year, even if the cost of the technology fee were not distributed through the life of the stand.

2.3 Summary of Findings

Farming conditions for alfalfa forage vary considerably throughout the United States and we have not identified major cost elements that dominate farming costs under most circumstances. Percentage changes in yields or forage prices have a much greater impact on returns to alfalfa farming for forage than equivalent percent changes in any cost factors. Economies of scale in land preparation mean that technologies (seed varieties) that require more land preparation would be more attractive (and of larger benefit) to larger farms.

GT alfalfa production for forage will have impacts on the cost of seed and the cost of herbicide use. There is also enough evidence to suggest possible benefits on the quality of hay that would presumably lead to higher sales prices Alfalfa forage farmers aiming at maximizing returns during the time horizon of an alfalfa life stand would likely benefit financially from the adoption of GT alfalfa.

2.0 Impacts on Exports

2.1 Trends

2.1.1 Alfalfa Seed

Data on alfalfa seed exports is provided by USDA Foreign Agricultural Service (FAS) through its U.S. Trade Internet System (FASonline). Saudi Arabia has been the largest export market of U.S. alfalfa seed after passing Argentina, having increased its purchases significantly in 2006 and doubling in size in 2007. Other important markets in Mexico, Canada, and Argentina have fluctuated but remain at similar levels over the five year period. Data for the first six months of 2008 suggests Saudi Arabia's major purchases continue ($14,801,000 in January – June of 2008). Table R-1 shows the size of the major export markets over a six-year period.

Table R-1. U.S. Exports of Alfalfa Seed, $1000

	2002	2003	2004	2005	2006	2007
Saudi Arabia	7,533	13,523	11,659	12,233	17,172	38,075
Mexico	6,600	8,636	9,652	9,955	10,018	9,578
Argentina	2,837	3,300	7,682	6,793	5,521	5,062
Canada	2,081	2,867	4,294	5,573	5,042	2,960
Other*	6,912	10,674	10,685	10,404	7,389	10,379
Total	25,963	39,000	43,972	44,958	45,142	66,054

Source: USDA, FAS (FASonline). Code 120921 of the US Harmonized Tariff System; *Includes Japan, China, and Peru, among others.

FASonline does not provide price data for the different export markets. However, by comparing quantities imported to the value of the export market, table R-2 shows value per metric ton of exported U.S. alfalfa seed. Saudi Arabia not only purchases the most U.S. alfalfa seeds, it also pays the highest price.

Table R-2. U.S.Exported Alfalfa Seed, $ value per Metric Ton

	2002	2003	2004	2005	2006	2007
Saudi Arabia	1,655	3,714	3,202	3,393	3,919	4,852
Mexico	2,550	2,435	2,721	3,018	3,346	3,438
Argentina	2,635	1,070	2,490	3,080	3,573	3,769
Canada	1,863	2,081	3,117	2,874	3,829	3,970
Other	11,570	2,515	2,518	3,105	3,570	4,087
Total	2,614	2,454	2,767	3,122	3,668	4,328

Source: USDA FAS (FASonline). Code 120921, value of export / quantity of export.

2.1.2 Alfalfa Hay and Processed Alfalfa

Total U.S. exports of alfalfa hay grew considerably between 1998 and 2002 but then stabilized somewhat in export value, while likely declining in quantities[68]. Japan is by far the main destiny of U.S. alfalfa hay exports, followed by South Korea and Taiwan. Japan's share of U.S. exports

[68] FASonline, reports quantities traded of the "greatest number of like units of measure for grouped commodities." To the extent that this reflects total quantities of alfalfa hay exported, there has been a decline in exports in recent years.

and Mexico imports and consumes regularly GE corn, soybeans and cotton from the United States (FAS, 2008b). Mexico's existing labeling requirements for GMOs have not been implemented, according to Gruère G. P. (2006).

In the case of Canada, another important market for alfalfa downstream products from the United States, GT alfalfa has also been approved and there is no mandatory labeling for GE products (Gruère G. P., 2006).

2.2.2 Beyond Standards in Main Export Markets

As in the case of Europe, mandatory labeling requirements for food in Japan have resulted in an incentive for producers to substitute non-GE ingredients for GE ingredients (Gruère G. P. and Rao S. R., 2007). Because of the higher threshold of GE content and exemptions of highly processed foods, there are still many products with GE ingredients that are sold in Japan without GE labeling, such as cheese, soya souce and soy oil (Gruère G. P. and Rao S. R., 2007). Corn used for feed is typically GE corn, since meat fed with GE corn does not need to be labeled. Corn used for food consumption and soybeans used for Tofu, on the other hand, are typically GE free (Grueré G. P., 2006).

Because alfalfa hay is predominantly used as feed, the impacts of deregulation associated with the export market in Japan may be similar to those of soybean and corn. Japanese regulations do not seem to have had a significant impact on these crops and labeling is not required for products from GE fed animals, at least not for meat (Grueré, 2006).

However, for retail products where labeling is not required, there may still be a share of consumers that would prefer not to consume products with GM ingredients. Several consumer surveys suggest Japanese consumers would prefer not to consume foods with GE ingredients and would be willing to pay an extra amount for GE-free products (Chern et al., 2002; Bertolini et al., 2003). In these cases, it is up to producers to decide whether using GE ingredients – or GE feed in animal products – poses a risk to businesses.

There is evidence that businesses have often chosen to protect themselves against market risks associated with commercializing GE products, in face of consumer negative perceptions, even in the absence of labeling, at least in countries other than the United States. A USDA (2005) document notes how business associations have sometimes adopted lower required levels of unintended presence for acceptance of products than those required by legislation (United Kingdom). The same document notes that some insurance companies have added exclusions to insurance contracts to protect themselves from potential losses triggered by the presence of GE material.

There is some indication that Japanese alfalfa importers are concerned with importing GE alfalfa. Putnam (2005) states that foreign importers have asked for GE-free alfalfa and that this has lead U.S. exporters to require signed contracts from producers asserting the GE-free status of alfalfa sold to them. Similar anecdotal evidence is provided by Woodward (2004) and recognized in NAFA (2008b).

The attitude of businesses in the absence of required labeling in retail products can be explained by the perception of market risks associated with GE products, given consumer negative perceptions. The extent to which this attitude of businesses changes with time may depend on consumer information as well as on perceived and real liabilities in cases of losses due to the presence of GE material.

In the case of South Korea, Non-Government Organizations (NGOs) have increasingly pressured for expansion of labeling requirements to products using GE ingredients, independently of whether these can or cannot be detected in the final product (USDA FAS, 2008a). USDA FAS (2008a) notes that labeling of feed does not seem to have an impact in the market because most feed is GE, but that an expansion of food labeling requirements to include use of GE ingredients even when not detectable could turn South Korea into a non-GE market. As in the case of Japan, there is evidence of consumer negative views of GE products (Cho, Undated; USDA FAS, 2008a). South Korean businesses, however, have been opposing expansion of GE labeling given the potential increase in their costs from buying non-GE products.

2.2.3 U.S. Alfalfa Supply for Export Markets

Something between 1.1% and 1.5% of U.S. alfalfa hay production was exported in 2007 (in metric tons, calculated comparing USDA FAS export data with production data as reported by USDA ERS, 2007). An exact number is not easy to achieve because exports are reported in hay, meal and pellets and weights must be compared to production alfalfa hay production. In 2007, exports of alfalfa seed represented approximately 54% of the quantity produced (in metric tons, calculated comparing USDA FAS export data with 2007 Census of Agriculture data).

We found no detailed information on the origin of alfalfa for exports within the United States. Various documents suggest a concentration of alfalfa hay and seed for exports in Western states. Woodward (2004) suggests 99% of hay exports come from Western states. Putnam (2005) suggests about 4.5% of alfalfa from six Western states (California, Washington, Oregon, Idaho, Nevada, Utah) is exported. Woodward (2004) notes some 20% of Washington alfalfa may be exported reaching 35%-50% in the Columbia Basin where the counties of Grant, Adams, Benton and Franklin produce almost 70% of the state's alfalfa hay. Putnam (2005) also suggests California's Imperial Valley production is highly aimed at export markets. Mueller (2005) estimates that about 80 percent of California alfalfa seed production goes for export. In all of these export-heavy regions, growers do not necessarily export their entire crop but possibly only a few cuttings (Putnam, 2005). This means that export markets may have a greater influence on production decisions than their share of the market.

2.2.4 Discussion

The main U.S. client for alfalfa seed, Saudi Arabia, would currently not purchase GT alfalfa seeds. Whether Saudi Arabia would continue purchasing non-GT alfalfa seeds from the United States would likely depend on the extent to which non-GT alfalfa seed producers are able to avoid unintended presence of GT alfalfa traits.

United States sales of alfalfa for forage to Japan may decrease with GT alfalfa deregulation. There is evidence of precautionary resistance from Japanese importers for GT alfalfa and the United States has already been losing market share to competitors (Australia). Exporters may have to show that any unintended presence of GT traits would fall well below Japan's one percent threshold level for presence of GM feed.

Beyond the above, there is much uncertainty surrounding the future or trade of GM products. In our Technical Report *Downstream Effects to Organic Production and Marketing of Deregulation of Glyphosate-Tolerant Alfalfa* (appendix T), we presented evidence that there is little information in Europe, Japan, United States, as well as in other countries, regarding GE products. To the extent that familiarity is related to acceptance (or rejection) of GE products, there is space for consumer receptivity to change or consolidate over time. Many countries do not have or must still implement their own regulatory systems for GE products (Gruère and Rao, 2007) and the analysis above is focused solely on U.S. current trading partners. Other potential future clients are not considered, although by far the main world importers are Japan and South Korea in the case of alfalfa hay and Saudi Arabia (after the United States) in the case of alfalfa seeds.

2.3 Summary of Findings

U.S. exports of alfalfa hay and processed alfalfa are considerably concentrated in Japan, and U.S. exports of alfalfa seeds have increasingly gone to Saudi Arabia. Japan and South Korea are the world's largest importers of forage and Saudi Arabia is the largest importer of alfalfa seed, after the United States.

Saudi Arabia will not import GT alfalfa seeds. There is no evidence, however, that Saudi Arabia will not continue to import non-GT U.S. alfalfa seed as long as exporters are able to guarantee seed purity standards.

There is evidence that Japan may decrease its imports of non-GT alfalfa hay from the United States with GT alfalfa deregulation. This seems to be motivated mainly by businesses concerned with negative reactions from consumers, even in the absence of labeling requirements in downstream dairy and meat products.

Table R-17. Canada Alfalfa Meal and Pellets Exports, $1,000

	2003	2004	2005	2006	2007
Japan	15,117	25,406	25,223	22,679	22,470
United States	3,097	1,293	2,933	3,983	6,813
Other	2,036	5,439	2,534	2,699	3,974
Total	20,250	32,138	30,690	29,361	33,257

Source: Statistics Canada, as reported by Industry Canada, www.ic.gc.ca. Code 121410 of the Harmonized System: subset of 1214 reported above.

If GT alfalfa deregulation reduces U.S. exports to Japan, it is likely that Canada and Australia would try to fulfill the existing gap left by the United States. This would possibly reduce the supply of foreign non-GT alfalfa available for import to the U.S. This would impact U.S. trade only to the extent that particular varieties are imported rather than domestically produced, assuming the domestic market would already be facing an excess supply of non-GT alfalfa hay and seed.

3.3 Summary of Findings

U.S. imports of alfalfa hay and seed come mostly from Canada. To the extent that GT alfalfa deregulation reduces foreign demand for U.S. exports, alfalfa hay and seed production previously destined to foreign markets may be channeled to the domestic market. As the domestic market for non-GT alfalfa hay and seed is expected to decrease with GT alfalfa deregulation, U.S. production is likely to substitute imports.

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 Glphosate-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 will 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 material may affect producer costs and returns, given an existing demand for GE-free alfalfa:

a) *Loss in production*. If producers cannot avoid GT alfalfa material above those levels found acceptable by the market, any alfalfa seeds or forage previously destined to those markets will have to be shifted to salvage markets that may 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 must be incorporated into its production costs.

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 ad 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, the supply curve for that market will shift upwards. If non-GT alfalfa material 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 curve for that market will shift downwards. These shifts are illustrated in figure S-9 below.

Pollen Movement from Alfalfa Seed Production Fields

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Abstract

An alfalfa pollen flow study was conducted near Fruita, CO (Mesa Co.) during the summer of 2006 with he objectives of determining the distance that bees transport Roundup Ready® alfalfa pollen under local field conditions, and estimating the role alkali bees play in alfalfa pollen transport in the area. We harvested seed from feral alfalfa plants at 23 sites on roadsides, abandoned fields, and edges of active hay fields within two miles of Roundup Ready® alfalfa seed fields. We also collected bees from these sites throughout the alfalfa bloom season to determine which species were moving pollen. The harvested seed was planted and seedlings treated with Roundup® to assay for the presence of the Roundup Ready® gene. The gene was found at 83% of the collection sites, out to a distance of 1.7 miles from the pollen source. Alfalfa leafcutter bees and honey bees were the most common bees collected at the seed harvest sites. Honey bees appeared to be the most important bee involved in long distance pollen transport. More *Melissodes* and *Anthophora* species than alkali bees were captured at the seed collection sites. Alkali bees played a minor role in long distance transport of pollen under these conditions.

Introduction

Roundup Ready® (RR) alfalfa is grown for seed on approximately 900 acres of land near Fruita, Colorado (Mesa County). It has been produced in the area since 2004. These seed production fields are pollinated primarily by managed alfalfa leafcutter bees, *Megachile rotundata*, but many native bees, including alkali bees, *Nomia melanderi*, are present in the fields. Several alkali bee nesting sites are known in the vicinity of the RR seed production fields, and alkali bees are at times very common in the area. Table 1 lists bee species that have been captured in alfalfa seed production fields near Fruita.

We conducted a research program in 2006 to:

1) Determine the distance that RR pollen is moving from alfalfa seed production fields.
2) Estimate the role of alkali bees in pollen movement from the seed production fields.

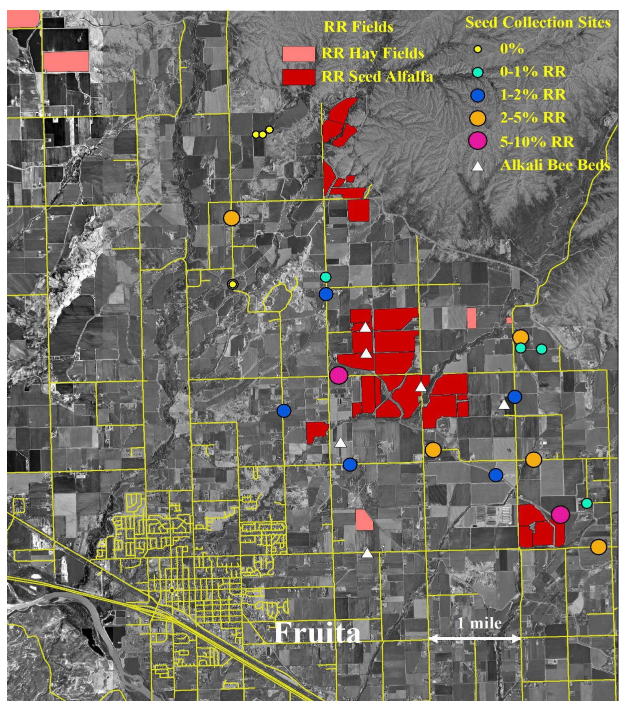

Figure 1. Location of RR seed fields (red) and hay fields (pink), seed collection sites (circles coded by amount of RR seed found), and alkali bee beds.

3) Determine which bee species were active in moving RR pollen from seed production fields.

Methods

The RR fields we used as the study site are located approximately 2 miles NW of Fruita CO. They are isolated from other RR alfalfa seed production by 7 miles of open farm and range land. There were several RR alfalfa hay fields planted in the area in the fall of 2005 and spring of 2006. First and second cuttings in these fields were taken no later than early bloom growth stage, so the amount of RR pollen from these fields was relatively small and present only for a few days For the purposes of this study we assumed that the RR alfalfa seed production fields were the sole source of RR pollen. Figure 1 shows the location of RR seed production fields and RR alfalfa hay fields in the study area.

We located sites in the area where feral alfalfa plants produced seed. The sites were at different directions and distances from seed production fields. Distances to seed fields were measured on a straight line basis, using aerial photographs imported into ArcMap 9.1. Our most distant site was 1.7 miles from the nearest seed field. Seed was collected from 23 sites.

The seed collection sites were located on roadsides, field edges, and waste areas. Except for a single site, no extra management was taken to allow them to produce seed. Site locations, descriptions and distances from RR seed production fields are listed in Table2.

We gathered seed as soon as enough was mature enough to allow for collection of about 1000 seeds. At ten sites, we collected on two dates to determine the amount of mid and late summer pollen flow.

Seed was cleaned in the lab at the Western Colorado Research Center at Fruita. The cleaned seed was sent to Forage Genetics, Nampa ID where it was assayed for the RR gene. They planted the seed in flats, counted the seedlings then sprayed them two times with Roundup® herbicide. The survivors were then counted as an assay for the RR gene. A number of randomly chosen survivors were tested for the RR gene using SDI test strips to test for the presence of the CP-4 gene.

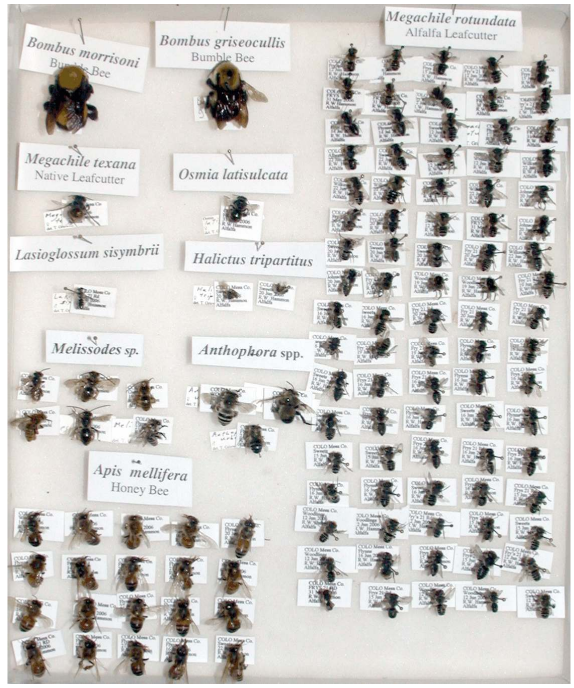

Figure 2. Bees captured at seed collection sites. Leafcutter and honey bees dominated the captures at all sites.

Bees were collected from the seed production fields and seed collection sites on a regular basis, beginning with first bloom in late May. The primary objectives were to find alkali bees and to document the diversity of bees in the area. The collected bees were taken to the USDA Bee Lab in Logan, UT for identification.

It is important to note that the bee collections are not a quantitative representation of species we saw in the field. We quit collecting honey bees and leafcutter bees because they were so common. The focus of the collection was the other bee species, so honey and leafcutter bees areunder-represented in the collection. Bees captured at the seed collection sites are pictured in Figure 2.

Results

The results of the RR seed assays are presented in Table 2 and Figure 1. Seedlings that survived the Roundup® application in the bioassay tested positive for the CP-4 gene, so all surviving seedlings were considered RR. The RR gene was found at 19 of 23 seed collection sites. The percentage of RR seed at sites where it was present ranged from 0.18 to 9.46%.

There was no correlation between distance from RR pollen source and the percent RR seed.

There was significant early season movement of the RR gene. Seed collected as early as mid-July had 0.4% RR genetics present. Two of these sites were within 0.5 mile of the RR pollen source. Leafcutter bees were common at these sites and they were probably responsible for most of the short-distance early season pollen flow. We caught alfalfa leafcutter bees at seed collection sites a full two weeks before managed bees were released into local shelters at seed production fields.

Female alkali bees did not emerge until June 22nd, with the peak of the emergence in late June and early July. The time span between pollination and seed maturity is about 28 days, so movement of the RR gene to seed collected before late July could not have been by alkali bees. One collection site (#26) was located within 200 yards of an alkali bee bed, and tested more than 5% RR seed. This site was 0.5 mile from a RR seed field. A second collection site (#11) was also about 100 yards from an alkali bee bed, but tested only 1.5% positive for RR seed, even though it was only 0.4 miles from a seed field. The mere presence of alkali bees nesting areas in the area did not guarantee high amounts of RR pollen movement.

The percentage of RR seed was apparently unchanged from the first to second seed collection date at 5 of the ten sites that were sampled twice. All of the pollen movement occurred before mid July at four of these sites.

Alfalfa leafcutter bees and honey bees were the dominant species taken while sampling bee populations. Previous research has shown that alfalfa leafcutter bees do not transport pollen over distances greater than one mile under most conditions. Honey bees are known to be capable of transporting pollen more than one mile. The other bees taken in the collections that would be capable of transporting pollen to the furthest seed collection site are bumble bees (*Bombus morrisoni* and *B. griseocullis*), *Melissodes* sp., *Anthophora* spp., and *Osmia latisulcata*. Only one alkali bee was taken at a remote seed collection site, although five nesting sites were found in the area. We must assume that most alkali bee foraging was within seed fields or local in nature.

Table 1. Bees found in Fruita CO alfalfa seed production fields. Bees are listed in approximate order of abundance in fields limited to the seed production fields.

Megachile rotundata	Alfalfa leafcutter
Apis melifera	Honey bee
Nomia melanderi	Alkali bee
Melissodes sp	
Anthophora spp (2)	Digger bees
Bombus morrisoni	Bumblebee
Bombus griseocullis	Bumblebee
Lasioglossum sisymbrii	
Halictus tripartitus	
Halictus confusus	
Megachile texana	Leafcutter bee
Osmia latisulcata	

Conclusions

Bees are capable of moving the RR gene at least 1.7 miles. The farthest distance they can move pollen cannot be determined from this project because we found the RR gene at our most distant site from the pollen source. Pollen movement at the furthest site occurred late in the season, since the 8/11 seed collection had no RR seed, while the 9/19 collection had 3.8% RR seed.

Alkali bees were probably of minor importance in long distance pollen movement. *Melissodes* sp., *Anthophora* spp., and *Bombus* spp. were more common in collections than alkali bees. Several other taxa of native bees including *Megachile* spp., *Osmia latisculata*, *Lasioglossum* sp., and *Halictus* sp. are responsible for short and mid range movement of pollen.

Honey bees were probably the most important species involved in long-distance pollen transport. Most of these bees are apparently feral since only one hobby beekeeper could be located in the area.

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Table 1. Seed collection site descriptions and RR assay results.

[1] N is the number of alfalfa seedlings tested for the RR gene in bioassays.

		G.P.S.			Collection Dates					
Site	**Description**	**North**	**West**	**Distance**	**1st**	**% RR**	**N[1]**	**2nd**	**%RR**	**N**
1	Edge of active field	39.233	108.716	0.84	7/10	0.00%	305	9/7	0.00%	51
2	Edge of active field	39.176	108.668	0.44	7/12	0.18%	552	8/16	0.41%	726
3	Edge of active field	39.171	108.650	0.30	7/13	0.42%	475	8/30	1.07%	656
4	Abandoned field	39.209	108.701	0.47	7/28	1.06%	470			
5	Abandoned field	39.197	108.658	0.87	7/26	1.21%	829	9/7	1.40%	358
6	Edge of active field	39.199	108.662	0.72	7/27	0.20%	503	9/7		
7	Edge of active field	39.199	108.661	0.81	7/27	2.81%	178	9/7		
8	Edge of active field	39.197	108.662	0.66	7/27	0.27%	374	9/7		
9	Edge of active field	39.233	108.713	0.65	7/26	0.00%	219			
10	Edge of active field	39.233	108.714	0.73	7/28	0.00%	238	8/16		
11	Edge of active field	39.179	108.697	0.43	7/31	0.70%	1002	9/7	1.50%	467
12	Roadside	39.207	108.701	0.33	8/10	9.46%	560	8/16	9.17%	1669
13	Roadside	39.203	108.701	0.25	8/11	4.50%	977	9/19	4.05%	469
14	Abandon field	39.212	108.729	1.68	8/11	0.00%	398	9/19	3.78%	608
15	Edge of active field	39.170	108.655	0.02	8/11	3.29%	821			
16	Roadside	39.209	108.720	1.31	8/11	0.00%	820	9/19	0.00%	539
20	Abandon property	39.219	108.720	1.04	9/7	0.25%	800			
21	Abandoned field	39.188	108.710	0.28	9/7	0.58%	693			
23	Edge of active field	39.164	108.648	0.40	8/30	1.58%	506	9/25	0.96%	313
24	Abandoned field	39.179	108.660	0.51	8/30	2.23%	764			
26	Roadside	39.189	108.664	0.52	9/7	5.08%	610			
27	Roadside	39.181	108.680	0.26	9/19	2.43%	823			
28	Abandoned field	39.193	108.699	0.15	9/25	2.03%				

IDAHO ALFALFA & CLOVER
SEED GROWERS ASSOCIATION

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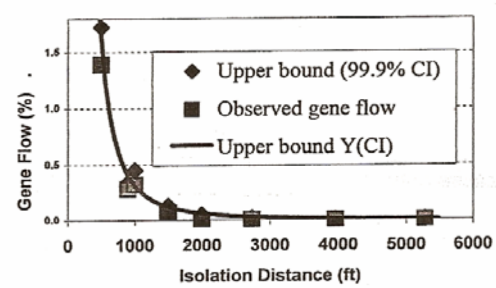
As harvest is coming to a close and equipment is being winterized, growers finally have a chance to sit down and review the year as well as put a pencil to how the crops did in 2006. The Idaho Alfalfa/ Clover Seed Growers Association thought this would be a good opportunity to bring growers up to speed on the latest developments in the Alfalfa Seed industry.

The Association of Official Seed Certifying Agencies, (AOSCA) is currently taking a recommendation under advisement that would change the genetic purity level of Certified alfalfa seed. Certified alfalfa seed isolation distance is currently set at 165 feet with expected purity being 99.0%. Due to some recent research conducted by Dr. Larry Teuber at University of California Davis, it indicates that this level of purity is not practical and should be changed to 98.5%. This change would give the consumer better representation of the seed that is being purchased, but should not have any effect for seed growers regarding cleanouts. The only exception to this would be genetic purity relating to Roundup Ready contamination in a non-Roundup ready alfalfa seed.

Distance (ft)	Gene flow (%)
50	1.4
100	1.35
165	**1.28**
300	1.15
600	0.85
900	0.55
1000	0.45
1320	0.13
2000	-0.55

As many growers are aware, this is the second year of Roundup Ready (RR) alfalfa seed on a large scale. States with current production are Wyoming, Montana, Washington, and Idaho. According to research conducted by Forage Genetics during 2000-2002 using Leafcutter bees, the industry was assured that only 900' was needed to prevent gene flow over at an acceptable level. Forage Genetics data indicated at 900 feet gene flow contamination would be approximately 0.28%. At 2000 feet the gene flow contamination would be approximately 0.0%. [1]
Honeybees, bumble bees, and other pollinators were not considered in this data.

Figure. Pollen-mediated gene flow



Based on this data, the industry and Idaho Crop Improvement Association set the isolation distance at 900 feet between RR alfalfa seeds fields and synthetic alfalfa seed fields. Industry agreed that this should keep the gene transfer to an acceptable level of less than 1%.

At the end of the 2006 harvest, some companies began testing genetic purity in alfalfa seed lots using standardized litmus tests. Lots that showed contaminations were then sent to Midwest Seed Lab to conduct grow out tests on the seed. This independent testing agency confirmed that eleven lots of seed tested positive for the RR gene as of November 1 2006. (see chart below)[3] All of the contaminated field exceeded the 900 feet isolation distance, as well as the predicted contamination percentages shown in Forage Genetics 2000-2002 data. The foundation field located in Idaho was approximately 7900 feet from the nearest Roundup Ready field and tested 0.2% from the grow out test. This foundation field cannot be used as seed stock for future production.

- over -

During an Alfalfa Seed Advisory meeting at Idaho Crop Improvement Agency (ICIA) on November 2, 2006, industry representatives were asked to explain the contamination of these seed lots. No explanation was offered.

Although foreign countries have approved Roundup Ready technology, and Animal and Plant Health Inspection Service (APHIS) has deregulated the production in the United States, the issue remains of how will the markets or buyers accept the technology. Industry agrees among themselves that domestically there is not an issue, except for organic markets, yet Washington State recommends that Roundup Ready technology not be planted for seed or hay production. Export markets such as the European Union are also reluctant to accept the Roundup Ready technology.

Hay and Seed fields

Growers also need to be aware of issues regarding Roundup Ready hay. Industry is currently reluctant to place alfalfa seed fields next to Roundup Ready hay fields, and some companies have clauses in their contracts regarding the matter. At the ICIA meeting, this issue was discussed thoroughly as well as different potential contamination scenarios. When industry representatives were asked who would be liable if a hay field contaminated an alfalfa seed field, they simply responded with "check the liability with Monsanto". It was then stated by industry that they would determine if a grower took appropriate actions to prevent contamination from a neighboring hay field before buying seed showing genetic impurity.

State	Acres	Percent Roundup	Distance from RR production
Montana	16	.4	2600 ft
Montana	25	.4	4000 ft
Montana	25	.3	4000 ft
Montana	15	.3	1600 ft
Montana	35	.9	1400 ft
Montana	23	.3	950 ft
Montana	26	.2	1500 ft
Montana	43	.2	1500 ft
Montana	22	Trace	1 mile
Wyoming	26	.3	1700 ft
Idaho	2 (foundation)	.2	1.5 miles

Forage Genetics 2000-2002 data states, "Under recommended hay management practice it is likely that actual gene flow from hay to seed fields ***may*** be less than 0.2% at approximately 165 ft."[2] (emphasize added). As anyone in the agricultural industry knows, management, weather, custom cutting, mechanical breakdowns, etc., can result in a field blooming during peak pollination periods. In some instances, plants may be missed during the cutting period thus resulting in seeds being produced, such as in the corners of center pivots, wet spots, and waste ditches. Considering these conditions, growers need to be aware of what your neighbor is doing since his growing and cultural practices may exclude you from growing conventional alfalfa seed on lands that you own or rent!!!

The Growers Association responsibility is to watch out for the interests of all growers and to encourage the production and sale of high quality Alfalfa and Clover seed. The Association also recognizes that through new technology, agriculture is given new tools to survive in this ever-changing world. However, this recent data creates questions as to the accuracy of the pollen flow data on Roundup Ready varieties and synthetics varieties as it relates to genetic purity. We feel that growers need to be aware of this new data and how it may affect their contracts based on genetic purity clauses. Alfalfa seed growers should look at genetic purity language in contracts, since there are a number of different tolerances ranging from 0 to 1 % or more.

Our growers meeting in January 16, 2007 will offer a panel discussion relating to genetic purity and how it may affect growers and the alfalfa seed industry. Information about the Seed School will be mailed after the first of the year.

Future Events

Idaho Oregon Seed School January 16, 2007 @ Hampton Inn, Nampa
38th Winter Seed School, Las Vegas, NV January 22-23, 2007

[1,2] Pollen-mediated Gene Flow in Alfalfa: A three-year summary of field research
S. Fitzpatrick, P. Reisen and M. McCaslin Forage Genetics International, West Salem, WI, Nampa, ID, and Prior Lake, MN

3 Letter obtained from Idaho Crop Improvement dated November, 1 2006.