THE CASE FOR ROUNDUP READY ALFALFA

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INTRODUCTION

In February 2007 a Federal Court judge ruled that the USDA's environmental analysis of Roundup Ready Alfalfa was deficient in that it did not include a "hard look" at, 1) the potential impact on organic and other alfalfa growers that are producing for non-GE markets; and 2) a potential incremental effect that Roundup Ready Alfalfa commercialization may have on the generation of glyphosate resistant weeds. In June of 2007 the judge issued a permanent injunction that vacated the original deregulation decision pending the USDA/APHIS preparation of an Environmental Impact Statement (EIS). The ruling acknowledged the FDA's finding that Roundup Ready Alfalfa was safe for food and feed, and allowed the continued harvest of existing Roundup Ready Alfalfa forage and seed production fields. However the injunction prohibited any new planting of Roundup Ready Alfalfa until, and unless, a new deregulation decision was made by USDA/APHIS based on the EIS.

This session is titled "Should Roundup Ready Alfalfa be De-regulated?" The food and feed safety for the trait has been established. The primary issue is on potential economic impact on organic and other GE-sensitive markets. On this topic the issues related to deregulation of Roundup Ready Alfalfa will be almost identical for other biotech traits in alfalfa. We believe that the key question is "how do we construct a stewardship program that makes it possible for growers of alfalfa with biotech traits to coexist with organic and other alfalfa growers that produce for GE-sensitive markets?"

Corn, soybean and cotton growers have shown that coexistence is possible, with both biotech and organic acres increasing significantly over the last decade. These crops present a model for stewardship that enables co-existence, and that has allowed producers to capture increased farm income associated with improved weed and insect control from biotech traits. The National Center for Food and Agricultural Policy estimated that 123 million acres of biotech-derived crop varieties were planted in the U.S. in 2005 and that the associated biotech traits increased net return to growers by $2 billion (Sankula, 2006)..

CURRENT U.S. MARKETS FOR ALFALFA HAY AND ALFALFA SEED

What do we know about the current markets for U.S. alfalfa hay and alfalfa seed? Using National Ag Statistics Service (NASS) and USDA Foreign Ag Service (FAS)[2] along with a few industry and academic expert sources, we have put together the following summary on estimated

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number of production acres associated with various alfalfa hay and seed markets (see Table 1). Key assumptions in calculating these estimates are as follows:

1) Current isolation guidelines will effectively manage Adventitious Presence (AP) of the Roundup Ready trait to $\leq$0.5% (see Fitzpatrick 2007).
2) Adventitious presence sensitive (AP sensitive) markets are defined here as seed markets requiring less than 0.5% AP and hay markets requiring non-detectable AP using commercially available RRA hay test strips.
3) 0.67% of alfalfa hay is sold as organic (NASS 2005 estimate)
4) 3% of non-organic hay is AP sensitive (Putnam, 2006)
5) 98% of hay export is AP sensitive (this is a market, rather than regulatory issue)
6) 6% of PNW hay production is for export (Shewmaker, et.al., 2005)
7) 0% of U.S. alfalfa seed production is certified organic (industry consensus)
8) 5% of non-organic seed for domestic use is AP sensitive (industry consensus)
9) Export seed numbers were adjusted for seed coating (industry consensus)

Although the reported NASS and FAS numbers will vary some from year to year, and best estimates are used in the case that there is no officially reported data, we believe this summary accurately captures the relative size of these various markets for U.S. alfalfa hay and seed production.

Conclusion: Most of U.S. hay and seed production are not AP-sensitive, although there are significant local markets for AP sensitive hay (Washington alfalfa hay exports to Asia) and AP sensitive seed (California alfalfa seed exports to Latin America and the Middle East). Although the organic hay market is small, the organic dairy industry is growing, and offers a potentially profitable market for many smaller producers.

COEXISTENCE OF VARIOUS MARKETS

Alfalfa producers and academic experts agree co-existence is possible. In October 2007 about 70 stakeholders attended a meeting on "Peaceful Coexistence: Creating a Strategy for Harmony Among GM, Organic and Conventional Alfalfa Producers" sponsored by the National Alfalfa and Forage Alliance (NAFA). Speakers and attendees included growers, academic and industry stakeholders representing both domestic and export markets for conventional, Roundup Ready, and organic alfalfa hay and seed production. The overwhelming consensus of this group was that coexistence was possible if stewardship programs were in place to help insulate AP sensitive markets (e.g. seed export, hay export and organic hay). In addition to the stewardship efforts put forward by GE producers, the AP-sensitive producers must continue to apply their own market-specific production practices to ensure their product's differentiation (e.g., organic buffer zones, avoidance of prohibited practices, using certified planting seeds, lot segregation, official certification, etc.). NAFA will be publishing a consensus plan for coexistence based on this meeting. Putnam (2006) came to the same conclusion when he concluded that "simple methods to assure coexistence without disruption of sensitive (hay) markets should be effective under

[2] The National Ag Statistics Service (NASS) collects and publishes data on planted and harvested acres of alfalfa hay, by state. The NASS data also includes an estimate of the % of all hay produced that is sold as organic. The USDA Foreign Ag Service (FAS) collects and publishes data on alfalfa hay and seed exports, by export country.

most conditions." Stakeholders at the NAFA meeting were in agreement that an AP tolerance greater than zero should be established

GENE FLOW AND STEWARDSHIP

Managing gene flow from biotech to non-biotech alfalfa hay and/or seed is basis for any coexistence strategy. A critical first step is to understand potential gene flow between different sources.

Hay to Hay gene flow. Putnam (2006) describes and estimates the magnitude of the multiple biological barriers to gene flow from one hay field to another. He concludes that the risk of hay to hay gene flow is "infinitely small". This risk can be reduced to zero for hay growers producing for an organic or AP-sensitive market by simply buying the right seed (non-GE) and harvesting the hay before the ripe seed stage.

Seed to Seed gene flow. Seed production is required for effective gene flow. Alfalfa seed production requires insect pollinators. These bee pollinators not only carry pollen from plant to plant within a seed production field, but can stray to neighboring seed production fields. In certified seed production this pollen-mediated gene flow is managed by requiring a minimum isolation distance between a certified alfalfa seed production field and a neighboring alfalfa seed (or hay) field. The isolation for certified seed has been deemed appropriate to meet the Federal standards of 99% varietal genetic purity.

Are current isolation standards for certified seed adequate for managing pollen-mediated gene flow in Roundup Ready alfalfa seed production? Beginning in 2001 scientists at FGI and UC Davis began a series of experiments using the Roundup Ready gene as a marker to measure pollen-mediated gene flow for leafcutter bee and honeybee pollinators (Fitzpatrick, et.al 2003 and Teuber et.al, 2005). This gene flow data has been used to design Roundup Ready alfalfa isolation distances required to appropriately manage AP. In the Pacific Northwest, where the overwhelming majority of seed production is for domestic markets and leafcutter bees are used as primary pollinators, a 900 ft isolation distance between Roundup Ready and conventional alfalfa seed production is being used to manage AP to $\leq$0.5%, a common industry standard for AP tolerance in conventional seed of other crop species. The 900 ft isolation was a science-based determination and is greater than 5 times the standard isolation requirement for conventional Certified seed, and coincidentally, the same isolation requirement for Foundation class seed. In California, where over 60% of the seed production is for AP sensitive export markets and honeybees are used as primary pollinators, a 3 mile isolation distance is being used to manage AP to a non-detect level, a common industry standard for seed destined for export markets where there is no regulatory approval of the trait (e.g. Saudi Arabia). This isolation standard is greater than 95 times the standard isolation requirement for conventional Certified seed. This isolation distance was adopted by consensus of a California seed industry stakeholder group convened by the UC Seed Biotech Center in 2005 (UCSBC, 2005), is science-based, and recognizes the importance and sensitivity of the alfalfa seed export market in the state. The common ground here is an effective RRA seed production stewardship (i.e. coexistence) strategy needs to be: 1) science-based; 2) market sensitive; and 3) pollinator specific. We believe current

isolation standards and seed field location reporting for RRA seed production meet these requirements and that AP-sensitive seed producers have effective quality assurance methods available to them.

Hay to Seed gene flow. Just as the Roundup Ready trait was used to effectively measure pollen-mediated seed-to-seed gene flow, separate experiments were conducted by UC Davis and FGI to measure potential forage to seed pollen-mediated gene flow when RRA forage production fields were allowed to bloom, during the peak pollination period, in proximity to conventional seed production fields. Current isolation requirements for Certified seed production of conventional varieties requires 165ft isolation from all alfalfa (seed, forage or feral) planted of a different variety. With both honeybee and leafcutter bee pollinators, $\geq$165ft isolation between RRA forage (50% bloom) and conventional seed production reduced seed AP to <0.1%. This data suggests that current Certified seed isolation standards are adequate to manage potential hay to seed AP.

Gene flow from Feral alfalfa. Feral plants are crop plants that have escaped cultivation. Feral alfalfa plants can sometimes be found on road edges, in fence lines and in abandoned fields. In a 2001/2002 multi-state survey, feral plants were found within 2000 meters of cultivated alfalfa at 22% of the survey sites (Kendrick, 2005). Although we expect that with time some Roundup Ready plants could become part of the feral alfalfa population, there is no reason to believe they will become a disproportionate part of the these population, since the trait provides have no fitness advantage over the wild-type. Will feral Roundup Ready alfalfa plants be a significant source of potential gene flow to conventional alfalfa hay or seed?

No, many of the biological filters limiting hay-to-hay gene flow also exist for feral-to-hay gene flow. This risk is very low and by simply cutting the hay field before the ripe seed stage reduces gene flow risk to zero. Most hay is cut at late bud to early flower stage, six weeks before the ripe seed stage. Virtually all of the alfalfa seed production in the western states is irrigated, and seed production fields are sprayed regularly to control Lygus and other insect pests. Feral plants have neither the benefit of irrigation or insect control and have poor fitness compared to their cultivated cousins. Furthermore amount of pollen from a handful of weak feral plants will be negligible compared to the pollen produced within the seed production field itself – where plants are at a much higher density and being managed specifically for seed production. Potential feral-to-seed pollen mediated gene flow is very low based on the relative fitness, and the relative low abundance of pollen from feral plants (Hammon and Reisen, 2007).

Summary. Although understanding and managing gene flow is a foundation for effective stewardship, there are multiple other important components, including: best practices for seed production, seed harvesting and seed processing to minimize potential seed mixing of biotech and conventional varieties; and trait licensure of seed and hay growers with required adoption of best practices for stewardship.

POTENTIAL BENEFITS FROM BIOTECH TRAITS

The history of wide adoption of biotech traits by American farmers is primarily based on one thing – improved net farm income. In a recent nationwide survey of Roundup Ready alfalfa growers, more than 98% expressed satisfaction with variety and trait performance. Growers

reported higher yields and improved forage quality with Roundup Ready alfalfa and estimated an increase of approximately $50 net income per acre compared with conventional types. Several growers also reported a significant benefit related to human safety in handling Roundup herbicides compared to those used in conventional alfalfa production systems.

There are also environmental benefits with biotech traits. Sanguta (2006) estimated that in 2005 the adoption of biotech traits by U.S. farmers reduced pesticide use by 69.7 million lbs. Roundup Ready crops are also widely credited for an increase in no-till planting, decreasing both energy use and soil erosion. Putnam (2005) projected that the adoption of Roundup Ready alfalfa would result in the replacement of many currently-used herbicides in fields planted with RR alfalfa. Therefore, he did not believe that the introduction of this GE crop would increase herbicide in total, but where adopted, will cause a shift of herbicide use to glyphosate. He further finds that where glyphosate (Roundup) replaces other herbicides that are more highly soluble and subject to runoff, the introduction of this technology may reduce the overall impact of herbicides on the environment. Several winter-applied herbicides currently used in California have been detected in wells in the Central Valley and are of strong concern to regulators. Growers who use these herbicides are subject to severe restrictions for use based upon soil type and groundwater characteristics. It is anticipated that glyphosate presents a lower risk to the environment compared with some of these herbicides (DPR website, State of California).

New traits. The Consortium for Alfalfa Improvement[3] is a is a cross-institutional collaboration focusing on using biotech tools for improving alfalfa for dairy and biofuels feedstock. Lignin reduction to increase fiber digestibility has been a key CAI research focus. Reduced lignin transgenic plants have been in field testing since 2001, and have consistently shown lower lignin content and a 10 to 15% increase in fiber digestibility. In 2007 two reduced lignin genotypes were used in "proof of concept" feeding studies conducted with both young lambs and dairy cows. The U.S. Dairy Forage Research Center predicts that a 10% increase in fiber digestibility could increase milk and beef production by $350 million/year and reduce manure production by 2.8 million tons/year. A second CAI research project on improving the efficiency of alfalfa protein utilization shows promising progress. Tannin alfalfa, which would increase the proportion of alfalfa protein that bypasses the rumen (RUP), could significantly decrease the cost of protein supplements for high producing dairy cows and decrease N-losses on dairy farms. The USDFRC estimates that tannin alfalfa could result in a 12% increase in net return for the dairy operation and decrease on-farm nitrogen losses by 25%.

In the last several years there has been an explosion in genomics-based research for discovery of new genes that add value to crops. Industry alone is probably investing close to $1 billion/yr in these activities. Alfalfa is poised to take advantage of the fruits from this research investment. Other new biotech traits currently in various stages of development include drought tolerance/improved water use efficiency, improved salt tolerance, increased biomass/forage yield and delayed flowering.

[3] The Consortium for Alfalfa Improvement member organizations are Forage Genetics Intl., The Samuel Roberts Noble Foundation, Pioneer HiBred Intl., and the U.S. Dairy Forage Research Center.

WEED RESISTANCE

The judge also asked a second question. Would the deregulation of Roundup Ready alfalfa, and the increased use of glyphosate herbicide associated with its hay and seed production, significantly increase the likelihood of developing herbicide tolerant weeds in U.S. crop systems? This is highly unlikely for two reasons. 1) the commonly recommended method for managing weed resistance to specific herbicides, or insect resistance to pesticides, is to use an integrated pest control strategy that combines two or more modes of action for pest control. We believe that many herbicide programs for Roundup Ready alfalfa will likely contain at least one non-glyphosate herbicide to provide residual control of summer weeds, and that *all* Roundup Ready alfalfa fields will be subjected to multiple harvests during the season. Removing all above ground plant parts repeatedly during the season is an effective and proven method of weed control, independent of the glyphosate herbicide; and 2) the incremental increase in glyphosate use due solely to Roundup Ready alfalfa will be minimal due to the limited number of acres of alfalfa compared to corn and soybeans.

SUMMARY

On their website, the Center for Food Safety advocates a halt to the approval of new biotech traits in crops, pending the adoption of new standards for safety testing, and advocates "the containment and reduction of existing genetically engineered crops." The potential safety issues they raise are inconsistent with the findings of the National Academy of Sciences, the U.N. Food and Agriculture Organization, the American Medical Association, the World Health Organization and several other international organizations which all conclude that genetically enhanced food/feed are as safe as their conventional counterparts.

What is at stake is the grower's right to choose what crop to produce, what market to produce for, and what technology to employ in their farming system. Responsible, science-based stewardship helps protect farmer choice, and is in the best interest of all sectors of American agriculture. Roundup Ready is the first of several new biotech traits that will increase yield and/or quality of the crop. Agriculture is on the cusp of what is being called the "Second Green Revolution", driven in large part by increases in productivity and crop value associated with current and future biotech traits. Let's make sure alfalfa is part of this significant advancement in science and technology.

Let me close with two quotes from Dr. Norman Borlaug, 1970 winner of the Nobel Peace Prize, father of the "Green Revolution", esteemed scientist and plant breeder.

"Genetic modification of crops is not some kind of witchcraft; rather, it is the progressive harnessing of the forces of nature to the benefit of feeding the human race."

'Genetically engineered crops are playing an increasingly important role in world agriculture, enabling scientists to reach across genera for useful genes to enhance tolerance to drought, heat,

cold, and waterlogging, all likely consequences of global warming. I believe biotechnology will be essential to meeting future food, feed, fiber, and biofuel demand."

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Table 1. Current Markets for U.S. Produced Alfalfa Hay and Seed
(acres in thousands)

Alfalfa Hay and Haylage	Southwest		PNW		InterMountain		Plains		MW/East		Southeast		Total	
	%	acres	%	acres	%	acres	%	acres	%	acres	%	acres	%	acres
Forage produced/used on farm	14%	218	20%	477	50%	1,695	35%	970	80%	10,095	75%	360	59.5%	13,814
GM sensitive														
organic		1		3		11		6		68		2	1%	91
other		7		14		51		29		303		11	3%	415
GM insensitive		210		460		1,633		935		9,724		347	96%	13,308
Hay sold to third parties in U.S.	85%	1,321	74%	1,765	50%	1,695	65%	1,795	20%	2,511	25%	120	39.7%	9,207
GM sensitive														
organic		9		12		11		12		17		1	1%	62
other		40		53		51		54		76		4	3%	278
GM insensitive		1,272		1,700		1,633		1,729		2,418		115	96%	8,867
Hay sold to export markets	1%	16	6%	143		0	0	6	0%	13		0	0.8%	177
GM sensitive		16		140									88%	156
GM insensitive		0		3									1%	3
Total acres alfalfa hay/haylage		1,554		2,385		3,390		2,770		12,619		480		23,198
Total AP sensitive	4.7%	73	9.3%	222	3.7%	124	3.6%	101	3.7%	464	3.8%	18	4.3%	1,002

Alfalfa Seed	Southwest		PNW		InterMountain		Plains		MW/East*		Southeast		Total	
	%	acres	%	acres	%	acres	%	acres	%	acres	%	acres	%	acres
Dormant alfalfa seed	1%	0.4	92%	48.8	100%	15.8	90%	2.1	100%	7.0		0.0		74.1
GM sensitive														
organic		0		0		0		0		0			0%	0.0
export		0		4.0		1.8		0		0			8%	5.8
other		0		2.4		0.8		0.1		0.5			5%	3.8
GM insensitive		0.4		42.4		13.2		2.0		6.5				
Non/semi-dormant seed	99%	43.6	8%	4.2	0%	0.0	10%	0.2	0%	0.0		0.0		48.0
GM sensitive														
organic		0		0		0		0		0			0%	0.0
export		25.2		2.4		0		0		0			58%	27.6
other		2.2		0.2		0.0		0.0		0.0			5%	2.4
GM insensitive		16.1		1.7		0.0		0.2		0.0				
Total acres seed production		44.0		53.0		15.8		2.3		7.0		0.0		122.1
Total AP sensitive	62%	27.4	17%	8.9	17%	2.6	4%	0.1	7%	0.5		0.0	32%	39.6