Roundup Ready Alfalfa Farmer Benefits, Environmental Safety and Stewardship

- The Roundup Ready System: A decade of proven benefits and safety -

I. Overview

Roundup Ready® alfalfa, the first commercial perennial crop with Roundup Ready technology, offers an effective, environmentally responsible alternative weed-control system in alfalfa that contributes significantly to grower profits and the production of enhanced quality animal feed for the dairy industry. In 2005, Monsanto Company and Forage Genetics International (FGI) introduced Roundup Ready alfalfa in the United States. Roundup Ready alfalfa joined soybean, corn, cotton and canola as the fifth commercial crop tolerant to applications of Roundup agricultural herbicides. Since mid 2005, more than 4,000 Monsanto licensed alfalfa forage producers in 48 states have purchased more than 3.7 million pounds of Roundup Ready alfalfa seed, resulting in approximately 220,000 acres currently planted to the new alfalfa varieties.

Roundup Ready alfalfa, like other Roundup Ready crops, provides a wide range of benefits to farmers and downstream users. The Roundup Ready alfalfa weed control system simplifies and improves weed management during stand establishment, enhances the flexibility of weed control in established stands, improves forage quality by reducing the weed content of harvested forage, increases yield and hay quality, improves rotational crop options enabling more efficient land use, and increases income for farmers. In addition, the higher quality hay produced from Roundup Ready alfalfa enables dairies to produce more milk per acre of alfalfa hay.

The Roundup Ready alfalfa weed control system provides distinct advantages over non-glyphosate based weed control systems. Weed management in alfalfa is complicated by the more than 90 weed species that are of economic importance in the crop and by the different management practices that are required for spring seedings, fall seedings, established stands, pure stands and mixed species culture. Gianessi et al. estimated that the value of alfalfa hay, in California alone, is reduced \$21 million per year due to weeds. University of Nebraska studies conducted with the Roundup Ready alfalfa system showed a 0.2 to 1.0 ton/acre yield advantage in the establishment year over conventional alfalfa treated with standard herbicide programs.

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The safety of Roundup Ready alfalfa and use of Roundup brand agricultural herbicides over the top of Roundup Ready alfalfa has been thoroughly evaluated before market introduction. The coordinated efforts of three U.S. regulatory agencies (USDA, EPA and FDA) in the review of Roundup Ready alfalfa resulted in the conclusion that Roundup Ready alfalfa is as safe as conventional alfalfa varieties for food and feed uses and environmental release. Several international regulatory agencies confirmed the safety of Roundup Ready alfalfa.

Roundup Ready alfalfa has been responsibly introduced to the alfalfa industry, enabling forage and seed producers to produce Roundup Ready, organic or conventional alfalfa. Alfalfa is a forage crop. Management practices employed in the production of forage from Roundup Ready alfalfa greatly diminish the chance of gene flow to conventional and organic forage fields. High-quality alfalfa forage fields are managed to intentionally prevent nearly all pollen and seed formation. A University of California report has estimated that a number of factors would be needed for gene flow and detectable presence of the Roundup Ready trait in forage fields to occur, including synchronous flowering of nearby forage fields, successful cross pollination, seed maturation before forage cutting, seed establishment in the field, and subsequent growth and survival of a new alfalfa seeding. According to UC Davis researcher Dr. Dan Putnam, the combination of frequent harvests, lack of significant flowering, lack of significant seed production, and the highly competitive and allelopathic nature of alfalfa that prevents ready germination of alfalfa seeds in existing fields should prevent most if not all gene transfer. Due to these factors associated with the management and biology of alfalfa, the likelihood of adventitious presence occurring between forage fields becomes infinitely small, likely to be far less than 0.001 percent of field biomass.

Scientific research was conducted to establish appropriate, science-based, Roundup Ready alfalfa seed production systems that support production of Roundup Ready and conventional or organic alfalfa seed. Commercial alfalfa seed production is a specialized, separate practice from forage production. Less than one percent of the 23 million acres of alfalfa grown annually is devoted to seed production. Seed of Roundup Ready alfalfa varieties must be grown under contract and license, and Forage Genetics International (FGI) has implemented strict policies and best practices for the production of Roundup Ready alfalfa seed, including field isolation, pollinator management, stand termination verification and seed field reporting to state seed certification organizations. Research conducted with leaf cutter and honey bees, two of the principle pollinators used for commercial seed production, confirms that gene flow between commercial seed fields can be effectively managed using spatial isolation.

Monsanto and FGI have secured regulatory approvals for food and feed use in key export markets and detection methods are available to detect

the trait or unique genetic sequence, if desired to verify the nature of a crop. Monsanto and FGI have secured regulatory approvals for Roundup Ready alfalfa in key hay export markets. Similar to other crops where biotech traits have been commercially developed, methods to detect the trait or unique genetic sequence in alfalfa seeds, leaves or dry hay materials are available to those who wish to do so and want to verify the nature of their crop.

Weed control in Roundup Ready alfalfa can be effectively managed without increasing the risk of herbicide resistance. Monsanto includes recommendations to minimize the risk of development of glyphosate-resistant weeds in Roundup Ready alfalfa in its Technology Use Guide, which is sent to every grower who has purchased Roundup Ready alfalfa seed in the U.S. These recommendations include the use of an additional herbicide in the Roundup Ready alfalfa of at least two different methods of weed control, chemical and/or cultural, further reduces the risk of weed resistance occurring.

The Roundup Ready System, introduced in 1996 in the U.S., has provided extensive agronomic, economic and environmental benefits during more than a decade of use. In 2006, Roundup Ready crops were planted on 172 million acres globally. The introduction of the Roundup Ready system (Roundup Ready crops combined with Roundup brand agricultural herbicides) in soybean, corn, cotton, canola, and alfalfa has provided farmers in the U.S. and other countries that have adopted this technology with superior management options for controlling weeds that reduce yield and farmer profitability.

The Roundup Ready System since 1996 has reduced costs, increased the simplicity of weed control, saved time on-farm, facilitated higher off-farm income, reduced herbicide use, and decreased the environmental impact associated with herbicide use. Globally, the Roundup Ready System has generated more than \$17 billion of farmer net income, including \$3.4 billion in 2005 alone. U.S. farmers in 2005 received \$1.5 billion of increased income, largely from more cost-effective weed management systems available with Roundup Ready crops.

The Roundup Ready System has enabled farmers to reduce use of herbicides by nearly 300 million pounds since 1996. As a result, adoption of Roundup Ready crops has decreased the global environmental impact associated with herbicide use by more than 10 percent. In the U.S., the environmental impact was reduced 29 percent in Roundup Ready soybeans, 24 percent in Roundup Ready cotton, 4 percent in Roundup Ready corn, and 38 percent in Roundup Ready canola.

The Roundup Ready System has increased adoption of reduced/ conservation tillage and soil conservation practices. Conservation tillage improves water quality and creates habitat for wildlife. The control of existing weeds has been a major barrier to the success of conservation tillage systems. Roundup Ready technology has facilitated the adoption of soil-saving reducedand no-tillage farming systems. The use of the Roundup Ready System instead of plowing and tillage has significantly reduced the loss of topsoil due to soil erosion, improved soil structure with higher organic matter, eliminated runoff of sediment and fertilizer, reduced on-farm fuel use, reduced CO₂ emissions, and increased carbon sequestration in soil.

The Roundup Ready System has made a significant contribution to reducing greenhouse gas emissions from agricultural practices.

Reductions in fuel use and plowing/tillage combined to reduce CO_2 emissions into the atmosphere by more than 20 billion pounds in 2005. This reduction is equivalent to removing almost 4 million cars from the road for a year.

Glyphosate has favorable environmental characteristics and a long history of safe use. Glyphosate has an excellent human health and environmental profile and a long history of safe use in more than 130 countries. This has been a key factor in the acceptance of the glyphosate family of agricultural products as among the most widely used herbicides in the world. When used according to label directions, these products do not represent a hazard to human health and the environment. This is confirmed by the extensive studies and by the firsthand experience of millions of farmers and home gardeners who have used this product.

Stewardship programs for Roundup Ready cropping systems are robust to support the proper use and long-term effectiveness of the glyphosate family of agricultural products. Herbicide resistant weeds are not unique to Roundup Ready cropping systems, and are generally controlled with other herbicides and/or cultural practices. Farmers have been managing herbicideresistant weeds for decades and there are hundreds of known cases of herbicide resistance to other commonly used herbicides. Attention to glyphosate-resistant weeds has increased with the concurrent adoption and use of Roundup Ready crops. Worldwide, there are 12 weed biotypes that have developed resistance to glyphosate, and seven of these biotypes are found in the US. The number of weed species that have developed resistance is low in comparison to the substantial acreage treated worldwide. Glyphosate-resistant weeds are not a consequence of adoption of the Roundup Ready System, but were first found in conventional cropping systems and have occurred in both systems. Although there are some glyphosate-resistant weeds found in the U.S., growers continue to adopt and successfully use Roundup Ready crops.

Monsanto is committed to the proper use and long-term effectiveness of its proprietary herbicide brands through a robust stewardship program. Monsanto considers product stewardship to be a fundamental component of customer service and responsible business practices. As part of its stewardship program, Monsanto invests significantly in communication of recommendations

meant to minimize the risk of weed resistance occurring and in research on best practices for weed-resistance management¹.

Roundup Ready crops have been grown successfully alongside conventional and organic crops. A decade of rapidly increasing demand for and adoption of the Roundup Ready System by growers has demonstrated the ability of alternative cropping systems to successfully coexist. There have been few, if any, reported incidents of conventional or organic production systems having lost market due to the presence of biotechnology. In fact, the organic industry has thrived during the first decade of biotechnology by offering an alternative to those who want one. Some markets or buyers may demand product specifications based on preferences that go beyond regulatory, variety certification or organic standards (e.g., they may insist on "100 percent biotech free"). In those cases, the incumbent costs and the responsibility to meet such specifications) lie with those who choose to serve those markets and specifications, not the vast majority of producers who see value in planting deregulated biotech crops.

II. Roundup Ready Alfalfa Provides Significant Benefits to Farmers Comparable to Other Roundup Ready Cropping Systems

Roundup Ready alfalfa, like other previously introduced Roundup Ready crops, provides a wide range of benefits to farmers and downstream users. Use of the Roundup Ready System enables growers to greatly improve weed management, increase yields, produce a better quality crop, be more profitable, enable dairies to produce more milk per acre, and plan crop rotations so they can efficiently manage their land use.

Farmers established about 220,000 acres of Roundup Ready alfalfa in the first year

Since mid-2005, more than 4,000 Monsanto licensed alfalfa forage producers in 48 states have purchased more than 3.7 million pounds of Roundup Ready alfalfa seed, resulting in approximately 220,000 acres currently planted to the new alfalfa varieties. According to a 2006 independent survey, these plantings accounted for 5 percent of the newly established alfalfa planted in the U.S.² Since current prices for high quality hay average approximately \$140 per ton, the value of these stands associated with the forage harvested over a five year period (typical stand life) is approximately \$450 million.³

¹ <u>http://www.monsanto.com/monsanto/us_ag/content/stewardship/tug/2007TUGPDF.pdf</u>

² James, 2006.

³ <u>www.okstate.edu</u>

The Roundup Ready alfalfa weed control system simplifies and improves weed management during stand establishment, enhances the flexibility of weed control in established stands, improves forage quality by reducing the weed content of harvested forage, and increases income for farmers

Weeds consistently reduce the yield of pure alfalfa harvested and negatively affect forage nutritional quality.⁴ Weed management in alfalfa is complicated by the more than 90 weed species that are of economic importance in the crop⁵ and by the different management practices that are required for spring seedings, fall seedings, established stands, pure stands and mixed species culture. Weed control is especially critical and challenging during stand establishment, and the presence of weeds in mature fields can diminish the quality of the hay, reduce its value as feed and cause producers to sustain financial penalties commensurate with a lesser grade hay. Gianessi et al.⁶ estimated that the value of alfalfa hay, in California alone, is reduced \$21 million per year because of weeds in harvested hay. Glyphosate does not persist in soil, which means that farmers can manage crop rotation programs without concern about plant-back restrictions or herbicide carryover to subsequent crops. In addition, the superior crop safety of the Roundup Ready alfalfa system compared to other herbicides used in alfalfa increases the likelihood that a newly established stand will mature into a pure stand, with higher nutrient and economic value.

The Roundup Ready alfalfa weed control system provides distinct advantages over non-glyphosate based weed control systems

Weeds compete with alfalfa seedlings for moisture, nutrients and light. Alfalfa seedlings are poor competitors due to their small seed size and limited energy reserve, thus they cannot out-compete weeds. The limitations of non-glyphosate based herbicides used in alfalfa have forced growers to resort to alternative options, such as seeding with a companion or nurse crop, which may suppress weeds but also competes with alfalfa and reduces the hay quality compared to pure alfalfa stands. In practice, optimum harvest timing for the alfalfa and nurse crop are not in sync and delaying the first cutting for 60 days to allow the alfalfa to establish can sacrifice hay quality. Another option is for growers to delay stand establishment until the fall when weed pressure is reduced. All these approaches reduce the value of a grower's first-year production. Research shows that weeds can represent up to 76 percent of the first cutting if effective herbicides are not used during the establishment phase.⁷ To compound the challenge, several currently available herbicides can cause crop injury, which further impairs the seedlings' ability to compete. Poorly established stands may never fully recover. Because alfalfa is a perennial crop, weeds often continue to

⁴ Peters and Linscott, 1988.

⁵ Hower et al., 1999.

⁶ Gianessi et al., 2002.

⁷ Gianessi, et al.,2002.

establish themselves during subsequent growing seasons. An infestation of summer grasses can result in forage that is 50 to 70 percent non-alfalfa with a penalty of as much as \$40 per ton.⁸ Roundup is a broad-spectrum herbicide. Many of the non-glyphosate herbicides used in alfalfa have a narrow window of application, restrictive preharvest intervals, or do not control the numerous types of weeds infesting alfalfa fields.

Increased yield and quality due to the Roundup Ready alfalfa system enables dairies to increase in milk production per acre

University of Nebraska conducted studies with the Roundup Ready alfalfa system showed a 0.2 to 1.0 ton per acre yield advantage in the establishment year over conventional alfalfa (Rebound 4.2) treated with standard herbicide programs. This equated to an average net income advantage of \$109 per acre in 2005 and \$91 per acre in 2006 for the Roundup Ready alfalfa system over conventional alfalfa and herbicide programs.⁹ Not only was more hay produced, but the hay was of better quality. A standard called relative feed value (RFV) is often used to compare nutritive values of hay and forage.¹⁰ In a University of Nebraska trial,¹¹ forage from Roundup Ready alfalfa had an RFV of 208 compared with an RFV of 171 for untreated conventional alfalfa. The cash hay value difference between these hays is approximately \$30 per ton, based on an estimated \$0.80 per RFV quality bonus.¹² This increased yield and quality of alfalfa hay translate into more milk from cows. Research done at the University of Minnesota predicted a dramatic difference in milk production. Based on yield and quality data, Roundup Ready alfalfa would produce an average of 8,204 pounds of milk per acre, compared with 7,568 pounds per acre for the conventional alfalfa— or nearly an eight percent increase.¹³

III. The Safety of Roundup Ready Alfalfa and Use of Roundup Brand Agricultural Herbicides Over the Top of Roundup Ready Alfalfa has been Thoroughly Evaluated Before Market Introduction

The coordinated efforts of three U.S. regulatory agencies (USDA, EPA and FDA) in the review of Roundup Ready alfalfa resulted in the conclusion that Roundup Ready alfalfa is safe as conventional alfalfa varieties for food and feed uses and environmental release. Several international regulatory agencies confirmed the safety of Roundup Ready alfalfa

⁸ Wilson, 2005.

⁹ Wilson, 2002; Wilson, 2006.

¹⁰ University of Wisconsin, 2000; South Dakota State University, 2004

¹¹ Wilson, 2005.

¹² Rankin, Hay. Pricing Spreadsheet, University of Wisconsin. <u>http://www.uwex.edu/ces/crops/HayPricing.htm</u>

¹³ Sheafer, 2004 (unpublished).

The Roundup Ready alfalfa system, like other Roundup Ready cropping systems, underwent a thorough safety assessment performed by the U.S. EPA, U.S. FDA¹⁴ and U.S. Department of Agriculture (USDA).¹⁵ Similarly, regulatory agencies in key non-U.S. export markets reviewed the safety of the product (see below). The conclusion from these reviews was that the food/feed derived from Roundup Ready alfalfa is as safe as existing conventional alfalfa for human consumption and animal production, and Roundup Ready alfalfa is as safe as conventional alfalfa for the environment. This included a review of the impact on wildlife (birds, mammals and insects) as well as the potential for the improved alfalfa to adversely affect other plant life. USDA found no direct effects of the Roundup Ready alfalfa on non-target species as a part of the decision to deregulate the product based upon extensive field and laboratory studies. EPA granted "reduced risk" status to glyphosate use over the top of Roundup Ready alfalfa expediting their review. Reduced risk status was granted in part due to glyphosate's lower toxicity and better environmental profile compared to other herbicides traditionally applied to conventional crops¹⁶.

IV. Roundup Ready Alfalfa has been Responsibly Introduced to the Alfalfa Industry, Enabling Forage and Seed Producers to Produce Biotech, Organic or Conventional Alfalfa

Alfalfa is a forage crop, and forage management practices employed in the production of forage from Roundup Ready alfalfa greatly diminish the chance for gene flow to conventional and organic forage fields

The potential for gene flow from alfalfa hay field to hay field differs significantly from gene flow in seed production fields. A series of environmental and biological barriers exist (as discussed below) in forage production systems which are likely to prevent significant gene flow and detectable presence of the Roundup Ready trait in conventional or organic forage fields. To optimize forage value per acre, producers who manage alfalfa forage fields for the dairy market (the primary customers for Roundup Ready alfalfa) typically harvest prior to flower development. High-quality alfalfa fields are therefore managed to intentionally prevent nearly all pollen and seed formation. Forage growers intentionally harvest at the pre-bud to early (10 percent) bloom stage because feed quality drops rapidly after the onset of bloom. Even when some limited flowering occurs, the potential for pollen and gene flow between forage fields is extremely low because alfalfa requires an insect pollinator (usually leafcutter bees or honeybees) for pollination, alfalfa pollinators are not attracted to forage alfalfa fields, and alfalfa does not shed pollen to the wind.

¹⁴ FDA, 2004.

¹⁵ USDA, 2005.

¹⁶ <u>http://www.epa.gov/opprd001/workplan/fy04workplan.pdf</u>

Alfalfa seed producers must stock bees to achieve pollination; however bees are not stocked on forage production fields because they are not needed for forage production. Honeybees, if present by chance, mainly collect nectar, not pollen, and therefore are much less likely to cause pollination.¹⁷ Only one honeybee in 100 collects pollen from alfalfa¹⁸ and only 22 percent of their floral visits resulted in pollination.¹⁹ Honeybees tend to avoid alfalfa if other crop or weed flowers are present.²⁰ Dan Putnam at the University of California found that, although gene transfer from one hay field to another is theoretically possible, a range of environmental barriers make gene movement very unlikely. Putnam identified a number of steps that would be necessary for gene transfer to occur between alfalfa forage production fields in order to cause adventitious presence of the Roundup Ready trait in conventional or organic hay. These steps include: synchronous flowering of nearby forage fields, the presence of pollinators and significant movement of pollinators between fields, successful cross pollination and fertilization, adequate time for seed maturation before forage cutting, subsequent seed establishment in the field, and the development of new alfalfa seedings that survive competition from existing alfalfa plants in numbers sufficient to contribute significantly to the dry matter of the subsequent hay crop. According to Putnam, the combination of frequent harvests, lack of significant flowering, lack of significant seed production, and the highly competitive and allelopathic nature of alfalfa that prevents ready germination of alfalfa seeds in existing fields should prevent most if not all gene transfer. Due to these factors associated with the management and biology of alfalfa, the likelihood of adventitious presence occurring between hay fields becomes infinitely small, likely to be far less than 0.001 percent of field biomass.²¹

Prior to the introduction of Roundup Ready alfalfa, scientific research was conducted to establish appropriate, science-based, seed production systems that support production of Roundup Ready and conventional or organic alfalfa seed

Commercial alfalfa seed production is a specialized, separate practice from forage production. Less than one percent of the 23 million acres of alfalfa grown annually is devoted to seed production²², which occurs almost exclusively in the Pacific Northwest and western states where late summer seed ripening may occur without damage from rain. FGI is the only Monsanto-licensed producer and developer of Roundup Ready alfalfa varieties. Seed of Roundup Ready alfalfa varieties must be grown under contract and license, and only may be sold by Monsanto-licensed seed companies by variety name. FGI has implemented strict policies and best practices for the production of Roundup Ready alfalfa

¹⁷ Cane et al., 2002.

¹⁸ Root, 1983.

¹⁹ Cane et al, 2002.

²⁰ Teuber, et al., 2005.

²¹ Putnam, 2005.

²² USDA-NASS, 2002.

seed including, field isolation, pollinator management, stand termination verification and seed field reporting to state seed certification organizations. FGI based their seed production best practices on research conducted with leaf cutter and honey bees, two of the principle pollinators used for commercial seed production. Research conducted with these two species confirms that gene flow between commercial seed fields can be effectively managed using spatial isolation. Information on gene flow, as well as FGI's seed production practices, is available on the FGI website.²³ Commercial Roundup Ready alfalfa seed production field locations may be obtained from State Crop Improvement or Agricultural Departments so that organic or conventional alfalfa producers that wish to avoid the Roundup Ready trait may do so^{24} .

> Monsanto and FGI have secured regulatory approvals for food and feed use in key export markets and detection methods are available to detect the trait or unique genetic sequence if desired to verify the nature of a crop

Monsanto and FGI have secured regulatory approvals for Roundup Ready alfalfa in key hay export markets. Approvals to support food, feed and processing uses have been obtained or are in progress in all key alfalfa export markets. Approvals have been obtained in Canada, Japan, Philippines and Mexico, and there are no restrictions on export to Taiwan. Regulatory approval for food and feed use is pending in South Korea. Only 1.6 percent of the U.S. alfalfa crop is exported, and these five nations account for 99 percent of all U.S. exported hay. In addition, regulatory approval for food and feed use has been granted in Australia.

The approval of Roundup Ready alfalfa for food, feed, and processing uses includes a determination of substantial equivalence, and no potential for weediness, invasiveness, or altered impacts on interacting organisms compared to currently grown alfalfa by the relevant regulatory authority. For example, the Canadian authority concluded: (1) "these plants do not display any additional novel traits and are substantially equivalent to currently grown alfalfa, in terms of their potential environmental impact and livestock feed safety." (2) "...the novel traits have no intended effects on alfalfa weediness or invasiveness, led the CFIA to conclude that alfalfa events J101 and J163 have no altered weed or invasiveness potential compared to currently commercialized alfalfa." and (3) "...the CFIA has determined that the unconfined release of alfalfa events J101 and J163 will not result in altered impacts on interacting organisms, including humans, compared to current alfalfa varieties."²⁵ Similarly, the Japanese authority concluded, "As a result of the item by item assessment of Adverse

 ²³ <u>http://www.foragegenetics.com</u>
²⁴ <u>http://www.certifiedseed.net/</u>

²⁵ Canadian Decision Document DD2005-53. Determination of the safety of Monsanto Canada Inc.'s Roundup Ready Alfalfa (Medicago sativa L.) Events J101 and J163. http://www.agbios.com/docroot/decdocs/05-328-001.pdf

Effect on Biological Diversity caused by competitiveness, productivity of harmful substances and crossability are similar to those of the parental lines."26

Finally, some growers have expressed a desire to supply non-Roundup Ready alfalfa hav to foreign markets. Similar to other crops where biotech traits have been commercially developed, methods to detect the trait or unique genetic sequence in alfalfa seeds, leaves or dry hay materials are available to those who wish to do so and want to verify the nature of their crop. Because regulatory approvals have been secured, export of alfalfa containing Roundup Ready alfalfa is allowed. There are no feed-labeling regulations related to the presence of biotech traits in the key export markets for Roundup Ready alfalfa; thus, any claim regarding content of biotech material must be based on a buyer and seller agreement, not on government regulations.

V. Benefits Derived from the Adoption of Roundup Ready Crop Technology

> The Roundup Ready System has reduced costs and generated more than \$17 billion of farmer net income since 1996

In 2006, Roundup Ready crops were planted on 172 million acres globally. The introduction of the Roundup Ready system (Roundup Ready crops combined with Roundup brand agricultural herbicides) in soybean, corn, cotton, canola, and alfalfa has provided farmers in the U.S. and other countries that have adopted this technology with superior management options for controlling weeds that reduce yield and farmer profitability. In 2005, Roundup Ready crops generated increased returns for farmers of \$3.4 billion globally. Since their introduction in 1996, these crops have generated a cumulative, incremental value for farmers of more than \$17 billion.²⁷ The National Center for Food and Agricultural Policy estimated that Roundup Ready crops generated cost savings of \$1.5 billion for U.S. farmers in 2005, largely from more cost-effective weed management systems available with Roundup Ready crops.

Сгор	HT Soy	HT Corn	HT Cotton	HT Canola	TOTAL HT Crops
2005	2,842	212	166	195	\$3,415
1996-2005	14,417	795	927	893	\$17,032

Global Farm Income Benefits From GM Crops (Million Dollars)

Brookes and Barfoot, 2006

²⁶ Japanese Biosafety Clearinghouse Document on Biosafety. http://www.bch.biodic.go.jp/download/en_Imo/J101_J163enRi.pdf ²⁷ Brookes and Barfoot, 2006.

> The Roundup Ready System has improved weed control, reduced the need for multiple herbicides to manage weeds, and provided superior crop safety

The Roundup Ready System provides growers with improved weed control compared to herbicide programs used in conventional crops. Some conventional herbicides cause injury to the crop, while the Roundup Ready System provides superior crop safety. Typically, use of the Roundup Ready System replaces the use of combinations of other soil residual or foliar-applied herbicides needed to provide broad spectrum weed control comparable to the glyphosate family of herbicides.

> The Roundup Ready System has enabled farmers to reduce herbicide use and decrease the environmental impact associated with herbicide use

The Roundup Ready System has enabled farmers to reduce use of herbicides by nearly 300 million pounds since 1996.²⁸ As a result, adoption of Roundup Ready crops has decreased the global environmental impact associated with herbicide use by more than 10 percent. In the U.S., the environmental impact was reduced 29 percent in Roundup Ready soybeans, 24 percent in Roundup Ready cotton, 4 percent in Roundup Ready corn, and 38 percent in Roundup Ready canola.

> The Roundup Ready System has increased the simplicity of weed control, saved time on-farm, and facilitated higher off-farm income

The Roundup Ready System increases the simplicity and flexibility to control a broad spectrum of weeds without crop injury, crop rotation restrictions, or carryover problems. Farmers using the Roundup Ready System make fewer trips over their fields to apply herbicides, which translates into ease of management, and reduced soil compaction and fuel use. Also, higher off-farm income is significantly related to the adoption of herbicide tolerant crops and conservation tillage. According to a 2007 USDA-ERS report, technologies that economize on management time, including Roundup Ready crops and adoption of conservation tillage practices that are enabled by Roundup Ready crops are associated with higher off-farm income.²⁹

The Roundup Ready System has increased adoption of reduced/ \geq conservation tillage and soil conservation practices

Conservation tillage improves water quality and creates habitat for wildlife.³⁰ The control of existing weeds has been a major barrier to the success of conservation

 ²⁸ Brookes and Barfoot, 2006.
²⁹ Fernandez-Cornejo et al., 2007.

³⁰ CTIC, 2000; Fawcett and Towry, 2002.

tillage systems.³¹ The Roundup Ready System has facilitated the adoption of soil-saving reduced- and no-tillage farming systems. As of 2004, Roundup Ready soybean farmers had increased no-till acreage by 64 percent, and farmers growing Roundup Ready corn and cotton increased no-till acres by 20 percent and 37 percent, respectively.

The use of the Roundup Ready System instead of plowing and tillage has significantly reduced the loss of topsoil due to soil erosion,³² improved soil structure with higher organic matter,³³ eliminated runoff of sediment and fertilizer, reduced on-farm fuel use,³⁴ reduced CO₂ emissions,³⁵ and increased carbon sequestration in soil.³⁶ The American Soybean Association estimated that the Roundup Ready soybean system saved 247 million tons of irreplaceable topsoil and reduced fuel use by 234 million gallons in 2000.³⁷ Roundup Ready Systems also have made a significant contribution to reducing greenhouse gas emissions from agricultural practices.³⁸ Reductions in fuel use and plowing/tillage combined to reduce CO₂ emissions into the atmosphere by more than 20 billion pounds in 2005. This reduction is equivalent to removing almost 4 million cars from the road for a year.

Glyphosate has favorable environmental characteristics and a long history of safe use

Glyphosate has an excellent human health and environmental profile and a long history of safe use in more than 130 countries. This has been a key factor in the acceptance of glyphosate products as among the most widely used herbicides in the world. When used according to label directions, these products do not represent a hazard to human health and the environment. This is confirmed by the extensive studies and by the firsthand experience of millions of farmers and home gardeners who have used this product.

Glyphosate, the active ingredient in Roundup branded agricultural products, inhibits an enzyme that is essential to plant growth; this enzyme is not found in humans or other animals, contributing to the low risk to human health from the use of glyphosate according to label directions.³⁹ Comprehensive toxicological studies in animals have demonstrated that glyphosate does not cause cancer, birth defects, mutagenic effects, nervous system effects or reproductive problems.⁴⁰ In fact, after a thorough review of all toxicology data available, the

³¹ Nowak, 1983.

³² ASA, 2001.

³³ Kay, 1995; CTIC, 2000.

³⁴ Brookes and Barfoot, 2006; ASA, 2001.

³⁵ Brookes and Barfoot, 2006; Kern and Johnson, 1993; CTIC, 2000.

³⁶ Brookes and Barfoot, 2006; Reicosky, 1995; Reicosky and Lindstrom, 1995.

³⁷ ASA, 2001.

³⁸ Brookes and Barfoot, 2006.

³⁹ Franz et al., 1997.

⁴⁰ U.S. EPA, 1993; Williams et al., 2000; European Commission, 2002; WHO/FAO, 2004.

U.S. EPA concluded that glyphosate should be classified in Group E ("Evidence of Non-carcinogenicity in Humans"), the most favorable category possible.⁴¹ Glyphosate has favorable environmental characteristics, including tight binding to most soils, making it unlikely to move to groundwater or reach nontarget plants, and degradation over time in soil and natural waters.⁴² Finally, glyphosate has been shown to have favorable environmental characteristics compared to other herbicides.⁴³

VI. Stewardship Programs for Roundup Ready Cropping Systems are Robust to Support the Proper Use and Long-Term Effectiveness of the Roundup Branded Agricultural Products

Weed control in Roundup Ready alfalfa can be effectively managed without increasing the risk of herbicide resistance

The approval for cultivation of Roundup Ready alfalfa has facilitated additional uses of glyphosate in alfalfa, which added a new and very effective herbicide option for growers in their cropping systems that had not been available previously. There are relatively few herbicides that can be used in the establishment of alfalfa which are both crop safe and efficacious on a broad variety of weed species. Additionally, because a well-established stand of alfalfa is highly competitive with weeds, fewer weed-control applications are needed. Further, alfalfa is cut on average three to four times a year, and therefore another cultural method of weed control (i.e., cutting) is introduced into the system naturally. Monsanto includes recommendations to minimize the risk of development of glyphosate-resistant weeds in Roundup Ready alfalfa in its Technology Use Guide, which is sent to every grower who has purchased Roundup Ready alfalfa seed in the U.S. These recommendations include the use of an additional herbicide in the Roundup Ready cropping system, where appropriate. The use in Roundup Ready alfalfa of at least two different methods of weed control, chemical and/or cultural, further reduces the risk of weed resistance occurring.

Attention to glyphosate-resistant weeds has increased with the concurrent adoption and use of Roundup Ready crops

The approval for cultivation of Roundup Ready crops has facilitated additional uses of glyphosate in crops that were not available previously. The public debate on the use of Roundup Ready crops is one reason for the increased scrutiny on the occurrence and management of glyphosate-resistant weeds.⁴⁴ Although glyphosate is considered to be a low-risk herbicide for weed resistance, all herbicides exert pressure on a weed population to select for resistant weed

⁴¹ U.S. EPA, 1993.

⁴² Giesy et al., 2000.

⁴³ Nelson and Bullock, 2003.

⁴⁴ Beckie, 2006.

biotypes. Worldwide, there are 12 weed biotypes that have developed resistance to glyphosate, and seven of these biotypes are found in the U.S.⁴⁵ The number of weed species that have developed resistance is low in comparison to the substantial acreage treated worldwide. Additionally, glyphosate-resistant weeds are not a consequence of adoption of the Roundup Ready System, but were first found in conventional cropping systems and have occurred in both systems. Finally, it is important to note that no confirmed glyphosate-resistant weeds have occurred as a result of gene flow from a Roundup Ready crop in the U.S.

> Herbicide-resistant weeds are not unique to Roundup Ready cropping systems, and are generally controlled with other herbicides and/or cultural practices

Farmers have been managing herbicide-resistant weeds for decades and there are hundreds of known cases of herbicide resistance to other commonly used herbicides.⁴⁶ These resistant weeds are generally controlled with the use of alternative herbicides and/or cultural methods, such as tillage or crop rotation. The occurrence of an herbicide-resistant weed biotype generally does not end the useful lifespan of the herbicide in guestion. For example, there are more than 60 cases of triazine-resistant weeds, but atrazine is still used on more corn acres in the U.S. than any other herbicide. Additionally, although there are some glyphosate-resistant weeds found in the U.S., growers continue to adopt and successfully use Roundup Ready crops. A recent Monsanto grower survey found that growers in the coastal region, which is an area that has higher reports of glyphosate-resistant horseweed, had grower satisfaction ratings of 95 percent in 2005.47 Further, market adoption of Roundup Ready cotton has not decreased in the Delta region, including Western Tennessee, an area that also has had numerous reports of glyphosate-resistant horseweed. Therefore, when supported with appropriate technical support and management recommendations, growers have successfully managed this resistance concern while still using a Roundup Ready cropping system.

Glyphosate-based agricultural herbicide labels include information on management practices developed to minimize the risk of weed resistance from occurring

Glyphosate-based agricultural herbicide labels from major registrants include information on weed-control management practices developed to minimize the risk of weed resistance from occurring. Additionally, agricultural chemical companies have formed an industry coalition, the Herbicide Resistance Action Committee (HRAC), to harmonize information on herbicide resistance. Herbicide registrants are recommended to include information on the herbicide mode of action to aid growers in planning herbicide use practices and as a

⁴⁵ Heap, 2007. <u>www.weedscience.org</u> ⁴⁶ Heap, 2007. <u>www.weedscience.org</u>

⁴⁷ Marketing Horizons, Inc., 2005.

reminder to adopt effective weed-resistance management practices required by EPA PR Notice 2001-5. EPA has the leadership role in regulating the use of pesticides under FIFRA and ensuring proper use instructions are available to growers though the evaluation of supporting data and approval of the herbicide end-use product labeling.

Monsanto is committed to the proper use and long-term effectiveness of its proprietary herbicide brands through a robust stewardship program

Monsanto considers product stewardship to be a fundamental component of customer service and responsible business practices. As part of its stewardship program, Monsanto invests significantly in communication of recommendations meant to minimize the risk of weed resistance occurring and in research on best practices for weed-resistance management. Monsanto makes the recommendations through a variety of means including direct mailings of the Technology Use Guide⁴⁸ to each grower purchasing a Roundup Ready crop product, a public website⁴⁹ containing recommendations and additional information, and reports in farm media publications. Growers are required to comply with Monsanto's stewardship recommendations by signing a Monsanto Technology/Stewardship Agreement, which is required for the purchase of any traited seed product. Monsanto also collaborates with U.S. academics to provide their recommendations for appropriate stewardship of Roundup Ready crops, as well as crop commodity groups who have launched several weed-resistance educational modules available on their websites. Further, Monsanto urges farmers to report any incidence of repeated nonperformance on a particular weed, and Monsanto investigates cases of unsatisfactory weed control to determine the cause. In cases where resistance is suspected, Monsanto provides recommendations for alternative control methods for farmers and carries out additional research when deemed necessary.

VII. Roundup Ready Crops have been Grown Successfully Alongside Conventional and Organic Crops for More than a Decade

A decade of rapidly increasing demand for and adoption of the Roundup Ready crops by growers has demonstrated the ability of alternative cropping systems to successfully coexist. Organic crop production has thrived since the introduction and large scale production of genetically modified crops, including Roundup Ready soybeans and Roundup Ready corn. Organic corn acreage grew from 32.650 acres in 1995 to 130.672 acres in 2005; organic soy grew from 47,200 acres in 1995 to 122,217 acres in 2005. More than 9000 acres of organic cotton were grown in 2004.⁵⁰ During the time period from 1995 to 2005 the acreage of biotech corn, soybean and cotton grew to occupy 52, 87, and 79 percent of the

 ⁴⁸ <u>http://www.monsanto.com/monsanto/us_ag/content/stewardship/tug/2007TUGPDF.pdf</u>
⁴⁹ <u>http://www.weedresistancemanagement.com</u>

⁵⁰ USDA-NASS, 2007.

U.S. acreage, respectively. Interestingly, states with the greatest concentration of organic soybean and corn crops are often states with above average penetration of biotech crops. For example, the leading organic corn growing states are Iowa, Minnesota and Wisconsin. Of these, Iowa and Minnesota have above average penetration of biotech crop plantings – 32 percent and 36 percent, respectively, of total corn plantings relative to the U.S. average of 26 percent in 2001.⁵¹

The Roundup Ready alfalfa trait has been deregulated and is fully legal to move through commerce. Therefore, unintended or adventitious presence of the trait in non-biotech or organic crops is not of legal consequence. Thus organic producers, whose production standards prohibit them from planting biotech crops, can market their crops as USDA-certified organic even if biotech traits are detectable. Some markets or buyers may seek to demand product specifications based on preferences that go beyond regulatory, variety certification or organic standards (e.g., they may insist on "100 percent biotech free"). Such a demand is based solely on preference, and a matter of agreement to contract specification between buyer and seller. The American Farm Bureau advises its growers not to agree to contract terms and specifications that are not reasonable, attainable and fully understood⁵². Where a grower agrees to contract specifications, the incumbent costs and the responsibility to meet such specifications (and any consequent liability associated with failing to meet such specifications) properly rest with those who choose to serve those markets and specifications, not the vast majority of producers who see value in planting deregulated biotech crops.

VIII. Summary

Roundup Ready alfalfa has been shown through extensive study to be as safe as existing alfalfa varieties for use as feed or food. It does not differ from conventional alfalfa in its potential to impact the environment. Roundup Ready alfalfa can provide significant economic benefits to growers and downstream users of alfalfa forage. At the same time, the use of the Roundup Ready alfalfa system to control weeds offers significant environmental benefits that have been realized in other Roundup Ready weed control systems.

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⁵¹ Brookes and Barfoot, 2006.

⁵² http://www.nasda.org/NASDA-Pew/AFBF_Organic_%20Production_Contracts.doc

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