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August 6, 2010

Mr. Michael C. Gregoire
Deputy Administrator
Biotechnology Regulatory Services
Animal and Plant Health Inspection Service
U.S. Department of Agriculture
4700 River Road, Unit 98
Riverdale, MD 20737

Re: Environmental Report - Partial Deregulation Measures for Cultivation of Roundup Ready® Alfalfa Events J101/J163

Dear Mr. Gregoire:

Forage Genetics International, LLC ("FGI"), a wholly owned subsidiary of Land O'Lakes, Inc. ("Land O'Lakes"), is an alfalfa breeding and seed production company and one of the original petitioners who sought a determination of non-regulated status for glyphosate-tolerant alfalfa in Docket No. APHIS-2007-0044. On behalf of the cooperative members of Land O'Lakes and our customers, we are writing to request that the Animal and Plant Health Inspection Service ("APHIS") grant a temporary "partial deregulation" or implement other administrative interim measures to mitigate the harm to the interests of those members and farmers resulting from delays in commercial planting of glyphosate-tolerant alfalfa. We request that such measures be implemented until such time as APHIS concludes its review of the petition for non-regulated status and its new decision on the petition takes effect. The proposed interim measures are consistent with the type of partial deregulation discussed recently by the U.S. Supreme Court in the *Geertson* case.

Land O'Lakes

Land O'Lakes is a farmer-owned food and agricultural cooperative representing the interests and needs of more than 300,000 direct and indirect members across America.

Land O'Lakes was organized in 1921 with the goals of enabling a stronger presence in the marketplace and of giving farmer-members a stronger voice in their own economic destinies. As a farmer-owned cooperative, Land O'Lakes proved to be an idea, and an organization, that worked for its producer-members. In the late 1920s, members asked us to take that cooperative idea into the agricultural inputs marketplace, and we entered the farm supply business. Our goal at that time was to provide farmer-members a secure, competitively priced supply of high-quality inputs. It was from those beginnings that our current Feed, Seed and Crop Protection Products businesses were born. Innovation is a hallmark of Land O'Lakes' performance in both agricultural inputs and the food side of our business.

Our structure as a cooperative continues to benefit members in a variety of ways: generating market access (and capturing value from the market) for our farmer-members; providing a secure source of high-quality agricultural inputs; enabling members to participate in the profits/losses generated by our businesses; and developing and delivering new products and services tailored to member needs. And, through their representation on our board of directors, our farmer-members exercise control over the strategic direction of the cooperative. Ultimately, a key element in determining that strategic direction is our stated Mission of "optimizing the value of our members' dairy, crop and livestock production."

A Leader in Agricultural Technology

FGI is a vertically integrated alfalfa seed company involved in basic R&D, plant breeding/product development, seed production, sales and marketing of alfalfa seed. Our research efforts include the development of biotechnology traits and conventional breeding. The seed products we develop are sold in both the U.S. and export markets, and to both conventional and organic alfalfa producers.

We see significant grower value for biotechnology traits, but understand that there are sectors of the U.S. and global markets that will choose not to plant alfalfa with these traits. The continued success of our business depends on our ability to serve all of these markets – biotechnology, conventional and organic – and includes a commitment to stewardship practices that enable market and environmental coexistence. Again, this dedication to sound science and producer choice is an important part of our company culture.

Biotechnology can play a significant role in the future of alfalfa, which is the fourth largest crop grown in the U.S. and is a key component of the diet of dairy cows. Alfalfa acres have been declining over the past 20 years, due in part to weed and quality issues. Additionally, growers have reduced the amount of alfalfa planted in part because the availability of biotechnology in other crops provides growers a better opportunity to manage production risks compared to growing conventional alfalfa. As acres of alfalfa decline, so too do the benefits that alfalfa provides as a key contributor to sustainable agriculture, including:

- Nitrogen fixation/crop rotation benefits
- Reduced soil erosion compared with row crops
- Deep, extensive root systems that improve soil tilth and sequester carbon

- Key source of digestible fiber and protein that can be produced right on the farm for the diet of dairy cows.

In order to address the problems in alfalfa caused by weed and quality issues, FGI has worked with Monsanto Company ("Monsanto") to develop glyphosate-tolerant alfalfa known as Roundup Ready® alfalfa ("RRA"). Under an exclusive license from Monsanto, FGI has been the developer, a seed producer, and seller of RRA. FGI's alfalfa breeding program developed all of the initial RRA cultivars and, along with one other seed company licensed by FGI, has contracted the production of all of the RRA seed sold prior to March 2007. All seed harvested thereafter was placed in controlled storage subject to Court Order and APHIS Administrative Rule. Though it is FGI's intent to license other alfalfa breeding companies to develop RRA varieties in the future, FGI is currently the sole source of seed available for RRA varieties for planting. The RRA seed is to be sold by seed companies that are licensed by Monsanto to sell the product to licensed forage growers.

History of RRA

RRA was deregulated in June 2005 by APHIS following preparation of an Environmental Assessment (which included public comment) and the issuance of a Finding of No Significant Impact – a process consistent with 78 prior or more recent deregulation decisions issued by the agency.

In February of 2007, Judge Charles Breyer of the United States District Court for the Northern District of California held that APHIS had not taken a sufficiently "hard look" in its Environmental Assessment of RRA at certain specific issues in support of the agency's decision to deregulate RRA. Judge Breyer's determination focused principally on the potential for gene flow from RRA to conventional or organic alfalfa seed fields, noting that alfalfa seed production has traditionally occurred in certain fairly concentrated areas of certain Western states. Although Judge Breyer also expressed concern regarding a possibility of flowering by alfalfa forage crops, APHIS' experts, along with multiple academic experts, concluded that the possibility for gene flow from one forage field to another was highly remote. The evidence submitted in the case also indicated that RRA growers would suffer significant harm in excess of $200 million from a halt in their ability to plant and use RRA for forage production for crop years 2007, 2008 and spring 2009.

Judge Breyer issued a preliminary injunction in March 2007 preventing any new planting of RRA beginning March 30, 2007, and subsequently issued a permanent injunction in May 2007 that enjoined further planting and sale of RRA pending completion of an Environmental Impact Statement ("EIS"). The injunction allowed the continued harvest of hay and seed production fields established prior to March 30, 2007, subject to certain conditions imposed by the court. Finally, the court enjoined APHIS from granting the RRA deregulation petition "even in part" before preparation of an EIS.

® Roundup Ready is a registered trademark of Monsanto Technology LLC.

During the remedy phase in Judge Breyer's court, APHIS representatives testified that they believed the agency would conduct an EIS within two years of the court order. Based largely on APHIS' estimated timeline, FGI elected to honor its seed production contracts with individual seed growers rather than pay to terminate these contracts. FGI purchased seed from the seed growers of RRA varieties produced in 2007, 2008 and 2009. All RRA seed purchased by FGI during these years was produced under multi-year grower contracts in place prior to the injunction. FGI also recalled from its seed company customers, who in turn recalled from their customer-growers, RRA seed produced and shipped but not planted prior to March 30, 2007. Thus, millions of pounds of RRA seed are in controlled storage.

Preparation of the EIS has taken APHIS longer than anticipated. Next spring will mark the fourth anniversary of the injunction and the EIS has not been completed.

Impacts of *Geertson* Litigation – The Risk of Further Delay

Although all RRA seed is now in storage conditions designed to optimize medium-term seed viability, seed quality is beginning to deteriorate. Based on our tracking of changes in germination percentages over the last 12 months, and our experience with typical patterns in seed quality decline, we believe that missing the spring 2011 commercial planting opportunity would place a significant volume of seed stocks at risk of deteriorating below current Certified Seed quality standards.

Any further delay in commercial planting opportunity would greatly increase potential losses. The RRA inventory described above, and the risk associated with this inventory, is owned by FGI, and passed on to our parent company and, ultimately, its farmer-members.

Prior to Judge Breyer's injunction, approximately 5,500 growers planted about 250,000 acres of RRA in the fall 2005, spring 2006, fall 2006, and/or truncated spring 2007 planting seasons. In a survey of a random sampling of these 5,500 RRA growers, farmers self-report a yield advantage of 0.9 tons/per acre/per year for RRA, when compared to conventional hay production on their farms. Based on average current hay prices, that translates into a $110 per acre/per year farm-gate advantage. Based on expected potential sales in the spring of 2011, typical planting rates and an average four-year rotation, the aggregated incremental value of RRA associated with spring 2011 planting alone is approximately $160 million.

A missed opportunity to plant RRA in spring 2011 is lost income for alfalfa growers, particularly important during the recent period of lower hay prices and a difficult dairy economy.

Request for Temporary Partial Deregulation or Other Interim Measures

The District Court's injunction on planting of RRA was ultimately appealed to the U.S. Supreme Court. In its decision of June 21, 2010, the Court overturned Judge Breyer's injunction and specifically anticipated the ability of APHIS to take interim measures by partially deregulating RRA with appropriate mitigation conditions during the continued preparation of the EIS. In the Supreme Court's own words, "a partial deregulation need not cause respondents any injury at all, much less irreparable injury; if the scope of the partial deregulation is sufficiently limited, the risk of gene flow to their crops could be virtually nonexistent." The Supreme Court remanded the *Geertson* case for further proceedings consistent with its June 21 opinion.

In the interest of our farmer member/owners and alfalfa growers in general, we are requesting that APHIS grant such an interim partial deregulation of RRA. Our co-petitioner, Monsanto, concurs in this request. Enclosed for your reference is an Environmental Report which discusses a set of proposed interim measures, consistent with the measures discussed recently by the Supreme Court, along with the potential environmental impact of those measures. We set forth these proposed measures and conditions of use in the context of the ongoing RRA litigation. Although there has been no evidence of any actual harm to the environment from multiple years of RRA seed and forage crop cultivation to date, these measures are nevertheless crafted to further minimize (if not eliminate) any perceived risks previously identified in the litigation context. In short:

- For RRA seed production, only eight pre-authorized seed grower consortia at physically isolated locations would be allowed during this interim period. The seed growers at these specific pre-authorized locations have requested the opportunity to produce RRA seed and would be required to follow the best management practices of the National Alfalfa and Forage Alliance ("NAFA"). These best practices have been adopted by the industry as standards for any future RRA seed production as part of an overall stewardship program designed to ensure coexistence of various alfalfa hay and seed markets. In addition, certain minimum isolation requirements for RRA seed fields would be increased during this interim period.

- For production of RRA forage (i.e., hay or haylage), our request includes a number of interim measures, including seed identification requirements, field tracking and geographic restrictions that would locate the very large majority of these RRA forage production acres in areas with no alfalfa seed production at all. It is important to note that over 99% of the alfalfa planted in the United States is planted for harvest as forage.

Conclusion

In sum, we propose that APHIS grant our request for limited interim measures designed to mitigate harm to thousands of growers until APHIS' final decision on the petition for non-regulated status takes effect. By granting our request for partial deregulation of RRA, APHIS would protect the interests of agriculture and consumers and, at the same time, address potential environmental impacts cognizable under the National

Environmental Policy Act by providing for a negligible risk of gene flow from RRA plantings.

FGI, Land O'Lakes and our farmer member/owners appreciate the efforts APHIS has made to address the challenges that have been raised to the commercialization of RRA and pledge our continued support and cooperation as we face the challenges that lie ahead. Your prompt consideration of this request for interim administrative action will be greatly appreciated. Please contact me with any questions concerning this request.

Sincerely,

Mark McCaslin, PhD
President

Enclosure

cc: Monsanto Company

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ENVIRONMENTAL REPORT
Partial Deregulation Measures for Cultivation of Roundup Ready® Alfalfa Events J101/J163

August 5, 2010

ACRONYMS AND ABBREVIATIONS

ACCase	acetyl-CoA carboxylase (enzyme)
ADF	Acid detergent fiber
ai/A	Active ingredient per acre
ALS	acetolactate synthase (enzyme)
AMS	Agricultural Marketing Service (USDA)
AOSCA	Association of Official Seed Certifying Agencies
AP	Adventitious presence
APHIS	Animal and Plant Health Inspection Service (USDA)
ASTA	American Seed Trade Association
BMP	Best Management Practices
BNF	Biotechnology Notification Files
BRS	Biotechnology Regulatory Service (USDA APHIS)
BST	Bovine somatotropin
CEQ	Council on Environmental Quality
CFIA	Canadian Food Inspection Agency
C.F.R.	Code of Federal Regulations
CRLF	California red-legged frog
CTIC	Conservation Technology Information Center
CTP2	Chloroplast transit peptide
d	Dose
DNA	Deoxyribonucleic Acid
EA	Environmental Assessment
EC	European Commission (EU)
EEC	Estimated Environmental Concentration
EIS	Environmental Impact Statement
EPA	Environmental Protection Agency (U.S.)

EPSPS	5-enolpyruvylshikimate-3-phosphate synthase (enzyme)
ER	Environmental Report
ERS	Economic Research Service (USDA)
EU	European Union
FAO	Food and Agricultural Organization of the United Nations
FDA	Food and Drug Administration (U.S.)
FFDCA	Federal Food, Drug, and Cosmetic Act
FGI	Forage Genetics International
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
FONSI	Finding of No Significant Impact
FQPA	Food Quality Protection Act
FSANZ	Food Standards Australia New Zealand
ft	feet
GE	Genetic engineering or genetically engineered
GM	Genetically modified
GMO	Genetically modified organism
GPS	Global Positioning System
GR	Glyphosate resistant
GT	Glyphosate-tolerant
HSP70	Heat shock protein intron
IM/NRC	Institute of Medicine and National Research Council
in.	Inches
IPA	Isopropylamine salt
lbs.	Pounds
IM	Institute of Medicine
kg	Kilograms

M	Mendelian manner
mg	Milligrams
MRID	Master Record Identification Number
MT/SA	Monsanto Technology Stewardship Agreement
NA	National Academies
NAFA	National Alfalfa and Forage Alliance
NAS	National Academy of Science
NASS	National Agricultural Statistical Service (USDA)
NCBA	National Cattlemen's Beef Association
NDF	Neutral detergent fiber
NEPA	National Environmental Policy Act
No.	Number
NOP	National Organic Program
NRC	National Research Council
OECD	Organization for Economic Cooperation and Development
OFPA	Organic Foods Production Act
OSTP	Office of Science and Technology Policy
PNT	Plant with a Novel Trait
PNW	Pacific Northwest
POEA	Polyethoxylated Tallow Amine
PPA	Plant Protection Act
ppm	Parts per million
rDNA	Recombinant DNA
RED	Reregistration Eligibility Decision
RfD	Reference Dose
ROD	Record of Decision

RR	Roundup Ready
RRA	Roundup Ready® Alfalfa
TUG	Technology use guide
T-DNA	Transferred DNA
UC	University of California
µg	Micrograms
U.S.	United States
U.S.C	U.S. Code
USDA	U.S. Department of Agriculture
USDC	U.S. District Court
WHO	World Health Organization
WSSA	Weed Science Society of America
wt	weight

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SECTION 1.0 INTRODUCTION

This Environmental Report (ER) examines the environmental impacts of cultivation of Roundup Ready® alfalfa (RRA) lines J101 and J163 (J101/J163)[1] for a temporary period subject to a range of measures, including geographic restrictions, stewardship requirements and other limitations. This ER is provided in connection with the petitioners' supplemental request for non-regulated status *in part* (commonly known as "partial deregulation") for RRA. This document is intended to provide information that may be utilized by the United States Department of Agriculture's (USDA) Animal and Plant Health Inspection Service (APHIS) in complying with the National Environmental Policy Act (NEPA)[2] and its applicable regulations[3] either in connection with partial deregulation of RRA or for any other regulatory or administrative action adopting the measures addressed herein. A partial deregulation or other administrative action adopting the measures may be superseded at a later date after APHIS completes the Environmental Impact Statement (EIS) and makes its determination regarding the pending petition for complete deregulation of RRA.

Alfalfa (*Medicago sativa* L.) was planted on approximately 21 million acres in the U.S. in 2009. Overall crop value was $7.9 billion in the 2009-2010 crop year. Over 99 percent of the alfalfa planted in the U.S. is planted for harvest as forage, with less than one percent harvested for seed. RRA, which has been genetically engineered to be tolerant to the herbicide glyphosate, is currently cultivated on approximately 200,000 acres or less, (USDA NASS, 2010b; USDA APHIS, 2009), pursuant to permit or court order.

1.1 PURPOSE OF THIS ER

1.1.1 Background

In April 2004, under the requirements of the Plant Protection Act (PPA)[4] and its implementing regulations,[5] Monsanto Company (Monsanto) and Forage Genetics International (FGI) submitted a petition to APHIS for a determination of non-regulated status for RRA (Rogan and Fitzpatrick, 2004). Monsanto is an agricultural company involved in the development and marketing of biotechnology-derived agricultural products. FGI is an alfalfa seed company and a

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[1] The terms RRA and glyphosate tolerant alfalfa,or GT alfalfa are used interchangeably throughout this document.

[2] NEPA of 1969, as amended; Title 42 of the U.S. Code (42 U.S.C.) §§4321-4347.

[3] Council on Environmental Quality (CEQ) regulations implement NEPA and are found in Title 40 of the Code of Federal Regulations (40 C.F.R.), Parts 1500 through 1508. The U.S. Department of Agriculture has implemented NEPA regulations, which are found at 7 C.F.R. part 1b, as has APHIS, and those are found at 7 C.F.R. part 372.

[4] 7 U.S.C. §§7701-7786.

[5] 7 C.F.R. Part 340.

wholly-owned subsidiary of Land O'Lakes, Inc., a farmer-owned food and agricultural cooperative representing the interests and needs of more than 300,000 direct and indirect members across the U.S. APHIS, through its Biotechnology Regulatory Service (BRS), is one of three federal agencies responsible for regulating biotechnology in the U.S. under the Coordinated Framework described in Section 1.4. APHIS regulates genetically engineered (GE) organisms that may be plant pests, the Environmental Protection Agency (EPA) regulates plant incorporated protectants and herbicides used with herbicide-tolerant crops, and the U.S. Department of Health and Human Services' Food and Drug Administration (FDA) regulates food and animal feed. The FDA completed its consultation process for RRA in 2004 (Tarantino, 2004). EPA approved the use of glyphosate over the top of RRA on June 15, 2005. The use of glyphosate over the top of RRA did not require an increase in the existing glyphosate residue tolerance of 400 ppm in the animal feed, non-grass crop group. EPA issued a new glyphosate tolerance for alfalfa seed of 0.5 ppm on February 16, 2005.[6]

NEPA requires federal agencies to evaluate the potential impact of proposed major federal actions and consider such impacts during the decision-making process. After agency review for safety, including an evaluation of relevant scientific data and all public comments relating to potential plant pest risks and related environmental impacts, APHIS issued an Environmental Assessment (EA) pursuant to NEPA in 2005 (USDA APHIS, 2005). Based on that EA, APHIS reached a finding of no significant impact (FONSI) on the environment from the unconfined cultivation and agricultural use of RRA and its progeny (USDA APHIS, 2005). Accordingly, in June 2005, APHIS granted non-regulated status to RRA (USDA APHIS, 2005).

After RRA was deregulated, the seeds were sold and planted. During the growing season of 2005 and 2006, approximately 200,000 acres were planted in 1,552 counties in 48 states (Alaska and Hawaii were not included). Approximately nine months after APHIS granted non-regulated status to RRA, two alfalfa seed growers and seven associations filed a lawsuit against the USDA over its decision to deregulate RRA, claiming that APHIS' EA failed to adequately consider certain environmental and economic impacts as required by NEPA. In February 2007, the court granted the plaintiffs' motion for summary judgment, finding that APHIS is required to prepare an EIS before approving its deregulation of RRA, and vacated APHIS' 2005 decision to deregulate RRA (U.S. District Court (USDC), 2007a). On March 12, 2007, the Court issued a preliminary injunction order in the case (USDC, 2007b). The order prohibited all sales of RRA seeds, effective on the date of the order, pending the Court's issuance of permanent injunctive

[6] 40 C.F.R. §180.364; 70 Fed. Reg. 7864 (Feb. 16, 2005).

relief; and prohibited all future planting, beginning March 30, 2007. The Court also vacated APHIS's deregulation determination. On March 23, 2007, APHIS published a notice in the Federal Register describing the Court's decision that RRA was once again a regulated article.[7] On May 3, 2007, the Court issued a permanent injunction regarding the control of the RRA that had been planted, and requiring APHIS to issue an administrative order specifying mandatory production practices that must be implemented by RRA growers (USDC, 2007c). The Court issued an amended judgment on July 23, 2007, further clarifying the mandatory production practices (USDC, 2007d). APHIS issued its administrative order on July 12, 2007 (USDA APHIS, 2007a). In August and September 2007, USDA, Monsanto, FGI and others filed an appeal, arguing that the injunction was improper. After the Ninth Circuit Court of Appeals affirmed the district court decision, the U.S. Supreme Court decided to hear the case. In June 2010, in *Monsanto Co. et al. v. Geerston Seed Farms et al.*, the Supreme Court overturned the lower court ruling, striking down the injunction.

Following issuance of the district court's amended judgment in July 2007, APHIS commenced work on the EIS for complete deregulation. The Notice of Intent was published in the Federal Register on January 7, 2008.[8] The notice of availability for the draft EIS was published in the Federal Register on December 18, 2009.[9] In the draft EIS, APHIS preliminarily concluded that there is no significant impact on the human environment due to granting nonregulated status to RRA (USDA APHIS, 2009). The comment period for the draft EIS, following an extension granted by APHIS, concluded on March 3, 2010. Approximately, 145,000 comments were submitted. APHIS is now preparing the final EIS.

1.1.2 Purpose of and need for action

This ER has been prepared to support an anticipated EA to be prepared by APHIS with respect to a partial deregulation of RRA. The ER examines the environmental impacts of implementing the proposed measures laid out below, either through a partial deregulation of RRA or other administrative means. The proposed measures would allow commercialization and deregulation of RRA in limited areas and under specific cultivation conditions explained more fully below in Section 1.1.3. If APHIS concludes that an EA supports a FONSI for the proposed measures, APHIS could decide to implement such measures through "partial deregulation".

[7] 72 Fed. Reg. 13735 (Mar. 23, 2007).
[8] 73 Fed. Reg. 1198 (Jan. 7, 2008).
[9] 74 Fed. Reg. 67205 (Dec. 18, 2009).

1.1.3 The proposed measures

Monsanto/FGI have proposed the following measures to be implemented through partial deregulation or other administrative means. The companies state that these measures would allow a subset of alfalfa farmers to obtain the substantial benefits of RRA pending complete deregulation. For example, they expect RRA to (i) offer growers a wide-spectrum weed control option that will enhance stand establishment and increase alfalfa forage; (ii) increase flexibility to treat weeds on an as-needed basis; (iii) allow alfalfa production on marginal land with severe weed infestations; and (iv) provide growers with a weed control system that has a reduced risk profile for the environment. The proposed measures include a separate set of restrictions for RRA forage production and RRA seed production. These restrictions are described in the sections below.

FORAGE PRODUCTION RESTRICTIONS

1) **Grower Requirements**: Each grower is required to abide by the terms specified in their Monsanto Technology / Stewardship Use Agreement (MT/SA) and accompanying Technology Use Guide (TUG), which contractually obligates growers to comply with stewardship requirements related to growing RRA for forage. A copy of the MT/SA and TUG are included in Appendix A.
2) **RRA Seed Licensing Requirements**: All RRA seed is sold through a network of licensed seed companies and their retailers and dealers/distributors. Each seed company is required to have a current Genuity® Roundup Ready® Alfalfa Commercial License Agreement to sell RRA seed. This agreement specifies the limited rights of the seed companies to market the product, including stewardship requirements associated with RRA.
3) **Seed Identification**: RRA seed bag labeling and a unique purple seed colorant will be required product identity mechanisms to notify all RRA forage growers of the presence of the RRA trait and the geographic limitations for product use.[10]
4) **Crop Harvest (Forage only)**: RRA fields, except as noted under “Seed Production Restrictions” Section below, may be harvested for forage only. All growers shall adhere to limitations as outlined in the MT/SA and TUG (Monsanto TUG, attached as Appendix A).[11]

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[10] Similar labeling and use agreements are typically used for the sale and stewardship of other GE crops, so growers are currently familiar with such contractual obligations.
[11] Forage growers who have previously used RRA are familiar with this crop use limitation. See Appendix A.

5) **Geographic Restrictions for Forage Planting based on Cropping Practices**: Geographic restrictions will be placed on forage planting by state and county based on the amount of alfalfa seed produced (see Appendix B). Data on the amount of seed produced is from the 2007 Census of Agriculture, as summarized in Figure 1-1 (for additional details see Table 1-1 and Appendix B). Geographic restrictions for alfalfa forage plantings will be defined in three categories (Tiers I, II, and III) based on the amount of alfalfa seed production reported in each state. (See Appendix B for maps).

   a. Tier I: States with no reported alfalfa seed production (2007); 27 States and all counties within each.

      i. New RRA forage production plantings are allowed in accordance with the requirements established by the TUG and Genuity® Roundup Ready® Alfalfa Commercial License Agreement.

      ii. Forage growing is the only reported crop practice for alfalfa. No commercial alfalfa seed growth was reported in Tier I states in 2007. However, if conventional seed production fields are now present, then RRA forage grown near these new conventional seed production fields are subject to the requirement provided in Restriction Enhancement A (see Tier II.ii below).

   b. Tier II: States with <100,000 lbs annual seed production (2007); 12 States and all counties within each.
   Commercial alfalfa seed production occurs in these states; however, the number of seed growers, seed acres and cumulative pounds are limited and widely dispersed. Only 0.51 percent of the U.S. alfalfa seed crop is produced in these states (2007).

      i. New RRA forage production plantings are allowed in accordance with the requirements established by the TUG and Genuity® Roundup Ready® Alfalfa Commercial License Agreement.

      ii. Restriction Enhancement A applies if the RRA forage field is located within 165 ft of a commercial, conventional alfalfa seed production field. Under Restriction Enhancement A, the RRA grower must harvest forage before 10 percent bloom.

1. *Rationale for Restriction Enhancement A*: In grower locations where an individual RRA forage field is within 165 ft of a conventional seed production field, the TUG requires the RRA grower to mitigate RRA flowering by harvesting not later than 10 percent bloom stage to mitigate pollen production. RRA forage grower compliance with the TUG's 10 percent bloom stage harvest has been high and rarely was it delayed by weather or other factors. (See Appendix J). This restriction will address mitigations at or near geographic (county, state and federal) borders. The 165 ft distance is the science and market-based, industry recognized isolation distance for certified alfalfa seed crops (see Association of Official Seed Certifying Agencies (AOSCA), 2009); and, the potential extent of gene flow of 10 percent bloom hay to nearby seed crops is de minimis at 165 ft (Teuber and Fitzpatrick, 2007; Van Deynze et al., 2008).

c. <u>Tier III: States each having >100,000 lbs annual seed production (2007); 11 States. Enhanced restrictions to be applied based on predominant county cropping practices.</u> In the eleven states with greater than 100,000 acres of annual alfalfa seed production, additional by-county geographic restrictions will apply. In many cases, within each state, seed acreage is geographically concentrated and typically localized to a few specific counties where climate is suitable for seed growing. (See geographic maps for each of these states in Appendix B.) In these states, alfalfa seed is typically grown by professional growers under seed company contracts and official seed certification inspection programs are widely used by growers and the contracting seed companies. Alfalfa forage production is also a major enterprise in these states and in many cases it is geographically separate from seed crop acres.

   i. By-County criterion used to determine eligibility for new RRA forage plantings.

      1. <u>Counties without seed production reported</u> (Appendix B).

a. New RRA forage production is allowed in accordance with the requirements established by the TUG and Genuity® Roundup Ready® Alfalfa Commercial License Agreement.

b. Restriction Enhancement A: If RRA forage field is located within 165 ft of a conventional alfalfa seed field, RRA grower must harvest forage at or before 10 percent bloom.

c. Restriction Enhancement B: All RRA forage growers are required to report GPS coordinates of all RRA forage field locations. GPS field location information is available for monitoring and enforcing the planting restrictions applicable to RRA forage fields.

d. Forage production is the only reported crop practice in these counties. Commercial alfalfa seed growing is not reported.

2. <u>Counties with seed production reported</u> (Appendix B).

   a. Restriction Enhancement C: New RRA forage plantings are not allowed in counties with commercial alfalfa seed production.

   b. Commercial alfalfa seed growing is a predominant activity in these counties

   c. 99.5 percent of U.S. alfalfa seed production is in these counties.

6) **<u>Summary of Allowed Forage Production Scope:</u>**

   a. Nationwide, the counties excluded from new RRA forage production under the requested partial deregulation represent 99.5 percent and 21.84 percent of the alfalfa seed production pounds (lbs) and forage production acres, respectively (See Appendix B).

b. Nationwide, the counties where new RRA forage plantings are allowed (with various restrictions) include 0.5 percent and 78.16 percent of the alfalfa seed production (lbs) and forage production acres, respectively.

7) **Monitoring and Enforcement of Forage Crop Restrictions**

Support and enforcement of the partial deregulation of RRA for forage production would be accomplished by the following mechanisms.

a. **Education and Communication**: Education and communication activities would be conducted with hay growers, seed dealers/sellers and seed companies. Examples of these activities include training and information sessions for dealers and sellers, detailing the requirements for selling RRA, sales meetings, periodic visits with growers and sellers, and computer based training modules that can be tailored to specific areas of focus related to the product and requirements.

   i. **Training**: Online training would be required for each seed company staff member handling RRA as well as the appropriate personnel at Monsanto/FGI.

   ii. **The MT/SA and accompanying Monsanto TUG**: The MT/SA and accompanying TUG, a legal agreement between growers who utilize Monsanto technologies and Monsanto, would be updated to include direct reference to the partial deregulation conditions, including the limitations pertaining to where RRA forage can be grown and hay and forage management practices.

   iii. **Packaging Updates**: In addition to being clearly labeled as RRA seed, all bags of finished product would have an additional prominent tag that lists the states and counties in which the product could not be planted. In addition the seed would have a unique coating color (purple) that identifies it as being RRA seed.

   iv. **Dealer Requirements**: All dealers selling RRA would sign a dealer agreement legally binding them to adhere to the partial deregulation requirements.

v. **Industry Communications**: Alfalfa industry-specific groups would be utilized to support communication of the partial deregulation requirements in communications to their members. These include National Alfalfa and Forage Alliance (NAFA), American Seed Trade Association (ASTA), etc.

vi. **RRA Information Line**: A toll free number will be available for growers or other individuals to clarify information or answer questions regarding the partial deregulation.

b. **Assessment and Verification**: Multiple assessment and verification tools will be utilized to monitor and verify adherence to the partial deregulation request.

i. **Reconciliation of Sales Data**: All sales to hay growers will be reconciled with remaining RRA seed inventory at the end of the planting season (twice per year). This reconciliation will be part of a legal commercial requirement of the seed companies and dealers selling RRA.

ii. **GPS coordinates**: GPS coordinates will be collected on all sales in the eleven (11) Tier III states. The GPS coordinates will be collected on all fields planted with RRA. Information will be validated at time of receipt; questionable data will be reviewed.

iii. **Hotline**: A toll-free hotline will be available for individuals to report violations to the partial deregulation ruling.

c. **Proactive Sampling, Testing and Review, inclusion of third parties**: Various internal and/or third parties will be utilized to randomly review plantings and to determine grower compliance with the conditions of the partial deregulation.

d. **Enforcement**: Violations of the partial deregulation decision will have the following impacts:

i. **Grower**: Takeout of the alfalfa field in violation would be required. Grower has the potential to lose access to RRA.

ii. **Dealer**: Any dealer incentive payments would be at risk. In addition, dealers would also risk losing their ability to sell RRA in the future.

iii. **Seed Company**: Any seed company incentive payments would be at risk. In addition, seed companies would also risk losing their ability to sell RRA in the future.

e. **Ongoing Measurement**: An annual report would be prepared by FGI for the USDA summarizing activities in all areas identified above. Additional data would be provided upon request.

f. **Any potential additional investigation or action** would be conducted in accordance with all federal, state and local laws concerning individual property rights, inspections and sampling activities. Monsanto has demonstrated that it does not exercise its patent rights where trace amounts of patented seeds or traits are present in a farmer's fields as a result of inadvertent means.

Table 3-9. State Production of Alfalfa Seed (2007 Census of Agriculture).

State	Farms	Seed Acres Harvested	Pounds of Seed Harvested
California	114	36,625	19,083,458
Washington	82	17,127	10,860,608
Idaho	92	12,788	9,346,709
Wyoming	62	10,548	5,915,816
Nevada	19	6,498	4,237,101
Montana	80	10,338	3,729,635
Oregon	32	4,959	3,183,375
Utah	54	3,803	2,077,813
Arizona	53	5,206	1,902,669
South Dakota	47	6,014	428,447
Oklahoma	29	2,004	281,121
Texas	24	546	79,885
Minnesota	17	611	63,461
Missouri	19	399	40,540
North Dakota	6	(D)	34,784
New Mexico	15	310	29,907
Kansas	5	342	22,430
Nebraska	29	545	21,216
Michigan	10	(D)	15,610
New York	3	27	6,180
Iowa	5	(D)	(D)
Ohio	1	(D)	(D)
Colorado	8	1,815	(D)

(D): Data withheld to avoid disclosing data for individual farms.

Figure 1-1. Table 3-9 from Draft EIS for RRA.

Table 1-1 Alfalfa Seed and Hay Production Overview (State List)

	State	Seed - Acres Hvstd.	Seed - Operations	Seed - In Pounds	Alfalfa Hay - Acres	Alfalfa Hay - Operations	Alfalfa Hay - Tons	Existing Seed Production Category	Restrictions on new RRA forage plantings (all counties within state)	Within State By-County Geographic Criteria and Restrictions on new RRA forage production
Tier I: States with no reported alfalfa seed production (2007)	ALABAMA				7,526	340	16,944	None	TUG restrictions, plus, if field is within 165 ft of conventional seed production, then <10% bloom cut required	Not Applicable
	ALASKA				-	-	-	None		
	ARKANSAS				11,732	278	28,647	None		
	CONNECTICUT				8,343	349	18,441	None		
	DELAWARE				3,687	177	13,530	None		
	FLORIDA				6,951	141	14,993	None		
	GEORGIA				1,655	134	4,810	None		
	HAWAII				89	5	267	None		
	ILLINOIS				322,339	12,913	1,138,512	None		
	INDIANA				241,129	10,775	665,767	None		
	KENTUCKY				269,610	10,538	524,565	None		
	LOUISIANA				2,164	52	4,768	None		
	MAINE				10,089	246	23,876	None		
	MARYLAND				40,576	1,429	120,402	None		
	MASSACHUSETTS				9,921	406	22,537	None		
	MISSISSIPPI				3,931	159	7,113	None		
	NEW HAMPSHIRE				5,373	218	13,475	None		
	NEW JERSEY				20,310	728	51,483	None		
	NORTH				10,322	758	16,755	None		

	CAROLINA									
	PENNSYLVANIA				475,873	14,402	1,357,225			
	RHODE ISLAND				1,035	63	1,806	None		
	SOUTH CAROLINA				4,070	143	8,860	None		
	TENNESSEE				20,074	1,655	45,819	None		
	VERMONT				31,769	571	68,624	None		
	VIRGINIA				89,213	3,063	233,807	None		
	WEST VIRGINIA				28,465	1,185	62,484	None		
	WISCONSIN				1,517,522	30,810	3,673,619	None		
	Subtotal	-	-	-	3,143,768	91,538	8,139,129			
Tier II: States with <100,000 lbs seed production (2007)	COLORADO	1,815	8	-	861,053	8,648	2,887,865	Minor	TUGrestrictions,plus,if fieldiswithin165ftofconventionalseedproduction,then<10%bloomcut required	Not Applicable
	IOWA	-	5	-	830,440	22,040	3,054,729	Minor		
	KANSAS	342	5	22,430	793,140	9,643	2,986,134	Minor		
	MICHIGAN	-	10	15,610	698,595	16,431	1,707,036	Minor		
	MINNESOTA	611	17	63,461	944,775	20,398	2,671,173	Minor		
	MISSOURI	399	19	40,540	295,021	8,229	782,847	Minor		
	NEBRASKA	545	29	21,216	1,085,921	14,820	3,955,881	Minor		
	NEWMEXICO	310	15	29,907	236,103	4,272	1,176,242	Minor		
	NEWYORK	27	3	6,180	450,144	7,707	1,119,421	Minor		
	NORTH DAKOTA	-	6	34,784	1,457,604	8,985	3,072,682	Minor		
	OHIO	-	1	-	437,658	15,354	1,256,174	Minor		
	TEXAS	546	24	79,885	153,763	2,391	721,303	Minor		

	Subtotal	4,595	142	314,013	8,244,217	138,918	25,391,487	Minor			
Tier III: States with >100,000 lbs seed (2007)	ARIZONA	5,206	53	1,902,669	257,407	943	1,968,043	Major	**If 2007 census indicated NO in-county seed production, then:** See Census Criteria (See Appendix B for county list)	**If 2007 census indicated seed production in county, then:** TUG restrictions <u>and</u> GPS coordinate reporting; if new field is within 165 ft of conv.seed production, then 10% bloom cut required	No RRA forage planting allowed
	CALIFORNIA	36,625	114	19,083,458	986,982	3,587	7,057,014	Major			
	IDAHO	12,788	92	9,346,709	1,037,520	8,817	4,254,543	Major			
	MONTANA	10,338	80	3,729,635	1,868,756	9,711	3,936,445	Major			
	NEVADA	6,498	19	4,237,101	274,004	1,128	1,217,586	Major			
	OREGON	4,959	32	3,183,375	428,812	3,569	1,777,894	Major			
	OKLAHOMA	2,004	29	281,121	334,990	3,781	1,131,938	Major			
	SOUTH DAKOTA	6,014	47	428,447	1,996,599	12,653	4,414,338	Major			
	UTAH	3,803	54	2,077,813	548,570	7,780	2,172,218	Major			
	WASHINGTON	17,127	82	10,860,608	448,588	4,294	2,192,001	Major			
	WYOMING	10,548	62	5,915,816	674,284	4,007	1,696,438	Major			
	Subtotal	115,910	664	61,046,752	8,856,512	60,270	31,818,458				
	Grand Total	120,505	806	61,360,765	20,244,497	290,726	65,349,074				

RRA SEED PRODUCTION RESTRICTIONS

The National Alfalfa and Forage Alliance (NAFA) used current science and extensive stakeholder input to design the “Best Management Practices (BMP) for Roundup Ready Seed Production” (See Appendix C in this ER for additional details on BMPs for Roundup Ready® Alfalfa Seed Production). These BMP have been adopted by the industry as standards for any future RRA seed production as part of an overall stewardship program designed to ensure coexistence of various alfalfa hay and seed markets. All RRA seed grower contracts require full adherence to the NAFA BMP, a type of identity preserved process-based seed stewardship, which includes but is not limited to the following measures:

- RRA seed field location reporting to official seed certification agencies
- Field and isolation zone inspection by official seed certification agencies
- Equipment cleaning prior to and after use
- Segregated and uniquely identified seed handling and storage
- Planting stockseed labeling
- FGI RRA seed grower education and contracting
- Field termination reporting
- Seed company monitoring of compliance
- Annual third-party review of efficacy of BMP
- Other

FGI has individual seed-producer farmer partners who have asked for the opportunity to produce RRA seed crops.

Partial deregulation of RRA would include seed production that is restricted to eight defined seed grower consortia (Table 1-2). FGI has determined that each of these individual consortia could meet or exceed the National Alfalfa & Forage Alliance BMP for RRA Seed Production (NAFA, 2008a) parameters and the proposed partial deregulation enhancements to isolation distance described below (See Appendix C and Table 1-2).

1) **<u>Seed Identification</u>**: Stockseed container to be clearly labeled as containing RRA trait seed. Grower seed contracts and official field reporting will notify each seed grower regarding the measures imposed for seed growing.

2) **<u>Implement all NAFA BMP with Isolation Enhancement</u>**

   a. All BMP measures will be followed, documented, monitored and enforced for compliance by FGI or its representatives. In addition, each field will be inspected annually by the local seed certification agency, confirming minimum isolation standards for that production year.

   b. Measures will set the enhanced, minimum, isolation requirements for RRA seed fields as follows. The minimum required isolation from conventional, commercial seed fields will be 4 miles and 1 mile, when honeybees or leafcutter bees are the managed pollinating species, respectively.

   c. The potential for gene flow at NAFA BMP isolation is de minimis (Van Deynze et al. 2008) and this measure's proposed enhancement of isolation distance would further ensure de minimis gene flow potential into conventional seed crops should they be present.

3) **<u>Geographic Restrictions</u>**:

   a. Only eight pre-authorized, physically-isolated locations for RRA seed production will be allowed. Each location of proposed seed growing is composed of one to three large seed growers who will act together to manage isolation control within a local, informal RRA seed grower consortium.

Table 1-2 Eight Seed Grower Consortia								
Grower Consortium	**Counties and State**	**Number of requesting growers**	**Approximate number of initial acres (2010-2011)**	**Managed pollinator bee species**	**Seed harvest equipment status, ownership**	**Current isolation distance to conventional seed**	**NAFA Best Practices minimum isolation distance**	**Partial Deregulation Isolation, minimum distance**
A. Northern California	Lassen, CA	1	300	leafcutter	On-Farm	>5mi	900 ft	1 mi
B. Central California	Kings, Kern, Fresno, CA	2	2,000	Honeybee +leafcutter	On-farm	4 mi	3 mi	4 mi
C. Colorado	Mesa, CO	3	1,000	leafcutter	On-farm	>10 mi	900 ft	1 mi
D. Eastern Idaho	Oneida, Manidoka, Twin Falls, ID		500	leafcutter	On-farm	1 mi	900 ft	1 mi
E. Western Idaho	Ada, Canyon, Payette, ID	3	2,000	leafcutter	On-farm	1 mi	900 ft	1 mi
F. Nevada	Humbolt, Pershing, NV	2	600	leafcutter	On-farm	2 mi	900 ft	1 mi
G. Texas	Carson, Castro, Donley, Gray, Lamb, Ochiltree, Roberts, Swisher, TX	1	500	leafcutter	On-farm	>10 mi	900 ft	1 mi
H. Utah	Box Elder, Cache, Millard, Weaver, UT	3	500	leafcutter	On-farm	5 mi	900 ft	1 mi

1.2 RATIONALE FOR CREATION OF RRA

Alfalfa is a small seeded perennial forage crop that competes with annual weeds during establishment and with annual and perennial weeds in established stands. With irrigated alfalfa stands, weed seeds in irrigation water can reinfest the stand with weed seeds with every irrigation event. Weed infestation increases the risk of successful establishment and weeds generally compete with alfalfa for light, water, and nutrients. Weeds can have an adverse affect on the quality of harvested forage and effectively shorten the productive life of the alfalfa stand. RRA offers alfalfa growers a simpler, more effective, more flexible, and less expensive herbicide alternative for weed control. Current weed control programs in alfalfa production have serious limitations because certain weed species are difficult to control. Certain of these difficult to control weeds are poisonous and/or toxic to livestock. Glyphosate applications to RRA will offer flexibility in timing of weed control, including preplant, preemergence and/or postemergence applications. In contrast to most other commonly used alfalfa herbicides, glyphosate can safely be applied at virtually any stage of GT alfalfa development. The use of GT alfalfa can help increase alfalfa forage yield and forage quality through better weed control (Rogan and Fitzpatrick, 2004, pp. 20-21; Medlin and Siegelin, 2001).

Glyphosate is not used for in-crop weed control in conventional alfalfa (those without glyphosate tolerance) because it damages the plants. With GT alfalfa, growers have another option for weed control.

1.3 SCOPE OF ENVIRONMENTAL ISSUES ADDRESSED

During the lawsuit discussed above, certain specific issues were identified by the court as requiring additional NEPA analysis by APHIS (USDC, 2007). These primary issues are described below and are addressed in the Affected Environment and Environmental Consequences sections of this ER. Other issues identified by APHIS in the draft EIS are also addressed to the extent they are relevant to the proposal for partial deregulation to ensure full disclosure and analysis of any potential impacts associated with partial deregulation of RRA under the proposed measures. Many of the citations herein are to the draft EIS discussions of the basic facts regarding alfalfa, its weed threats and cultivation.

1.3.1 Gene transmission to non-genetically engineered alfalfa

Alfalfa is a perennial crop and is typically replanted every three to six years. The crop is typically harvested for forage three to eight times per year, depending on location and seasonal climate. Most alfalfa in the U.S. is harvested in the late vegetative stage (pre-bloom) to optimize yield and nutritional quality. Forage quality begins to drop dramatically in hay harvested after the flowering stage, and continues to deteriorate as the crop further matures toward pod/seed set (USDA APHIS, 2009, p. 40). Hay harvested after 10 percent bloom is generally of poor quality for feed and has low market value (USDA APHIS, 2009, p. G-6). This leaves little opportunity for pollination among forage crops. Alfalfa is exclusively pollinated by bees which normally pollinate other alfalfa plants growing in close proximity. However, pollinations at greater distances can occur (e.g, less than 1 to greater than 3 miles depending upon the bee species).

In contrast, growers promote flowering and seed ripening in commercial seed fields. In most fields, flower buds begin to form on stems approximately 4 to 6 weeks after field mowing during long-day photoperiods and warm weather. Once alfalfa begins flowering, it flowers indeterminately, and its duration depends on moisture, temperature, and other factors (Rogan and Fitzpatrick, 2004). Ripe seed, viable for germination, is formed 5 to 6 weeks after pollination (i.e., 9 to 12 weeks total after mowing). Seed harvested before this stage is not viable.

Cross-pollination between RRA and conventional or organic alfalfa crops could potentially result in the inadvertent presence of GE material in conventional or organic alfalfa hay intended for a market with specific or zero tolerance for the presence of GE material. Putnam (2006) estimated that the GE sensitive hay market is approximately 3 to 5 percent of the total market. He estimated that the majority of the market (95 to 97 percent) is composed of growers that may either adopt RRA varieties and/or are not likely to be GE sensitive in their buying decisions.

Detailed analysis of the potential for gene transmission from RRA has been conducted. Potential impacts from both hay and seed production on organic and conventional hay and seed production, other Medicago crops, and feral populations of alfalfa are analyzed in Sections 3.3 through 3.8 of this ER. A study of the topic was separately published (Van Deynze et al., 2008).

1.3.2 Socioeconomic impacts

The court found that APHIS failed to analyze in its initial EA the socio-economic impacts of deregulating RRA on organic and conventional farmers. Therefore, further analysis was conducted and is discussed in Sections 3.15 of this ER.

1.3.3 Consumer's choice to consume non-GE food

The court found that APHIS failed to analyze the possibility that deregulation of RRA would degrade the human environment by eliminating a consumer's choice to consume, or a grower's choice to grow, non-GE food. Therefore, further analysis was conducted and is discussed in Section 3.10 of this ER.

1.3.4 Potential for development of glyphosate-resistant (GR) weeds

As the adoption of GT crops has grown, the use of glyphosate has increased (National Research Council [NRC], 2010, Figures S-1, S-2, and S-3; Young, 2006). Concerns have been expressed that increased use of glyphosate may lead to development of GR weeds. Further analysis was conducted and is discussed in Sections 2.4 and 3.11 of this ER.

1.3.5 Cumulative effects of increased use of glyphosate

Further analysis of cumulative impacts from increased use of glyphosate was conducted and is discussed in Section 4 of this ER.

1.4 FEDERAL REGULATORY AUTHORITY – COORDINATED FRAMEWORK

Interagency coordination in scientific and technical matters is the responsibility of the federal Office of Science and Technology Policy (OSTP), which was established by law in 1976. A large part of the OSTP's mission is "to ensure that the policies of the Executive Branch are informed by sound science" and to "ensure that the scientific and technical work of the Executive Branch is properly coordinated so as to provide the greatest benefit to society" (OSTP, undated).

In 1986, the OSTP published a "comprehensive federal regulatory policy for ensuring the safety of biotechnology research and products", the *Coordinated Framework for the Regulation of Biotechnology* (Coordinated Framework) (OSTP, 1986). The OSTP concluded that the goal of ensuring biotechnology safety could be achieved within existing laws (OSTP, 1986).

The Coordinated Framework specifies three federal agencies responsible for regulating biotechnology in the U.S.: USDA's APHIS, the EPA, and the FDA. APHIS regulates GE organisms under the PPA of 2000. EPA regulates plant-incorporated protectants and herbicides used with herbicide-tolerant crops under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) and Federal Food, Drug, and Cosmetic Act (FFDCA). FDA regulates food (including animal feed, but not including meat and poultry, which is regulated by USDA), including food and feed produced through biotechnology, under the authority of the FFDCA. Products are regulated according to their intended use and some products are regulated by more than one agency. Together, these agencies ensure that the products of modern biotechnology are safe to grow, safe to eat, and safe for the environment. USDA, EPA, and

FDA enforce agency-specific regulations to products of biotechnology that are based on the specific nature of each GE organism.

In 2001, in a joint Council on Environmental Quality (CEQ)/OSTP assessment of federal environmental regulations pertaining to agricultural biotechnology, the CEQ and OSTP found that “no significant negative environmental impacts have been associated with the use of any previously approved biotechnology product” (CEQ/OSTP, 2001, p. 1).

For RRA, the plant is reviewed by USDA and FDA, whereas EPA is responsible for registering the use of the glyphosate herbicide and establishing a tolerance for allowable glyphosate residues.[12] As indicated herein, although certain issues such as weed resistance and impacts of glyphosate on animals or plants are addressed by EPA (not APHIS), this ER nevertheless addresses those issues.

1.4.1 USDA regulatory authority

The APHIS BRS mission is to protect U.S. agriculture and the environment using a dynamic and science-based regulatory framework that allows for the safe development and use of GE organisms. Under its authority from the PPA, APHIS regulates the introduction (importation, interstate movement, or release into the environment) of certain GE organisms and products.[13] A GE organism is presumed to be a regulated article if the donor organism, recipient organism, vector, or vector agent used in engineering the organism belongs to one of the taxa listed in the regulation[14] and is also presumed to be a plant pest. APHIS also has authority under these rules to regulate a GE organism if it has reason to believe that the GE organism may be a plant pest or APHIS does not have sufficient information to determine that the GE organism is unlikely to pose a plant pest risk.[15]

Under APHIS’ regulations a person may petition APHIS to evaluate submitted data and determine that a particular regulated article is unlikely to pose a plant pest risk, and, therefore, should no longer be regulated.[16] The petitioner is required to provide information related to plant pest risk that the agency may use to determine whether the regulated article is unlikely to

[12] Under the FFDCA and associated regulations, EPA sets a tolerance, or maximum residue limit, for pesticide treated food and feed items. A tolerance is the amount of pesticide residue allowed to remain in or on each treated food commodity. The tolerance is the residue level that triggers enforcement actions. That is, if residues are found above that level, the commodity will be subject to seizure by the government.

[13] 7 C.F.R. §340.

[14] 7 C.F.R. §340.2.

[15] 7 C.F.R. §340.1.

[16] 7 C.F.R. §340.6. entitled “Petition for determination of non-regulated status”.

present a greater plant pest risk than the unmodified organism.[17] If the agency determines that the regulated article is unlikely to pose a plant pest risk, the GE organism will be granted non-regulated status. In such a case, APHIS authorizations (i.e. permits and notifications) would no longer be required for environmental release, importation, or interstate movement of the non-regulated article or its progeny.

It was under these regulations that Monsanto/FGI submitted the petition for a determination of non-regulated status for event J101/J163 (Rogan and Fitzpatrick, 2004). J101/J163 alfalfa were considered regulated because they contain non-coding deoxyribonucleic acid (DNA) segments derived from plant pathogens and the vector agent used to deliver the transforming DNA is a plant pathogen (See Section 3.1 for a discussion of these concepts) (USDA APHIS, 2005, p. 5).

1.4.2 EPA regulatory authority

EPA is responsible for regulation of pesticides (including herbicides such as glyphosate) under the FIFRA.[18] FIFRA requires that all pesticides be registered before distribution, sale, and use, unless exempted by EPA regulation. Before a product is registered as a pesticide under FIFRA, it must be shown that when used in accordance with the label, it will not result in unreasonable adverse effects on the environment.

Under the FFDCA, as amended,[19] pesticides added to (or contained in) raw agricultural commodities generally are considered to be unsafe unless a tolerance or exemption from tolerance has been established. EPA establishes residue tolerances for pesticides under the authority of the FFDCA. EPA is required, before establishing a pesticide tolerance to reach a safety determination based on a finding of reasonable certainty of no harm under the FFDCA, as amended by the Food Quality Protection Act of 1996 (FQPA). The FDA enforces the tolerances set by the EPA. EPA approved the use of glyphosate over the top of RRA on June 15, 2005. The use of glyphosate over the top of RRA did not require an increase in the existing glyphosate residue tolerance of 400 ppm in the animal feed, non-grass crop group; this tolerance supports the feeding of alfalfa forage that has been treated with glyphosate to livestock. EPA issued a new glyphosate tolerance for alfalfa seed of 0.5 ppm on February 16, 2005.[20]

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[17] 7 C.F.R. §340.6(c)(4).
[18] 7 U.S.C. §136 et seq.
[19] 21 U.S.C. §301 et seq.
[20] 40 C.F.R. §180.364; 70 Fed. Reg. 7861 (Feb. 16, 2005).

1.4.3 FDA regulatory authority

FDA, which has primary regulatory authority over food and feed safety, has published a policy statement in the Federal Register concerning regulation of products derived from new plant varieties, including those genetically engineered (FDA, 1992). Under this policy, FDA uses a consultation process to ensure that human food and animal feed safety issues or other regulatory issues (e.g. labeling) are resolved prior to commercial distribution of a bioengineered food. Monsanto/FGI submitted a food and feed safety and nutritional assessment summary for RRA to FDA in October 2003. FDA completed its consultation process in 2004 (Tarantino, 2004; Hendrickson and Price, 2004). FDA's analysis and related impacts are discussed in Section 3.10.

1.5 THE NATIONAL ORGANIC PROGRAM AND BIOTECHNOLOGY

Congress passed The Organic Foods Production Act (OFPA) of 1990 to avoid the confusion and misrepresentation then taking place in the "organic" marketplace.[21] The OFPA required the USDA to establish a National Organic Program (NOP) to develop uniform standards and a certification process for those producing and handling food products offered for sale as "organically produced."[22] The OFPA requires certification under the NOP, which was finalized in 2000, to be process-based.[23] "The certification process does not guarantee particular attributes of the end product; rather it specifies and audits the methods and procedures by which the product is produced" (Ronald and Fouche, 2006). The NOP defines certain "excluded methods" of breeding that cannot be used in organic production, describing them as "means that are not possible under natural conditions or processes."[24] Along with genetic engineering, three other modern breeding techniques are specified as "excluded methods" in the regulations.[25] Thus, a certified organic grower cannot intentionally plant seeds that were developed by these specific excluded methods. However, because "organic" is based on process and not product, the mere presence of plant materials produced through excluded methods in a crop will not jeopardize the integrity of products labeled as organic, as long as the grower follows the required organic production protocol. Also, other modern breeding methods -

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[21] 7 U.S.C. § 6501 et seq.
[22] 7 C.F.R. Part 205, announced at 65 Fed. Reg. 80548 (Dec. 21, 2000).
[23] 7 U.S.C. §6503(a).
[24] 7 C.F.R. §205.2.
[25] *Id*.

for example, induced radiation or chemical mutagenesis - are not specified as excluded methods by the NOP (discussed in Section 3.1.1).

All organic growers' production plans must be approved by an organic certifying agent before the farm can be certified as "organic."[26] Such plans must include, among other things, steps the organic grower is taking to avoid what the NOP refers to as "genetic drift" from any neighboring crops using excluded methods.[27] Certification must include on-site inspections of the farm to verify the procedures set forth in the organic production plan.[28]

Thus, the NOP recognizes the coexistence of organic growers with neighboring growers who may choose to grow products developed using certain methods of biotechnology. So long as an organic grower follows an approved organic method of production that seeks to avoid contact with these specific biotechnology-derived crops, if some residue of the biotechnology-derived plant material is later found in the organic crop (or food produced from it), neither the crop (or food) nor the organic farm is in danger of losing its organic status. According to the standards established by the NOP, no grower or seed producer should lose organic certification due to inadvertent transmission of genetic material from a genetically engineered crop.

In the context of the genetic drift discussion, in the preamble of the NOP regulations, USDA emphasized that it is the use of excluded methods as a production method that is prohibited, not the mere presence of a product of excluded method:

> It is particularly important to remember that organic standards are process based. Certifying agents attest to the ability of organic operations to follow a set of production standards and practices that meet the requirements of the Act and the regulations. This regulation prohibits the use of excluded methods in organic operations. The presence of a detectable residue of a product of excluded methods alone does not necessarily constitute a violation of this regulation. As long as an organic operation has not used excluded methods and takes reasonable steps to avoid contact with the products of excluded methods as detailed in their approved organic system plan, the unintentional presence of the products of excluded methods should not affect the status of an organic product or operation.[29]

The NOP calls for testing only if there is "reason to believe" that a grower has used excluded methods.[30] The preamble states that a "reason to believe" may be triggered by situations such

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[26] *See* 7 C.F.R. Part 205, Subpt. E.
[27] *See id*. at 205.201; 65 Fed. Reg. 80547, 80556 (Dec. 21, 2000) (discussing "genetic drift").
[28] 7 C.F.R. §205.403.
[29] 65 Fed. Reg. 80547, 80556 (Dec. 21, 2000).
[30] 7 C.F.R. §205.670(b).

as a formal, written complaint to the certifying agent regarding the practices of a certified organic operation; the proximity of a certified organic operation to a potential source of drift; or the product from a certified organic operation being unaffected when neighboring fields or crops are infested with pests.[31]

This testing provision does not establish a zero tolerance standard for the presence of products of excluded methods in organically labeled food. Rather, it serves as a warning that excluded methods may have been used: "Any detectable residues of. . . a product produced using excluded methods found in or on samples during analysis will serve as a warning indicator to the certifying agent."[32]

> [T]hese regulations do not establish a "zero tolerance" standard. . . [A] positive detection of a product of excluded methods would trigger an investigation by the certifying agent to determine if a violation of organic production or handling standards occurred. The presence of a detectable residue alone does not necessarily indicate use of a product of excluded methods that would constitute a violation of the standards."[33]

Only if the organic producer intentionally used excluded methods of crop production will that producer be subject to suspension or revocation of organic certification.

Indeed, since the time GE crops were introduced in the U.S. in the mid-1990s, organic markets have grown and expanded (Smith, 2010b, p. 10).

1.5.1 Non-GMO Project working standard

The Non-GMO[34] Project is a non-profit organization created by leading members of the organic industry to "offer consumers a consistent non-GMO choice for organic and natural products that are produced without genetic engineering or recombinant DNA technologies" (Non-GMO Project, 2010a). The Non-GMO Project has created a working standard to implement its goal. The standard sets action thresholds for "GMO" (GE) adventitious presence for certain products. If these action thresholds are exceeded, the participant must investigate the cause of the exceedance and take corrective action (Non-GMO Project, 2010, p. 13). The standard sets a threshold of 0.25 percent for GE material for the presence of GE traits in non-GE seeds (p. 28), and a 0.9 percent threshold for non-GE food or feed (p.14).

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[31] *See* 65 Fed. Reg. 80547, 80629 (Dec. 21, 2000).
[32] *Id*. at 80628.
[33] *Id*. at 80632.
[34] GMO stands for genetically modified organism.

1.5.2 Growth in organic and GE farming

Expansion of organic farming has succeeded at the same time as the growth of GE crops. Consumer demand for organically produced goods "has shown double-digit growth for well over a decade" and organic products "are now available in nearly 20,000 natural food stores and three of four conventional grocery stores." Organic products "have shifted from being a lifestyle choice for a small share of consumers to being consumed at least occasionally by a majority of Americans" (USDA Economic Research Service [ERS], 2009c).

1.6 COEXISTENCE IN U.S. AGRICULTURE

1.6.1 Coexistence and biotechnology

Coexistence of different varieties of sexually compatible crops has long been a part of agriculture, especially in seed production, where large investments are made in developing new varieties and high seed purity levels are required by the Federal Seed Act's implementing regulations.[35] The aspect of coexistence most relevant to this document is that related to specific methods of crop production. In this context, coexistence refers to the "concurrent cultivation of conventional, organic, and genetically engineered (GE) crops consistent with underlying consumer preferences and choices" (USDA Advisory Committee, 2008). The differences among these crops that are particularly relevant to coexistence in this ER are in the types of breeding methods (sometimes referred to as "genetic modifications") that are associated with each of these three types of crop production.

"**Genetic engineering**" is defined by APHIS regulations as "the genetic modification of organisms by recombinant DNA techniques."[36] Recombinant DNA (rDNA) techniques are discussed in Section 3.1.1 of this ER. While there are many ways to genetically modify a crop, the APHIS definition of GE crops applies only to those developed using rDNA techniques, which are among the more modern breeding methods.

Organic crops are those produced in accordance with the requirements of the NOP, discussed in Section 1.5.

Conventional crops are simply those that are neither GE nor organic. They may be commodity crops (mass produced), or they may be identity preserved, with some characteristic tailored for a specific end user. Identity-preserved usually refers to a "specialty, high-value, premium or niche market" (Massey, 2002). One type of identity preserved product that has

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[35] 7 C.F.R. § 201
[36] 7 C.F.R. §340.1

been produced since the introduction of GE crops is “non-GE”; however, there are no mandatory standards governing the use and/or marketing of “non-GE” products. (USDA Advisory Committee, 2008).

Farmers who want to maximize their profitability must decide whether the higher prices (premiums) they may receive for organic or identity-preserved crops are sufficient to offset the added managerial costs of producing these crops. As researchers have noted, “Although yields on organic farms are sometimes less than those of conventional systems, price premiums make it an attractive option for growers looking for specialized markets and a higher-value product” (Ronald and Fouche, 2006).

1.6.2 USDA position on coexistence and biotechnology

It is USDA’s position that all three methods of agricultural production described above can provide benefits to the environment, consumers, and the agricultural economy (Smith, 2010b).

1.6.3 Coexistence in U.S. agriculture

The USDA Advisory Committee on Biotechnology and 21st Century Agriculture who reported that “coexistence among the three categories of crops is a distinguishing characteristic of U.S. agriculture, and makes it different from some other parts of the world,” expressed its belief that U.S. agriculture supports coexistence, and recommended continued government support of coexistence (USDA Advisory Committee, 2008). Among the Committee’s findings:

- The U.S. is the largest producer of GE crops in the world.
- The U.S. is one of the largest producers of organic crops in the world.
- The U.S. is one of the largest exporters of conventionally-grown, identity preserved, non-GE crops in the world.
- Some U.S. farmers currently are producing a combination of organic, conventional, and GE crops on the same farm.

Among the coexistence-enabling factors the Committee identified is the existing “legal and regulatory framework that has enabled different markets to develop” without foreclosing the ability of “participants in the food and feed supply chain to establish standards and procedures (e.g., not setting specific mandatory adventitious presence (AP) thresholds and having process-based rather than product-based organic standards).” At the same time, development of practices and testing methods that allow for voluntary thresholds has also enabled coexistence (USDA Advisory Committee, 2008).

As APHIS has previously observed, “studies of coexistence of major GE and non-GE crops in North America and the European Union (E.U.) demonstrated that there has been no significant gene flow from GE crops and that GE and non-GE crops are coexisting with minimal adverse economic effects” (Smith, 2010b, pp. 11-12) (citing Gealy et al., 2007; Brookes and Barfoot, 2003; Brookes and Barfoot, 2004(a) and (b), and Walz 2004). In addition, “the agricultural markets and local entities have addressed coexistence through contractual arrangements, management measures, and marketing arrangements. This market-based approach to coexistence has created economic opportunities for all kinds of producers of agricultural products.” (*Id.* p. 9). RRA is one of fifteen GT events previously deregulated by USDA. See APHIS, EPA, Petitions of Non-Regulated Status Granted or Pending by APHIS as of February 2, 2010, http://www.aphis.usda.gov/brs/not_reg.html).

1.7 ROLE OF THE NATIONAL ACADEMIES IN AGRICULTURAL BIOTECHNOLOGY

The analyses in this ER are based on published, peer-reviewed scientific papers; federal government assessments; assessments from international agencies; information from specialists from many universities; data collected by Monsanto/FGI under controlled conditions; and information from other relevant sources. One resource used for this ER is the National Academies (NA), a private, non-profit institution that advises the nation on scientific and technical matters. It consists of the National Academy of Sciences (NAS), the National Academy of Engineering, the Institute of Medicine (IM) and the National Research Council (NRC) (NA, 2010). Scientists, engineers and health professionals are elected by their peers to the academy and serve *pro bono*. Reports are prepared by committees of members with specialized expertise and reviewed by outside anonymous experts (Alberts, 1999). NA reports, as well as the scientific studies used in those reports, are used as applicable throughout this document.

The NA has been active in studies related to agricultural biotechnology since the 1970s and works cooperatively with federal agencies, and its reports have provided guidance and recommendations for process improvement to regulatory agencies (Alberts, 1999). The NRC 1989 guidelines for field testing of genetically engineered organisms were used as the basis for agency procedures for field trials (Alberts, 1999; NRC, 1989). In studies in 1987 and 2000 the NRC emphasized that the characteristics of the modified organism should be the object of a risk assessment, and not the methods by which the modifications were accomplished; and that the risks associated with recombinant DNA techniques are the same in kind as risks from other types of genetic modification (NRC, 1987; NRC, 2000). This position was re-iterated in a 2004 study prepared jointly by the IM and the NRC. Whether such compositional changes result in unintended health effects is dependent on the nature of the substances altered and the biological consequences of the compounds. To date, “no adverse health effects attributed to genetic engineering have been documented in the human population” (Institute of Medicine and National Research Council [IM/NRC], 2004, p. 8). In a 2002 report, the NRC “found that the current standards used by the federal government to assure environmental safety of transgenic plants were higher than the standards used in assuring safety of other agricultural practices and technologies” (NRC, 2002). The NRC reports that, while biotechnology is not without risk, since the first commercial introduction of transgenic plants, “biotechnology has provided enormous benefits to agricultural crop production” (NRC, 2008). NRC’s latest report on biotechnology in agriculture evaluates the impact of genetically engineered crops on farm sustainability (NRC, 2010). The authors concluded that an understanding of impacts on all farmers will help ensure that GE technology contributes to sustainability and that commercialized GE traits to date, when used properly, “have been effective at reducing pest problems with economic and environmental benefit to farmers” (NRC, 2010).

1.8 ALTERNATIVES

In addition to the alternative of implementing the partial deregulation measures (Alternative 2), this ER considers the alternative of full regulation (Alternative 1).

1.8.1 Alternative 1 – No Action

In conducting NEPA review, agencies consider a no action alternative, which provides a baseline against which action alternatives can be evaluated. This ER identifies the no action alternative as a return to full regulation – or the *status quo* when the petition for deregulation of RRA was initially submitted. Under this alternative, the introduction of RRA would be fully regulated and would require permits issued or notifications acknowledged by APHIS until APHIS completes its EIS and issues a Record of Decision (ROD) regarding whether to deregulate RRA. For purposes of this analysis, we assume that Alternative 1 would not involve widespread RRA cultivation, and instead would contemplate a return to conventional alfalfa crops or to crops other than alfalfa.[37]

[37] This ER does not address the acres of RRA planted prior to March 30, 2007, and cultivated pursuant to conditions required by the district court and implemented by APHIS by administrative order. These acres are reaching the end of their productive lives and will be removed within the next few years under either Alternative. Because their acreage and expected lifespan is so small, and because their impacts would be identical under either Alternative, the analysis of these limited impacts would not be meaningful within the scope of this ER.

1.8.2 Alternative 2 – Partial Deregulation

Under this alternative APHIS would implement the proposed measures described in Section 1.1.3.

SECTION 2.0 AFFECTED ENVIRONMENT

2.1 ALFALFA CHARACTERISTICS

Alfalfa (*Medicago sativa* L.) is a deep-rooted and short-lived perennial plant considered to be the "Queen of Forages" due to its high nutritional content for cattle, sheep and horses (USDA APHIS, 2009, p. 18).

2.1.1 Growth

Alfalfa is recognized as a widely adapted crop, growing in all continental States, as well as Alaska and Hawaii. Alfalfa initially grows from seed, but after each harvest or winter it will re-grow from buds arising from the perennial crown/root structure. As alfalfa grows, yield (i.e. above ground biomass) increases until alfalfa yield peaks at full bloom. However, juvenile vegetative alfalfa vegetative alfalfa plants have the highest nutritional value and that nutritional value decreases as the plant approaches full flower. The vegetative growth interval during most of the year is 22 to 40 days. The crop is typically harvested for forage three to eight times per year, depending on location and seasonal climate. The alfalfa plant grows until stopped by a hard freeze. Fields grown for forage production are typically maintained for 3 to 6 years or longer in some areas (USDA APHIS, 2009, p. 18-19).

2.1.2 Pollination

Alfalfa is predominantly cross-pollinated and the flowers depend entirely on bees for cross-pollination. Alfalfa requires bees to physically "trip" flowers to release pollen for egg fertilization and seed production (refer to Section 2.2.3) (USDA APHIS, 2009, p. 19).

Alfalfa is exclusively insect pollinated (Mallory-Smith and Zapiola, 2008). The flowers depend on bees for cross-pollination. Alfalfa seed farmers must stock bees to ensure pollination because most regions that cultivate alfalfa seed do not have naturally occurring populations of effective alfalfa pollinators. Forage farmers do not stock bees, however, because they do not want or need pollination of their fields (USDA APHIS, 2009, p. 94; Rogan and Fitzpatrick, 2004). Leafcutter bees (Megachile rotundata F.) are typically used to pollinate alfalfa seed production fields in the cooler Pacific Northwest (PNW), and honey bees (Apis mellifera) are primarily used in the Desert Southwest. However, a few growers in niche regions like southern Washington use alkali bees (Nomia melanderi) due to their unique geography and climate (USDA APHIS, 2009, p. 19). Alfalfa pollen is not carried by the wind; it is not wind-pollinated. Severe environmental conditions such as, heavy winds in combination with drought, may sometimes cause flowers to trip and self-pollinate. Although rare, self-pollinated seeds have inferior vigor and germination due to genetic inbreeding depression in alfalfa (Teuber, 2007).

Pollen-mediated gene flow decreases exponentially as the distance from the pollen source increases (Mallory-Smith and Zapiola, 2008). However, the type of pollinator determines the extent. All bees have a limited range over which they will search to efficiently collect pollen; most nectar or pollen foraging occurs close to the nest when flowers are present. The maximum foraging radius for each of the three commercially available bee species (honey bees, leafcutter bees, and alkali bees) depends heavily on the abundance of nectar and pollen resources. Leafcutter bees have the shortest routine foraging radius of less than a 1/4 mile. The honey bee and alkali bee having a forging range of 1 to 3 miles (Arnett, 2003; Gathmann and Tscharntke, 2002; Hammon et al., 2006; Teuber et al., 2005). Honey bees may infrequently transport alfalfa pollen and effect pollination up to 3 miles from the source (St. Amand et al., 2000; Teuber et al., 2004; Hammon et al. 2006). Honey bees are predominantly nectar collectors and as such they tend to avoid the tiny alfalfa flowers when other sources of nectar flowers are available. When visiting alfalfa flowers, honey bees are known as inefficient pollinators because they predominantly “side-feed” solely for nectar, i.e., they leave the flower closed (un-tripped) and un-pollinated. Feral honey bees and native bees including *Bombus* spp., *Osmia* spp., *Agapostomen* spp. and *Megachile* spp. can also be found visiting alfalfa flowers in varying numbers. These species may sometimes pollinate alfalfa flowers but their importance in alfalfa pollination is minor (USDA APHIS, 2009, p. O-5; Hammon et al., 2006; Arnett, 2002).

2.2 ALFALFA PRODUCTION

2.2.1 Forage production, general

Alfalfa is among the most important forage crops in the U.S., with more than 21 million acres in cultivation. Recognized as the oldest plant grown solely for forage, alfalfa has been used as livestock feed because of its high protein and low fiber content. Alfalfa is ranked fourth on the list of most widely grown U.S. crops by acreage and is ranked third among agricultural crops in terms of value (USDA APHIS, 2009, p. 17). The harvested acreage of alfalfa harvested for forage (dry hay) was approximately 21 million acres in 2009, which generated 71 million tons of hay at an average yield of 3.35 tons per acre (USDA ERS, 2010a and 2010b). Over the last 60 years (since 1951), harvested alfalfa hay acreage in the U.S. has ranged between 20.7 acres (2010) and 29.8 million (1957) (USDA ERS, 2010a). From 1951 to 2009 (latest year available), total U.S. production (dry) has ranged between 46.8 million tons (1951) and 91.9 million tons

(1986) (USDA ERS, 2010b). Since 1950, yields generally increased until about the mid-1980s; since then yields in most years have been around 3.3 tons per acre. The total acreage of harvested alfalfa has generally been declining since the mid-1980s, with 2010 the lowest year since 1950 (USDA ERS, 2010a). The production decreases are due to alfalfa's use in crop rotation declining in the U.S., and the increased use of corn silage as a source of forage in dairy diets coupled with the decline in dairy (milk) prices paid to farmers. Alfalfa requires different management, equipment, and labor schedules than other major cropping systems such as corn and soybeans. Transportation of bulky alfalfa hay or haylage to distant markets may be prohibitively expensive (USDA APHIS, 2009, p. 34). In the 2009/2010 season (May 2009 to April 2010), the average price farmers received for alfalfa hay was $115/ton, compared to $101/ton for other hay (USDA ERS, 2010c).

Alfalfa is grown for forage in almost every U.S. state. U.S. production of hay/haylage and seed harvested for the 2006 season is shown in Table 2-1. Haylage is alfalfa that is chopped at higher moisture content than hay, and stored in silos, bunkers or plastic bags to enable controlled fermentation to preserve the nutritional content. The major U.S. alfalfa producing regions include the Southwest, PNW, Inter-Mountain, Plains, North Central, and East-Central. The North-Central and the East-Central regions are the highest acreage hay and haylage regions in the U.S.; whereas, the Southwest and PNW regions produce the most seed in the U.S. (USDA NASS, 2010b).

Table 2-1 Alfalfa Forage and Seed Production by State
2006 National Agricultural Statistics Service Date

	State	Acres by State (1000s)		Hay and Haylage Harvested				
		Dry Hay 2006	Hay and Haylage 2006	Average Yield T/A	Forage Tons Harvested	Seed Production Acres	Average Yield (lbs/A)	Seed Lbs Harvested
Southwest	AZ	250	250	8.3	2,075	4	500	2,000,000
	CA	1,050	1,070	6.9	7,426	38	550	20,900,000
	NM	220	234	51	1,184	2	400	800,000
	Total	**1,520**	**1,554**		**10,685**	**44**		**23,700,000**
PNW	ID	1,180	1,230	4.5	5,523	28	700	19,600,000
	NV	270	270	5.1	1,377	5	600	3,000,000
	OR	430	430	4.4	1,892	5	650	3,250,000
	WA	440	455	4.9	2,239	15	750	11,250,000
	Total	**2,320**	**2,385**		**11,031**	**53**		**37,100,000**
Inter-Mountain	CO	780	780	3.8	2,964	0.6	200	390,000
	MT	1,550	1,550	2.1	3,255	5.5	200	3,025,000
	UT	560	560	4	2,240	2.2	200	1,320,000
	WY	500	500	2.8	1,400	7.5	400	4,125,000
	Total	**3,390**	**3,390**		**9,859**	**15.8**		**8,860,000**
Plains	KS	950	965	3.8	3,677	0.5	200	100,000
	NE	1,250	1,265	3.3	4,212	0.4	200	80,000
	OK	380	380	2.1	798	0.4	200	80,000
	TX	150	160	4.4	707	1	400	400,00
	Total	**2,730**	**2,770**		**9,394**	**2.3**		**660,000**
North Central	IA	1,180	1,230	4	4,908	0	0	0
	MN	1,350	1,500	3.6	5,460	0	0	0
	ND	1,450	1,450	1.2	1,740	0	0	0
	WI	1,650	2,400	3.9	9,336	0	0	0
	SD	1,800	1,820	1.6	2,930	7	250	1,750,000
	Total	**7,430**	**8,400**		**24,374**	**7**		**1,750,000**
East Central	CT	7	7	2.1	15	0	0	0
	DE	5	5	3.9	20	0	0	0
	IL	440	460	4.2	1,918	0	0	0
	IN	360	360	4.1	1,476	0	0	0
	ME	10	10	1.9	19	0	0	0
	MD	40	40	3.9	156	0	0	0
	MA	13	13	2.3	30	0	0	0
	MI	830	980	4	3.940	0	0	0
	MO	390	400	3	1,184	0	0	0
	NH	8	8	2.4	19	0	0	0
	NJ	25	25	2.5	63	0	0	0
	NY	370	610	3.3	2,019	0	0	0
	OH	470	550	4	2,195	0	0	0
	PA	500	660	3.8	2,515	0	0	0
	RI	1	1	3	3	0	0	0
	VT	45	90	3.6	322	0	0	0
	Total	**3,514**	**4,219**		**12,894**	**0**		**0**

Source: *USDA* APHIS, *2009, Table 3-20*

Cultural practices

Seeding and planting. The objectives of seedbed preparation are to manage crop residue (the leftover vegetative matter from the previous crop), minimize erosion, improve soil structure, and eliminate early season weeds. Alfalfa requires a good establishment for a long-lived productive stand. Results from seed failure include poor seedbed preparation, seeding too deep or too shallow, low moisture availability, freezing, diseases, insects, damage from herbicides, and excess competition for light and nutrients from a companion crop or from weeds. Slight differences in seeding may be in the equipment used, such as, drills, broadcasting, or aerial broadcasting. Seeding time during the year varies from region to region. Northern areas will generally seed in spring to avoid major freezing damage of young seedling plants whereas all other areas will seed in the fall. Recommended seeding times are based on the previous crop, soil water availability throughout the year, and the time of year. The recommended soil preparations are similar in all regions unless no-till planting is used and no-till planting can be used in all regions (USDA APHIS, 2009, p. 84). No-till productions systems do not have any associated tillage where weed control is entirely through chemical means.

Fertilizing. The only differences in fertilizing among alfalfa growers occur in the composition of the fertilizer used because of the different soil types in different regions. All regions generally recommend good availability of phosphorus and potassium. Nitrogen fertilizer is generally not recommended unless considerable refuse from the previous crop exists (USDA APHIS, 2009, p. 84).

Harvesting. Alfalfa grown for forage can be used for grazing or harvested as greenchop, haylage/silage or hay. The only major difference for harvesting in different regions is the total number of harvests per year. The northern regions typically have up to two or three harvests per year due to shorter growing seasons. Southern regions can have six or more harvests per year. The major differences are in the adaptation of different varieties to the different climates of the U.S. and differing levels of various pests (weeds, disease, and insects) (USDA APHIS, 2009, p. 84).

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Crop rotations. Crop rotations can help maintain soil fertility, reduce soil erosion, avoid pathogen and pest buildup, adapt to weather changes, avoid allelopathic effects (effects to reduce the growth of one plant due to chemical releases by another) and increase profits.

Weeds can be a problem in alfalfa, but once alfalfa is established, it acts as a suppressor of weeds and is commonly used in rotations for weed reduction. Alfalfa is also used in crop rotations because it provides nitrogen to the soil, which decreases fertilizer inputs in other rotations. Rotating perennials, such as alfalfa, with annuals also helps control weeds and improves soil tilth. Using other crops to rotate with alfalfa is likewise advisable because mature alfalfa is autotoxic to seedling alfalfa. (USDA APHIS, 2009, p. 73 and 75).

2.2.2 Organic alfalfa hay production

Between 2000 and 2005, the number of acres in certified organic alfalfa hay production fluctuated slightly, but overall showed an increasing trend. The percentage of total alfalfa hay acres certified as organic per year was between 0.51 to 0.92 percent nationally during this time period (see Table 2-2). During 2005 (the most recent year for which certified organic alfalfa acres are reported), there were 204,380 acres in certified organic production, which was approximately 0.92 percent of the U.S. alfalfa dry hay total (USDA APHIS, 2009, p. 48).

Table 2-2 Organic Alfalfa Hay Harvested Acreage.

Acreage	2000	2001	2002	2003	2004	2005
Total	113,157	116,608	155,437	135,717	175,260	204,380
Share of Total U.S. Acreage	0.51%	0.49%	0.67%	0.58%	0.81%	0.92%

Source: USDA-ERS, 2005; USDA-NASS, 2007; USDA APHIS, 2009, p. 48

Organic alfalfa hay production is similarly distributed geographically to conventional hay. However, production of organic alfalfa hay is a more significant proportion of total alfalfa hay production in some States. In 2005, for example, more than 4 percent of all alfalfa hay acreage in Idaho was organic, compared to just 0.92 percent nationally. Organic alfalfa, like organic dairy, also seems to occur in pockets, with 72 percent of organic acreage located in just 6 States—Idaho, Wisconsin, Minnesota, North Dakota, South Dakota, and California. These 6 States account for about 41 percent of total U.S. alfalfa acreage (USDA APHIS, 2009, p. 48).

The increased price per ton of hay received by organic growers is partially offset by a reduction in forage quality (due to increased weeds in the hay) and an approximately 12.5 percent reduction of alfalfa yield per acre (Long et al., 2007). The 2005 national average yield per acre for all alfalfa hay production was 3.39 tons. Based on differences in organic and conventional alfalfa yield from Long et al. (2007), the total estimated U.S. organic hay production in 2005 was about 606,242 tons; the total U.S. production of alfalfa hay in 2005 was approximately 76,149,000 tons. The resulting eaverage organic alfalfa yield per acre, in 2005, was 2.97 tons. This estimate is approximate, however, and is only presented here for illustrative purposes (USDA APHIS, 2009, p. 48).

2.2.3 Seed production

Maintaining seed purity, identity and quality

The Federal Seed Act and its implementing regulations[38] establish basic standards for certification of seed, which are carried out by state seed certifying agencies. A state seed certifying agency is created by state law, has authority to certify seed, and has standards and procedures approved by USDA "to assure the genetic purity and identity of the seed certified." Seed certifying agencies' standards and procedures must meet or exceed those specified in the

[38] 7 C.F.R. §201.

USDA regulations.[39] Federal law also allows for international seed certification. Through the certification process, the certifying agency "gives official recognition to seeds produced of a cultivar or named variety under a limited generation system which ensures genetic purity, identity, and a given minimum level of quality" (USDA, 2009a). In the case of alfalfa, State Crop Improvement Associations (or sometimes Seed Grower Associations) provide certifications that seed production followed minimum standards, such as isolation between different alfalfa varieties, absence of prohibited noxious weeds in the field, inspection of conditioning (separation) facilities, maintaining traceability of seed lots, and seed testing (USDA APHIS, 2009).

The most common levels of certification that would normally be available for consumer purchase would be "registered seed" or "certified seed." Breeder seed is controlled by the seed developer and is the source for the production of the other classes of certified seed, and foundation seed is normally used to establish new production fields (USDA, 2009a and 7 C.F.R. § 201.2). Standards are highest for Breeder/Foundation seed, next highest for Registered; while "Certified" has the least stringent requirements of the certified categories. In all cases, the party seeking the certification is responsible for ensuring the requirements are met.

Certified seed must have a label indicating, among other things, the percent of pure seed, inert matter, other crop, and weed seed. Seed purity standards vary between states but remain high, particularly for foundation seed stock. At least 99 percent of each seed harvest must contain the pure seed variety (i.e. < 1 percent genetic off-types), and there are strict limits on the allowable amounts of other crops, weeds and inert matter. After seed crops have been evaluated by seed labs, they are tagged with seed labels in accordance with law. The Association of Official Seed Certifying Agencies (AOSCA) requires that a representative sample from each submitted crop undergo multiple tests at a seed lab. All types of seed crops must be accurately labeled. The Foundation and Certified seeds are identified by a special tag that includes variety, kind, origin, net weight, percent pure seed, percent other materials, amount of noxious seed and weeds, and identification of the seed lab performing the analysis (USDA APHIS, 2009).

California, the leading producer of alfalfa seed, provides an example of typical rules for field eligibility (past use and spatial isolation) and seed purity standards. These rules are followed by most states. For cultivating Foundation seed (seed of the highest purity), alfalfa must not have grown on the land in the previous four years. For Certified seed, alfalfa must not have been grown on the land in the previous one to two years. These past use requirements may vary

[39] 7 U.S.C. §1551(a)(25); 7 C.F.R. §201.67.

depending on the intervening crops. The boundaries of the field must be clearly set and all noxious weeds and volunteer plants must be eradicated before planting. Foundation seed fields must be isolated from alfalfa of different varieties by 900 feet (ft). Certified fields must be isolated by 165 ft However, a “10 percent rule” provides some flexibility for Certified fields. Under this rule, if 10 percent or less of the Certified field is in the 165 foot isolation zone, then the entire field is considered Certified. However, if more than 10 percent is in the isolation zone, then that part of the field must be separated and not harvested as Certified seed (USDA APHIS, 2009).

Summary of practices for alfalfa seed production

Unlike alfalfa hay production, alfalfa seed production is largely concentrated both geographically and in the number of producers. Seed production occurs primarily in niche areas of the western U.S. on approximately 100 to 120 thousand acres under intensive management and irrigated field conditions (see Figure 1-1). It requires a long growing season with a very warm temperature, very low humidity during seed ripening, and specialized equipment. Most professional seed producers use cultured bees and specialized equipment associated with bee culture (USDA APHIS, 2009, p. 68).

Based on the 2007 Census of Agriculture, the top three seed producing states, accounting for over 60 percent of production, were California with 31 percent of produced seed, Washington with 17 percent, and Idaho with 15 percent. The remaining seed production was highly concentrated in the western states of Nevada, Oregon, Wyoming, Montana, and Utah (USDA APHIS, 2009).

As shown in Table 3-9 of the draft EIS (included as Figure 1-1 of this ER), within the seed producing states seed production is localized to certain counties. In the most recent USDA-NASS Census of Agriculture (2007), during 2002 and 2007, 1,234 and 806 farmers grew alfalfa seed on 110.6 and 120 thousand acres, respectively. This is a small number of growers in comparison to those growing alfalfa for forage (i.e., 344,000 and 290,000 alfalfa hay growers in 2002 and 2007, respectively). During 2007, 90 percent of the U.S. seed crop tonnage was grown by 304 seed growers operating farms with at least 100 acres of alfalfa seed (USDA-NASS, 2009). Therefore, most of the alfalfa seed production is managed by a relatively small number of large professional seed producers. Nearly all large growers have at least one proprietary seed production contract with one of the four national alfalfa seed production companies (USDA APHIS, 2009, p. 68-69).

Cultural practices used to produce seed are distinct from those used to produce forage. Professional seed growers usually grow seed under terms of a two or three year term seed company contract, by variety name. The contracting seed company supplies the stock seed (e.g., foundation seed) to the seed producer and the genetic source variety of the seed is documented. In contrast, seed companies purchasing or growing “common seed” or “catch crop” seed typically use lower management and inputs, the genetic identity of the stock seed is often unspecified/unknown and the resultant product quality is highly variable and cannot be certified as to cultivar or variety identity (USDA APHIS, 2009, p. 69).

Typically, seed fields are planted in the fall and clipped back in late spring so that bloom within the field is uniform, synchronous and optimally timed for the warm dry season and optimal pollinator activity. Weed and in-crop volunteer controls (herbicides and cultivation) are applied mainly prior to the start of pollination or after seed harvest. Flowering begins in approximately mid-June. Insecticides (primarily for *Lygus* control) and other pesticides are applied prior to bee release to avoid insecticide damage to the bees. At approximately 50 percent flower (early to mid-July), cultured bees are gradually moved into the seed field for pollination with their domicile or hive for local shelter. The field is actively pollinated for approximately one month, allowed to ripen seed for approximately 4 weeks more, and then, chemically desiccated or swathed several days prior to combining the seed. At the end of the pollination period and just prior to desiccation, the pollinating generation of bees is either at the end of their lifecycle (i.e., leafcutter or alkali bees), or are transported by the honeybee keeper to a different location to forage on fall-flowering plant species. Seed is harvested in mid August to late September depending on geography. In long-growing season regions, the cool-season alfalfa forage growth between seed crops is sometimes mechanically harvested or grazed (USDA APHIS, 2009, p. 69).

Stands of alfalfa grown for seed production only are usually maintained for an average of three production seasons. The length of the seed stand is generally predetermined by the seed production contracts and AOSCA variety certification standards. In contrast to forage stands, most alfalfa seed planted for seed production purposes is planted at a low density in widely spaced rows and not cut monthly. Consequently, weeds in the seed fields have more open area and time to proliferate and compete with the alfalfa. Therefore, weeds, insects, and pests are intensively managed in seed production systems. Weed seeds and weed debris in grower seed lots directly reduce the purity and yield of alfalfa seed and drive up growers’ costs to remove them (USDA APHIS, 2009, p. 69-70).

RRA seed production since 2005

In 2006-2007, RRA seed was produced in the U.S. on a widespread basis for the first time since deregulation in 2005. This presented an opportunity for FGI to implement an internal seed quality program to monitor the efficacy of the FGI Best Practices for RR Stewardship during Seed Production ("FGI Best Practices"). Conventional alfalfa seed lots grown and/or processed in proximity to RR seed in 2006 and 2007 were tested for the adventitious presence (AP) of the RR trait. The data showed that the AP of the RR trait in FGI conventional seed lots occurred infrequently and, in all cases if detected, was at a very low level—0.004 to 0.180 percent. This was well within the FGI's goal of <0.5 percent AP. This large-scale commercial validation of FGI Best Practices supports research-based isolation standards and demonstrates the effective implementation of quality control programs at both the grower and processor level. FGI believes that this, and more recent industry reviews together demonstrate that reasonable tools are available and are being used by seed producers to allow successful coexistence of diverse alfalfa seed market sectors and preserve conventional seed and hay market choices (USDA APHIS, 2009). In late 2007, following the Court's Decision, the FGI Best Practices were extensively reviewed by the Steering Committee of the National Alfalfa & Forage Alliance Peaceful Coexistence Workshop (October 10, 2007). The steering committee was composed of a broad array of alfalfa industry stakeholders. In January, 2008, NAFA's Board of Directors and all genetic suppliers of NAFA adopted the NAFA BMP (Appendix C) as requirements for RRA seed producers. A third-party panel of State Seed Certification Agencies has reviewed 2008 and 2009 conventional alfalfa seed crop year data and has stated that the NAFA BMP appear to be working to achieve coexistence, i.e., conventional and RRA varieties have been produced successfully during the period following widespread cultivation of RRA.

All alfalfa seed production since 2005

The latest information of total alfalfa seed production is from the 2007 Census of Agriculture, when 121,467 acres of alfalfa seed were harvested producing approximately 62 million pounds of seeds at an average productivity of approximately 510 lbs/acre.

Alfalfa seed acreage and production increased between 2002 and 2007, reversing the trend of decreases in alfalfa seed production over the preceding few years. Economic, social and competitive challenges face both U.S. alfalfa seed and forage growers. These challenges include: changes in global seed demand and production, economics, environmental constraints, regulatory issues, and insect control and weeds. The presence of weeds can have a greater impact on costs in alfalfa seed production than alfalfa forage production. Post-harvest separation of weed seed from the alfalfa seed is costly; therefore, the control of weeds in the field is a more desirable method of seed quality control. No primary or secondary noxious weeds are allowed for certified seed (USDA APHIS, 2009, p. 43-44).

Seed availability

All four of the major U.S. seed genetic suppliers and seed production companies (FGI, Pioneer Hi-Bred, Dairyland Seeds and Cal/West Seeds) sell conventional and/or organic seed products. Prior to the federal court injunction, these varieties were sold alongside of one or more RRA varieties. RRA was sold by more than 20 seed brands all of which continued to offer conventional cultivar products (USDA APHIS, 2009).

During the 2005-2007 period of deregulation of RRA, approximately 200,000 and 18,000 acres of RRA hay and seed, respectively, were grown with no substantiated disruption of the market for conventional alfalfa hay or seed (USDAS APHIS, 2009; McCaslin, 2007).

Organically certified and conventionally grown seed lots are routinely marketed to U.S. organic forage producers for the establishment of organic alfalfa forage fields. Although a small amount of organic alfalfa seeds used in the U.S. are purchased from U.S. seed distributors, little or none of the organic alfalfa seeds appear to have been originally grown in the U.S. (McCaslin, 2007). There is little information available to indicate if there are any certified organic alfalfa seed producers in the U.S. (USDA APHIS, 2009). Organic alfalfa seed sold in the U.S. by U.S. seed companies is therefore most likely to have been wholly or largely imported from organic producers in Canada or elsewhere, where insect pests in alfalfa seed production are less catastrophic and base production costs for seed are much lower (McCaslin, 2007).

2.3 GENE FLOW

This section provides background information on gene flow, which is relevant to the impacts analysis provided in Section 3 of this ER.

Gene flow has been defined as the “incorporation of genes into the gene pool of one population from one or more populations” (Futuyma, 1998). Gene flow is a basic biological process in plant evolution and in plant breeding, and in itself does not pose a risk (Bartsch et al., 2003; Ellstrand, 2006, p. 116).

There are several factors that influence the probability of gene flow between alfalfa fields. The following is a list of factors adapted from Putnam, 2006 (USDA APHIS, 2009, p. 100):

- Probability of synchronous flowering (e.g., the percentage of days where several plants flower simultaneously);
- Relative availability and abundance of pollen from various sources (e.g., the percentage of bloom during each day of synchronous flowering);
- Presence of pollinators and pollinator types
- Pollinator activity on days of synchronous flowering and placement of bee hives (e.g., influenced by timed bee release and weather);
- Distance between fields (alfalfa populations);
- Probability of seed maturation; and
- Probability of seed germination.

2.3.1 Hybridization

In plant biology, when gene flow occurs between individuals from genetically distinct populations and a new plant is formed, the new plant is called a hybrid (Ellstrand, 2003, p. 10). Hybridization is usually thought of as the breeding of closely related species or subspecies resulting in the creation of a plant that has characteristics different from either parent. Usually this occurs through deliberate human efforts; however, it can also occur indirectly from human intervention, or in nature. For example, when plants are moved to a new environment (with or without human intervention), they may hybridize with plants of a closely related species or subspecies in that new location.

For natural hybridization to occur between two distinct populations, the plants from the two populations must flower at the same time, they must be close enough so that the pollen can be carried from the male parent to the female parent, fertilization must occur, and the resulting embryo must be able to develop into a viable seed that can germinate and form a new plant (Ellstrand, 2003, pp. 11-13).

Characteristics that favor natural hybridization between two populations when the above requirements are met include (Mallory-Smith and Zapiola, 2008, p. 429):

- Presence of feral populations (domestic populations gone wild) and uncontrolled volunteers
- Presence of a high number of highly compatible relatives
- Self-incompatibility

- Large pollen source
- Large amounts of pollen produced
- Lightweight pollen
- Large insect populations (insect pollinated)
- Long pollen viability

Feral populations are discussed in Section 2.6. **Volunteers** are plants from a previous crop that are found in a later crop and are also discussed in Section 2.6.

There are **no sexually compatible** wild relatives of alfalfa present in the U.S. (Mallory-Smith and Zapiola, 2008; Van Deynze et al., 2008, p. 7). Therefore, movement of the CP4 EPSPS gene found in RRA varieties can only occur within or among cultivated or feral alfalfa populations (USDA APHIS, 2009, p. 94).

Alfalfa (*Medicago sativa* L.) is predominantly **self-incompatible**; that is, fertilization does not occur between the male and female parts on the same plant. Self-incompatible plants must be cross-pollinated (also known as "out-crossed") to form viable seed: that is, for fertilization to occur, the female part of the flower (the stigma) must successfully receive pollen from the male part of a second plant (the anther). The majority of cross-pollination in alfalfa is effected by bees visiting plants growing in very close proximity (i.e., within four meters) (St. Amand et al., 2000).

As discussed in Section 2.1.2, alfalfa is exclusively **insect-pollinated**, and, in seed production areas, farmers must stock bees to ensure economic levels of seed production.

Gene flow via seed mixtures

Nearly all alfalfa forage producers purchase seeds for planting, largely because grower-produced grower-saved-seed is only possible in the niche seed-growing geographies. Commercially produced seed is generally produced under a contract from a seed company: the foundation stock seed is provided to the contract grower by the seed company and seed lots are harvested, transported and conditioned by variety name and lot code. Such contracts and the typical use of official seed certification schemes maintain field and seed lot segregation, identity and varietal purity. Seed certification standards set limits on the percentage of other variety off-types that are allowed. Therefore, seed growers and seed producers are aware of the importance of routine cleaning of field equipment, seed transportation containers and seed processing equipment as means to mitigate off-types and weed seed presence to very low levels. Regardless of stringent management, commercial agricultural seeds are not and cannot be 100 percent pure. Therefore, it is widely recognized that some seed admixtures may still inadvertently occur, and that, in all but exceptional cases they are likely to pose no safety, economic or regulatory issues.

2.3.2 Seed-to-seed gene flow studies

FGI performed gene flow studies in Idaho from 2000 to 2002 using leafcutter bees for pollination, however, the presence of feral and native bees were also noted. These studies showed a mean gene flow of 1.39 percent at 500 ft and 0.0000 percent at ¾ of a mile (Fitzpatrick et al., 2002). Table 2-3 and Figure 2-1 below summarize the findings of these field studies.

Table 2-3. Summary of FGI Idaho Gene Flow Studies (Fitzpatrick et al., 2002)

Isolation distance	Year 2000	Year 2001 [a]	Year 2002 [a, b]	2000-2002 Overall Mean Observed gene flow (99.9% C.I. upper bound)
0 ft (Source Plot)	*Source* (1.0 A)	*Source* (1.6 A)	*Source* (1 A)	
500 ft	Reps 1-4: 0.03 A, N. [c]	-	-	**1.39%** (1.72%)
900 ft	-	Rep 1: 0.7 A, N. Rep 2: 1.6 A, N.E.	-	**0.28%** (0.34%)
1000 ft	Reps 1-4: 0.03 A, N. [c]	-	-	**0.32%** (0.45%)
1500 ft	Reps 1-4: 0.03 A, N. [c]	Rep 1: 1.6 A, W. Rep 2: 1.6 A, N.W.	Rep 1: 1 A, S.W. Rep 2: 1 A, S.E.	**0.08%** (0.13%)
2000 ft	Rep 1: 2.0 A, N.W. [a]	-	-	**0.00%** (0.05%)
2640 ft (1/2 mi)	-	-	Rep 1: 1 A, S.W. Rep 2: 1 A., S.E.	**0.003%** (0.02%)
3960 ft (3/4 mi)	-	-	Rep 1: 1 A, S.W. Rep 2: 1 A, S.E.	**0.0000%** (0.01%)
5280 ft (1 mi)	-	-	Rep 1: 1 A, N.W. Rep 2: 1 A, S.E.	**0.0000%** (0.01%)
Mean no. seed tested per trap distance	14,750	41,250	60,000	

Notes: Isolation distance between trap and source, number of replicates per distance, replicate plot size (acres), trap plot cardinal direction from source and, interplot land cover a,b,c, the mean observed gene flow and the upper bound of true gene flow (i.e., the 99.9 percent confidence interval upper limit) are given. Interplot land cover:a various crop species typical for the area (e.g., onions, corn, wheat, etc.); b roadways, or c fallow. "-" indicates distance not tested.

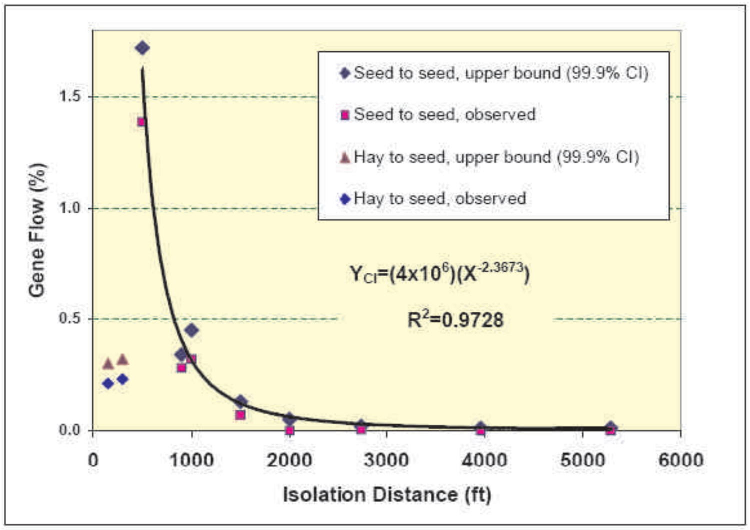

Figure 2-1 – Gene Flow

UC—Davis, Monsanto/FGI performed a gene flow study during the 2003 growing season using honey bees. The pollen-mediated gene flow at isolation distances of 900 ft, 5,000 ft, and 2.53 miles were 1.49 percent, 0.2 percent, and ≤0.06 percent, respectively (Teuber et al., 2007).

A mixed honey bee and leafcutter bee gene flow study was performed in the San Joaquin Valley of California in 2006 and 2007 (Teuber et al., 2007; Van Deynze et al., 2008). Summary data from those studies are presented in the Table 2-4 below.

Table 2-4 Seed to Seed Gene Flow (Teuber et al., 2007)

Distance	Gene Flow (% adventitious presence)
165 ft.	2.3
900 ft.	0.9
4,000 ft.	0.6
1 mile	0.2
3 miles	0.03
5 miles	Not detected

FGI conducted a gene flow study subsequent to the 2006 growing season which validated the FGI Best Practices (FGI, 2007). The observed gene flow ranged from 0.09 percent at an isolation distance of one mile to 0.01 percent at an isolation distance of three miles. At distances of 5 miles or greater, the gene flow was not detected.

To summarize, data collected under actual seed production conditions found gene flow ranging from 0.00 to 0.18 percent when FGI Best Practices were used. This is well below the FGI Company's domestic market goal of less than 0.5 percent adventitious presence. As required by the NAFA BMP (2008a), a third-party review panel has annually conducted a review of conventional seed crop gene flow data. In each of the two annual reviews, the panel has validated that NAFA BMP are working on a commercial scale to enable coexistence among conventional and RRA seed producers (NAFA, 2009; Fitzpatrick and Lowry, 2010).

2.3.3 Gene flow potential

This ER addresses potential gene flow pathways as follows:

- Potential for gene flow from RRA forage crops to conventional and organic forage crops (Section 3.3)
- Potential for gene flow from RRA forage crops to native alfalfa (Section 3.4)
- Potential for gene flow due to feral alfalfa populations (Section 3.5)
- Potential for gene flow from RRA forage crops to rangeland alfalfa (Section 3.6)
- Potential for gene flow from RRA forage crops to conventional or organic alfalfa seed production areas (Section 3.7)
- Potential for gene flow from RRA to any of the above receptors, in alfalfa seed production (Section 3.8)

2.4 ALFALFA WEED MANAGEMENT

2.4.1 Weed characteristics and concerns

While a weed can be defined as any unwanted plant, problem weeds are those that are competitive and persistent. Healthy, productive stands of alfalfa require attention to manage pests (including weeds), fertilizer inputs, irrigation (if applicable), and harvest timing. Weeds can be a problem in alfalfa particularly at establishment of a new stand and after the stand has started to thin toward the end of its life. Once a dense stand of alfalfa has been established, the competition of the alfalfa plants with weeds and the fact that alfalfa is cut at regular intervals during the production season act as suppressors of weeds. Weed control at establishment is a particularly important time since good weed control at this time leads to the establishment of a dense, healthy stand for the life of the crop.

Several years after sowing alfalfa when plants weaken and stands become thin weeds become more competitive with alfalfa and can contribute to a significant decline in alfalfa yield and forage value. Certain weed species found in alfalfa stands are particularly difficult to control, are poisonous to livestock, negatively affect palatably or livestock performance, impart off flavors to milk products, and may be noxious regulated species (USDA APHIS, 2009, p. 73).

Competition for light, water and nutrients. A grower tries to capture the plant resources on his land - primarily light, water, and nutrients - for his crop; however, competitive weeds often secure some of these resources for their growth, at the expense of the crop. Some common characteristics of competitive weeds are rapid seedling establishment, high growth rates, prolific root systems and large leaf areas.

Weed persistence. Persistent weeds are able to survive year after year on a given piece of ground, in spite of a farmer's efforts to control them. Some plants are both competitive and persistent through the production of large numbers of seeds. The bushy wild proso millet, for example, shatters upon contact when mature, and can produce 400 to 12,000 seeds per square foot. While high reproductive rates also contribute to a weed's persistence, seed dormancy is also an important trait in persistence. Cultivated soils typically contain thousands of seeds per square meter, waiting for the opportunity to germinate. Some seeds, for example, velvetleaf, can remain viable in the soil for up to 50 years. Many perennial weed species have the ability to reproduce from root fragments. Canada thistle, for example, has a deep, spreading root system that can continue to send up shoots after the surface plant has been removed multiple times. Some weeds have the ability to alter their characteristic in response to stress; for example, some weeds respond to drought by flowering and going to seed early (Tranel, 2003; McDonald et al., 2003, pp. 9-12).

Weeds are controlled in conventional alfalfa and RRA with chemicals (herbicides), cultural methods (rotation, mowing, companion crops, monitoring), and mechanical methods (tillage). The cultural and mechanical methods are permitted for organic farmers. RRA systems allow for the use of one additional herbicide, glyphosate.

2.4.2 Problem weeds in alfalfa production

The following weeds have been identified as problem weeds in alfalfa that prevent production of maximum yields: Barnyardgrass, Bermudagrass, Bluegrass (annual), Bromes, Buckhorn plantain, Bulbous bluegrass, Burning nettle, Canarygrass, Chesseweed, Chickweed (common), Coastal fiddleneck, Cupgrass, Dandelion (common), Dodder, Filarees, Field bindweed, Flixweed, Foxtail (green), Foxtail (yellow), Foxtail barley, Goosegrass, Groudsel (common), Hare barley, Johnsongrass, Junglerice, Knotweed, Lambsquarter (common), London rocket, Miner's lettuce, Mustards, Nettleleaf, Nightshade, Nutsedges, Palmer Amaranth, Pepperweeds, Prickly lettuce, Quackgrass, Redmaids, Russian thistle, Ryegrass, Shepardspurse, Sowthistle, tinkgrass, Wild oats, Wild Radish, Witchgrass, and Yellow starthistle (UC IPM, 2006) . These weeds are summarized in Table 2-5. Most of these weeds, and others, are present throughout all the alfalfa growing regions. Certain weeds are classified as annual, biennial or perennial. An annual or biennial is a plant that completes its life cycle to produce seed in one or two years (or less), respectively. Perennials are plants that live for more than two years. They may reproduce by seeds, rhizomes (underground creeping stems) or other underground parts. Weeds are further classified as broadleaf (dicots) or grasses (monocots).

Table 2-5 Weeds in Alfalfa

Common Name	Scientific Name and Synonyms	GR Biotype Reported in U.S.	Types	Season	East Central	North Central	Southeast	Winter Hardy Inter-Mountain	Great Plains	PNW	Moderate Inter-Mountain	Southwest
Barnyard grass	*Echinochloa crus-galli*, cockspur grass, Japanese millet watergrass cockspur watergrass	NA	Grass	SA	X	X			X	X	X	X
Bermudagrass	*Cynodon spp*.	NA	Grass	P			X		X			X
Bluegrass (annual)	*Poa annua* walkgrass, annual bluegrass	NA	Grass	WA			X		X			X
Bromes	Bromus spp.	NA	Grass	WA								X
Buckhorn plantain[1]	***Plantago lanceolata***	**No**	**Broadleaf**	**P**					**X**		**X**	
Bulbous bluegrass	*Poa bulbosa*	NA	Grass	P							X	
Burning nettle	*Urtica dioic* California nettle slender nettle stinging nettle tall nettle	NA	Broadleaf	A								X
Canarygrass	*Phalaris arundinacea* canary grass reed canarygrass *Phalaris canariensis* canary grass *Phalaris minor* canarygrass littleseed canarygrass	NA	Grass	WA								X
Chesseweed	*Malva neglecta* buttonweed	NA	Broadleaf	WA-P							X	X

Common Name	Scientific Name and Synonyms	GR Biotype Reported in U.S.	Types	Season	East Central	North Central	Southeast	Winter Hardy Inter-Mountain	Great Plains	PNW	Moderate Inter-Mountain	Southwest
	cheeseplant little mallow common mallow											
Chickweed (common)	*Stellaria media*	NA	Broadleaf	WA	X	X	X		X	X		
Coastal fiddleneck	*Amsinckia menziesii* var. *intermedia* coast buckthorn coast fiddleneck common fiddleneck fiddleneck	NA	Broadleaf	WA							X	
Cupgrass	*Eriochloa gracilis* southwestern cubgrass tapertip cupgrass *Eriochloa contracta* prairie cupgrass *Eriochloa villosa* wooly cupgrass	NA	Grass	SA					X			X
Dandelion (common)	*Taraxacum officinale* blowball common dandelion faceclock	NA	Broadleaf	P	X	X		X	X		X	
Dodder	*Cuscuta* 50 common names for the species in the genus	NA	Broadleaf	SA					X	X	X	X
Filarees	*Erodium spp.*	NA	Broadleaf	WA	X	X	X	X	X	X	X	X
Field bindweed	*Convolvulus arvensis* creeping jenny European bindweed morningglory perennial morningglory Smallflowered morningglory	NA	Broadleaf	P	X			X				
Flixweed	*Descurainia sophia* flixweed pinnate tansymustard	NA	Broadleaf	WA				X	X		X	
Foxtail (green)	*Setaria viridis* bottle grass green bristlegrass green foxtail green millet pigeongrass wild millet	NA	Grass	SA	X	X	X	X	X	X	X	
Foxtail (yellow)	*Setaria glauca* pearl millet pigeongrass	NA	Grass	SA	X	X	X	X	X	X		

Common Name	Scientific Name and Synonyms	GR Biotype Reported in U.S.	Types	Season	East Central	North Central	Southeast	Winter Hardy Inter-Mountain	Great Plains	PNW	Moderate Inter-Mountain	Southwest
	wild millet yellow bristlegrass yellow foxtail											
Foxtail barley	*Hordeum jubatum*	NA	Grass	P				X			X	
Goosegrass[1]	***Eleusine indica*** **crowsfoot grass** **Indian goosegrass** **manienie alil'I** **silver crabgrass** **wiregrass**	**No**	**Grass**	**SA**			**X**		**X**			
Groundsel (common)	*Senecio vulgaris* ragwort old-man-in-the-Spring	NA	Dicot	WA								X
Hare barley	*Hordeum leporinum* hare barley leporinum barley wild barley	NA	Dicot	WA				X			X	X
Johnsongrass[1]	***Sorghum halepense*** **aleppo milletgrass** **herbe de cuba** **sorgho d' Alep** **sorgo de alepo** **zacate johnson**	**Yes (1) State**	**Grass**	**P**			**X**		**X**			
Junglerice[1]	***Echinochloa colona*** **Junglerice** **watergrass**	**No**	**Grass**	**SA**								**X**
Knotweed	*Polygonum arenastrum* common knotweed doorweed matweed ovalleaf knotweed prostrate knotweed	NA	Broadleaf	SA						X		X
Lambsquarter (common)	*Chenopodium album* Lambsquarters White goosefoot	Yes	Broadleaf	SA	X	X	X	X	X	X	X	X
London rocket	*Sisymbrium irio*	NA	Grass	WA								X
Miner's lettuce	*Claytonia perfoliata*	NA	Dicot	WA-P								X
Mustards	*Brassica* spp.	NA	Broadleaf	WA			X	X				
Mustards	*Brassica* spp.	NA	Broadleaf	SA			X					
Nettleleaf	*Chenopodium murale*	NA	Broadleaf	SA								X
Nightshade	*Solanum sarrachoides* Hairy nightshade	NA	Broadleaf	SA			X			X		

Common Name	Scientific Name and Synonyms	GR Biotype Reported in U.S.	Types	Season	East Central	North Central	Southeast	Winter Hardy Inter-Mountain	Great Plains	PNW	Moderate Inter-Mountain	Southwest
	Hoe nightshade											
Nutsedges	*Cyperus esculentus* yellow nutgrass yellow nutsedge *Cyprus rotundus* chaguan Humatag cocograss kili'o'opu nutgrass pakopako purple nutsedge	NA	Grass	P								X
Palmer Amaranth[1]	***Amaranthus palmeri*** **carelessweed (type of pigweed)**	**Yes (8) States**	**Broadleaf**	**SA**					**X**			
Pepperweeds	*Lepidium densiflorum* Common pepperweed Greenflower pepperweed peppergrass	NA	Broadleaf	WA					X		X	
Prickly lettuce	*Lactuca serriola* China lettuce wild lettuce	NA	Broadleaf	WA					X	X	X	
Quackgrass	*Elytrigia repens* couchgrass quackgrass quickgrass quitch scotch twitch *Elymus repens* couchgrass dog grass	NA	Grass	P	X	X					X	X
Redmaids	*Calandrinia ciliate*	NA	Broadleaf	WA						X		X
Russian thistle	*Salsola kali* tumbleweed *Salsola iberica* prickly Russian thistle tumbleweed tumbling thistle	NA	Broadleaf	SA		X			X	X	X	
Ryegrass[1]	***Lolium multiforum*** **Italian ryegrass annual ryegrass**	**Yes (3) States**	**Grass**	**WA**			**X**				**X**	
Shepardspurse	*Capsella bursapastoris* Shephardspurse	NA	Broadleaf	WA	X	X	X	X	X	X	X	X
Sowthistle	*Sonchus* spp. (5 species)	NA	Broadleaf	P						X		
Stinkgrass	*Eragrostis cilianensis* candy grass lovegrass strongscented	NA	Grass	SA							X	

Common Name	Scientific Name and Synonyms	GR Biotype Reported in U.S.	Types	Season	East Central	North Central	Southeast	Winter Hardy Inter-Mountain	Great Plains	PNW	Moderate Inter-Mountain	Southwest
	lovegrass											
Wild oats	*Avena fatua* flaxgrass oatgrass wheat oats	NA	Grass	SA-WA		X				X	X	X
Wild Radish	*Raphanus raphanistrum*	NA	Broadleaf	SA	X	X	X					
Witchgrass	*Panicum capillare* panicgrass ticklegrass tumble panic tumbleweed grass witches hair	NA	Grass	SA	X						X	
Yellow starthistle	*Cantaurea solstitialis*	NA	Dicot	WA				X			X	

1 – Glyphosate resistant weed
Note: Refer to Table G-8 in the draft EIS for Glyphosate resistant weed infestations by state
Source: (UC IPM. 2006), (USDA APHIS, 2009, Tables G-3 and G-7), and (USDA, 2010b)

2.4.3 Use of herbicides to control weeds

Herbicides are used at three different phases in conventional alfalfa farming, which include stand establishment (to prepare the ground), established stands (to control weeds), and during stand removal (to kill alfalfa). The 17 EPA-registered herbicides that are used for stand removal or to control volunteer alfalfa include:

Herbicide	Mode of Action
2,4-DB (Butyrac, Butoxone)	- Synthetic Auxin; Growth regulator
Benfluralin (Balan)	- Dinitroanalines; Microtubule assembly inhibition
Bromoxynil (Buctril) -	- Nitriles; Photosystem II inhibitors
Clethodim (Prism, Select)	- Acetyl-CoA carboxylase (ACCase) inhibitors
Diuron (Karmex, Direx)	- Ureas, Amides; Photosystem II inihitors
EPTC (Eptam)	- Thiocarbamates; Seed growth inhibitors (shoot)
Hexazinone (Velpar)	- Photosystem II inhibitors
Imazamox (Raptor)	- Acetolactate synthase (ALS) inhibitors
Imazethapyr (Pursuit)	- ALS inhibitors
Metribuzin (Sencor)	- Photosystem II Inhibitors
Norfluzaon (Solicam)	- Carotenoid biosynthesis inhibitors
Paraquat (Gramoxone Inteon)	- Bipyridiliams; Cell membrane disruptor

Pronamide (Kerb)	- Dinitroanilines; Microtubule assembly inhibition
Sethoxydim (Poast)	- ACCase Inibitors
Terbacil (Sinbar)	- Photosytem II Inhibitors
Trifluralin (Treflan/TR-10)	- Dinitroanilines; Microtubule assembly inhibition

Source: (USDA APHIS, 2009, Table G-1) and (Heap, 2010)

Table 2-6 summarizes the effectiveness of the herbicides on broadleaf weeds in seedling alfalfa, Table 2-7 summarizes the effectiveness of the herbicides on grass weeds in seedling alfalfa, and Table 2-8 summarizes the effectiveness of herbicide combination control on weeds in seeding alfalfa.

Alfalfa stands are usually thinning and vulnerable to weeds after 2 to 8 years. Alfalfa stands are typically removed by killing the alfalfa by either tillage, herbicide application, or both. RRA cannot be removed using glyphosate; therefore, just like conventional alfalfa, RRA can be removed using tillage and/or labeled, non-glyphosate herbicides.

Table 2-6 Susceptibility of Broadleaf Weeds in Seedling Alfalfa to Herbicide Control

								POSTEMERGENT										
BROADLEAF WEEDS	**24DB[*1]**	**24DB[*3]**	**24DB[*4]**	**BRO[1]**	**BRO[2]**	**CLE[1]**	**CLE[2]**	**GYL[+]**	**HEX**	**IMA[1]**	**IMA[2]**	**IMZ[1]**	**IMZ[2]**	**PAR[*1]**	**PAR[*2]**	**PRO**	**SET[1]**	**SET[2]**
burclover	N	N	N	N	N	N	N	P	P	N	N	N	N	N	N	N	N	N
buttercup	N	N	N	N	N	N	N	-	-	C	C	P	C	P	C	-	N	N
celery, wild	N	N	N	N	N	N	N	C	P	N	N	N	N	N	P	-	N	N
chickweed	N	N	N	N	N	N	N	C	P	C	C	C	C	P	C	N	N	N
cocklebur	C	C	C	C	C	N	N	C	C	C	C	C	C	N	P	N	N	N
dock, curly (seeding)	P	C	C	N	N	N	N	C	N	N	P	N	N	N	N	P	N	N
doverfoot	N	N	P	N	N	N	N	C	-	C	C	C	C	P	C	N	N	N
fiddleneck	N	N	N	C	C	N	N	P	P	N	P	N	P	N	P	N	N	N
fillarees	N	N	N	N	N	N	N	P	P	P	C	P	C	N	P	N	N	N
groundsel, common	N	P	C	P	C	N	N	C	C	N	N	N	N	N	P	N	N	N
henbit	N	N	N	N	N	N	N	C	N	N	P	P	C	N	N	C	N	N
jimsonweed	P	C	C	C	C	N	N	C	-	C	C	C	C	C	C	-	N	N
knotweed (seedling)	N	P	C	P	P	N	N	C	C	P	C	P	C	N	N	C	N	N
lambsquarters	C	C	C	C	C	N	N	C	C	N	N	P	C	P	C	C	N	N
lettuce, miners	N	N	N	N	N	N	N	C	P	C	C	P	C	P	C	C	N	N
lettuce, prickly	P	C	C	P	C	N	N	C	N	N	N	N	N	P	C	C	N	N
mallow, little (cheeseweed)	N	N	N	N	N	N	N	P	N	P	C	P	C	N	N	N	N	N
milkthistle	N	N	P	N	P	N	N	C	-	N	N	N	N	P	P	N	N	N
mustard, black	N	P	C	C	C	N	N	C	P	C	C	C	C	N	P	N	N	N
nettle, burning	N	N	P	N	N	N	N	P	N	P	C	P	C	N	N	N	N	N
nightshade, hairy	P	C	C	C	C	N	N	C	C	C	C	C	C	-	C	C	N	N
oxtongue, bristly	-	P	P	P	C	N	N	-	-	N	P	-	-	-	-	-	N	N
pineappleweed	N	N	N	N	P	N	N	C	P	N	N	N	N	P	C	N	N	N
pigweed, redroot	C	C	C	N	P	N	N	C	C	C	C	C	C	N	N	C	N	N
radish, wild	N	P	C	N	P	N	N	C	P	P	C	P	C	N	P	N	N	N
rockpurslane, desert	N	N	N	N	N	N	N	C	N	C	C	N	N	P	C	P	N	N
rocket, London	P	C	C	P	C	N	N	C	P	C	C	C	C	C	C	C	N	N
rush, toad	N	N	N	-	-	N	N	C	C	C	C	-	-	N	N	C	N	N
shepherd's-purse	N	P	P	C	C	N	N	C	P	P	C	C	C	N	P	N	N	N
smartweed, swamp	P	C	C	P	C	N	N	C	C	C	C	-	C	N	P	N	N	N
sowthistle	P	C	C	C	C	N	N	C	N	N	N	-	-	N	C	N	N	N
speedwell, thymeleaf	N	N	N	N	N	N	N	C	N	N	N	N	N	N	N	P	N	N

spurge, petty	N	N	N	N	-	N	N	-	-	C	C	-	-	C	C	-	N	N
spurry, corn	N	N	N	N	N	N	N	C	C	N	N	-	-	-	C	C	N	N
starthistle, yellow	N	N	N	P	C	N	N	-	C	N	N	-	-	-	C	N	N	N
sunflower, wild	C	C	C	C	C	N	N	C	C	C	C	C	C	N	P	N	N	N
swinecress	N	N	P	N	P	N	N	C	C	C	C	-	-	N	P	N	N	N
willowherb, panicle	P	C	C	N	-	N	N	-	-	C	C	-	-	N	N	-	N	N

Source: (UC IPM, 2009)

Table 2-7 Susceptibility of Grass Weeds in Seedling Alfalfa to Herbicide Control

	POSTEMERGENT																		
GRASS WEEDS	**24DB[*1]**	**24DB[*2]**	**24DB[*3]**	**24DB[*4]**	**BRO[1]**	**BRO[2]**	**CLE[1]**	**CLE[2]**	**GYL[+]**	**HEX**	**IMA[1]**	**IMA[2]**	**IMZ[1]**	**IMZ[2]**	**PAR[*1]**	**PAR[*2]**	**PRO**	**SET[1]**	**SET[2]**
barley, hare	N	N	N	N	N	N	C	C	C	N	N	N	C	C	P	P	C	C	C
barnyardgrass	N	N	N	N	N	N	C	C	C	N	C	C	C	C	P	P	N	C	C
bluegrass, annual	N	N	N	N	N	N	P	C	C	P	N	P	N	P	P	C	C	N	N
brome, ripgut	N	N	N	N	N	N	C	C	C	N	N	N	C	C	P	P	C	P	-
canarygrass, hood	N	N	N	N	N	N	C	C	C	N	N	P	C	C	N	P	N	C	C
fescue, rattail	N	N	N	N	N	N	-	C	C	N	N	N	P	P	P	P	-	N	P
foxtail, yellow	N	N	N	N	N	N	P	C	C	N	N	P	C	C	P	P	N	C	C
goosegrass	N	N	N	N	N	N	P	P	C	N	N	N	N	N	N	N	N	P	P
oat, wild	N	N	N	N	N	N	C	C	C	N	P	P	C	C	P	P	C	C	C
punagrass	N	N	N	N	N	N	P	C	P	N	N	N	N	N	N	N	-	P	C
ryegrass, Italian	N	N	N	N	N	N	C	C	C/P^	N	N	N	C	C	P	C	C	C	C
wheat, volunteer	N	N	N	N	N	N	C	C	C	N	N	P	C	C	P	C	C	C	C

Source: (UC IPM, 2009)

Ratings Legend

C = control (100-80% control)
P = partial control (79-65% control)
N = no control (less than 65% control)
- = no information

Chemical Legend

24DB*[1] = 2,4-DB* (Butoxone 0.5, etc.)
24DB*[2] = 2,4-DB* (Butoxone 0.75, etc.)

IMA[1] = imazethapyr (Pursuit 0.063)
IMA[2] = imazethapyr (Pursuit 0.094)

24DB*[3] = 2,4-DB* (Butoxone 1.0, etc.)
24DB*[4] = 2,4-DB* (Butoxone 1.5, etc.)
BRO[1] = bromoxynil (Buctril 0.25)
BRO[2] = bromoxynil (Buctril 0.375)
CLE[1] = clethodim (Prism 0.1)
CLE[1] = clethodim (Prism 0.1)
GLY+ = glyphosate (Roundup WeatherMax)
HEX = hexazinone (Velpar 0.25)
IMZ[1] = imazamox (Raptor 0.032)
IMZ[2] = imazamox (Raptor 0.047)
PAR*[1] = paraquat* (Gramoxone 0.125)
PAR*[2] = paraquat* (Gramoxone 0.25)
Pro* = pronamide (Kerb 1.0)
Set[1] = sethoxydim (Poast 0.375)
Set[2] = sethoxydim (Poast 0.5)

Comments

NOTE: Weed size and spray coverage impact weed control as will herbicide rate, adjuvant type, spray volume, and environmental conditions.
* Permit required from county agriculture commissioner for purchase or use.
+ for Roundup-ready (RR) alfalfa only
^ glyphosate (Roundup) resistance developing in many crops

Table 2-8 Susceptibility of Weeds in Seedling Alfalfa to Herbicide Combination Control

POSTEMERGENT COMBINATIONS

BROADLEAF WEEDS	BRO IMA[1]	BRO 24DB[*2]	BRO SET[3]	BRO CLE[4]	BRO HEX[5]	IMA 24DB[*6]	IMA CLE[7]	IMA SET[8]	SET 24DB[*9]	IMA PAR[*10]	IMA HEX[11]
burclover	N	N	N	N	P	N	N	N	N	N	P
buttercup	C	N	N	N	N	C	C	C	N	C	C
celery, wild	N	N	N	N	N	N	N	N	N	P	P
chickweed	C	N	N	N	C	C	C	C	N	C	C
cocklebur	C	C	C	C	C	C	C	C	C	C	C
dock, curly (seeding)	C	C	N	N	N	P	N	N	C	N	P
doverfoot	C	P	N	N	N	C	C	C	P	C	C
fiddleneck	C	C	C	C	C	N	N	N	N	P	P
fillarees	C	N	N	N	P	P	P	P	N	C	C
groundsel, common	C	C	C	C	C	N	N	N	C	C	C
henbit	P	N	N	N	P	N	N	N	N	N	N
jimsonweed	C	C	C	C	C	C	C	C	C	C	C
knotweed (seedling)	P	P	P	P	P	C	P	P	P	P	C
lambsquarters	C	C	C	C	C	C	N	N	C	C	C
lettuce, miners	C	N	N	N	P	C	C	C	N	C	C
lettuce, prickly	C	C	C	C	C	C	N	N	C	C	N
mallow, little (cheeseweed)	C	N	N	N	N	C	P	P	N	C	C
milkthistle	P	P	N	N	N	N	N	N	P	P	-
mustard, black	C	C	C	C	C	C	C	C	P	C	C
nettle, burning	C	N	N	N	N	C	P	P	N	P	C
nightshade, hairy	C	C	C	C	C	C	C	C	C	C	C
oxtongue, bristly	P	P	C	C	P	-	N	N	P	-	P
pineappleweed	P	C	C	C	-	P	N	N	C	C	-
pigweed, redroot	C	C	P	P	C	C	C	C	C	C	C
radish, wild	C	P	P	P	P	P	P	P	P	P	C
rockpurslane, desert	C	N	N	N	N	C	C	C	N	C	C
rocket, London	C	C	C	C	P	C	C	C	C	C	C
rush, toad	C	-	-	-	C	C	C	C	N	C	C
shepherd's-purse	C	C	C	C	C	P	P	P	P	P	C
smartweed, swamp	C	C	C	C	C	C	C	C	C	C	C
sowthistle	C	C	C	C	C	N	N	N	C	C	N
speedwell, thymeleaf	N	N	N	N	N	N	N	N	N	N	N
spurge, petty	C	N	N	N	N	C	C	C	N	C	C
spurry, corn	N	N	N	N	C	N	N	N	N	C	C
starthistle, yellow	C	C	C	C	C	N	N	N	N	C	-
sunflower, wild	C	C	C	C	C	C	C	C	C	C	C
swinecress	C	N	P	P	-	C	C	C	P	C	C
willowherb, panicle	C	C	-	-	-	C	C	C	C	C	C
GRASS WEEDS											
barley, hare	N	N	C	C	N	N	C	P	C	P	N
barnyardgrass	C	N	C	C	N	C	C	C	C	C	C
bluegrass, annual	N	N	N	P	N	N	C	N	N	C	P
brome, ripgut	N	N	P	C	N	N	C	P	P	P	N
canarygrass, hood	P	N	C	C	N	P	C	C	C	P	P
fescue, rattail	N	N	N	-	N	N	-	N	N	P	N
foxtail, yellow	P	N	C	C	N	N	C	C	C	P	P

BROADLEAF WEEDS	BRO IMA[1]	BRO 24DB[*2]	BRO SET[3]	BRO CLE[4]	BRO HEX[5]	IMA 24DB[*6]	IMA CLE[7]	IMA SET[8]	SET 24DB[*9]	IMA PAR[*10]	IMA HEX[11]
goosegrass	N	N	P	N	N	N	P	P	P	N	N
oat, wild	P	N	C	C	N	P	C	C	C	P	P
punagrass	N	N	P	-	N	N	P	P	P	N	N
ryegrass, Italian	N	N	C	C	N	N	C	C	C	C	N
wheat, volunteer	P	N	C	C	N	N	C	C	C	P	P

Source: (UC IPM, 2009)

Ratings Legend

C = control (100-80% control)
P = partial control (79-65% control)
N = no control (less than 65% control)
- = no information

Chemical Legend

[1] = bromoxynil (Buctril 0.25) + imazethapyr (Pursuit 0.064)
[2] = bromoxynil (Buctril 0.25) + 2,4-DB*(Butoxone 1.0, etc.)
[3] = bromoxynil (Buctril 0.375) + sethoxydim (poast 0.375)
[4] = bromoxynil (Buctril 0.375) + clethodim (Prism 0.25)
[5] = bromoxynil (Buctril 0.25) + hexazinone (Velpar 0.125)
[6] = imazethapyr (Pursuit 0.063) + 2,4-DB*(Butoxone 0.5, etc.)
[7] = imazethapyr (Pursuit 0.063) + clethodim (Select Max 0.1)
[8] = imazethapyr (Pursuit 0.063) + sethoxydim (Poast 0.375)
[9] = sethoxydim (Poast 0.375) + 2,4-DB*(Butoxone 1.5, etc.)
[10] = imazethapyr (Pursuit 0.063) + paraquat* (Gramoxone 0.25)
[11] = imazethapyr (Pursuit 0.094) + hexazinone (Velpar 0.25)

Comments

NOTE: Weed size and spray coverage impact weed control as will herbicide rate, adjuvant type, spray volume, and environmental conditions.
* Permit required from county agriculture commissioner for purchase or use.

2.4.4 Non-herbicide weed management practices

Weeds can also be controlled through cultural and mechanical methods. Weed management options include:

- Rotation of crops
- Winter crops in rotation
- Mowing or flash grazing
- Companion crops/co-cultivation/interseeding/nurse crop
- Cover crops (smother crops) (prior to planting alfalfa)

- Field scouting for early detection
- Monitor for weed species and population shifts
- Mechanical removal
- Adjusting harvest frequency
- Burning
- Tillage cultivation (seed production only)

Forage harvest removes weed biomass and developing weed seedlings. Regular forage harvest at late vegetative/mid bud stage combined with healthy competitive stands, effectively manage many key weed species, especially during the middle stages of a specific stand. Crop rotations can help maintain soil fertility, reduce soil erosion, avoid pathogen and pest buildup, adapt to weather changes, avoid the effects to reduce growth of one plant due to chemicals released by another, and increase profits. Alfalfa is also used in crop rotation because it provides nitrogen to the soil, which decreases fertilizer inputs in other rotations. Perennials and annuals promote and restrict different weeds, so rotating perennial and annual crops helps control weeds in general. Rotating alfalfa is also advised because mature alfalfa is autotoxic to seedling alfalfa (USDA APHIS, 2009, p. 74-75).

2.5 HERBICIDE RESISTANCE

Herbicide resistance is “the inherited ability of a plant to survive and reproduce following exposure to a dose of herbicide normally lethal to the wild type” (WSSA, 1998).

Herbicide resistance is a result of natural selection. Plants within a population of a given species are not all identical; they are made up of “biotypes” with various genetic traits. Biotypes possess certain traits or characteristics not common to the entire population. Herbicides, that suppress or kill weeds, can exert selection pressure on weed populations. When a herbicide is applied, the plants with genes that can confer resistance to it, which had no special survival qualities before the herbicide was introduced, become the survivors who are then able to reproduce and pass on their genes. With repeated application of the same herbicide and no other herbicide or weed control practice, the resistant biotype becomes the dominant biotype in that weed community. In the mid-1950s, Harper (1957) theorized that annual, repeated use of any herbicide could lead to shifts in weed species composition within a crop-weed community. Similarly, Bandeen et al. (1982) suggested that a normal variability in response to herbicides exists among plant species and tolerance can increase with repeated use of an herbicide.

Indeed, as of June 27, 2010, 341 herbicide resistant weed biotypes have been reported to be resistant to 19 different herbicide modes of action (Heap, 2010). Glyphosate-resistant weeds account for 5 percent of the herbicide resistant biotypes (as documented on the www.weedscience.org website) while weeds resistant to herbicides that inhibit acetolactate synthase (ALS), such as Raptor and Pursuit, account for 31 percent of the herbicide resistant biotypes (Wilson, 2010a, p. 6).

Figure 2-2 shows the increase in herbicide resistant biotypes with time. Among the herbicides commonly used in conventional alfalfa, Prism, Poast and Select are ACCase inhibitors; Raptor and Pursuit are ALS inhibitors; Butyrac and Butoxone are growth regulators, and Karmex and Direx are in the category of photosynthesis inhibitors. Figure 2-2 shows only the number of confirmed resistant biotypes. The total extent and distribution of resistant biotype varies widely. Details of herbicide resistant weed in alfalfa are discussed in Section 3.11.

For as long as herbicide resistance has been a known phenomenon, public sector weed scientists, private sector weed scientist and growers have been identifying methods to address the problem. For instance, when a farmer uses multiple weed control tools, each effective on a particular species, herbicide resistance biotypes will be controlled and the resistance biotype generally will not become the dominant biotype within a population (Gunsolus, 2002; Cole, 2010a, p. 4). By contrast, weed resistance is known to occur most rapidly in areas where there is a sole reliance

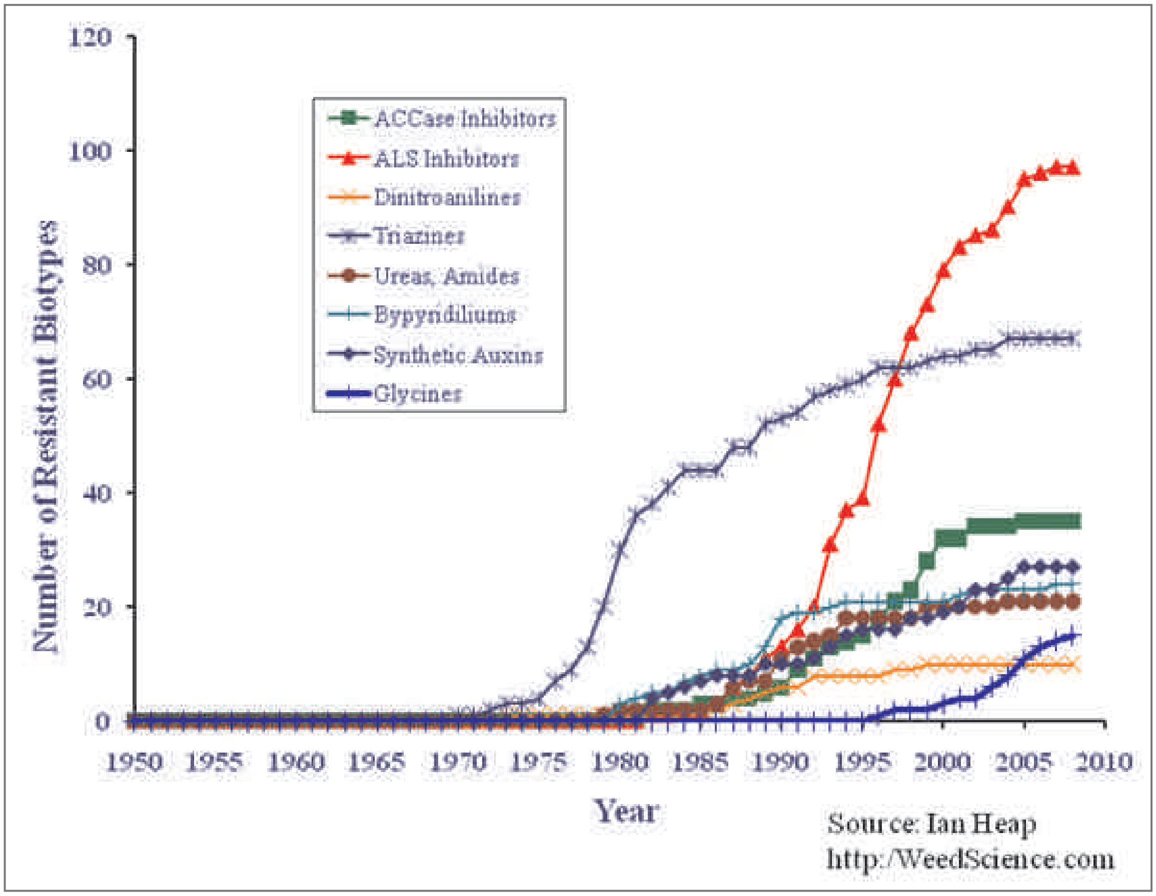

Figure 2-2. Herbicide resistance worldwide

on a single herbicide used repeatedly over multiple crop generations for the management of a specific weed spectrum.

When a grower encounters a biotype that is resistant to an herbicide he is using, the grower must use an alternate method of weed control. Management practices that can be used to retard the development of resistance, such as those routinely used by alfalfa growers, include herbicide mixtures, herbicide rotation, mowing, and crop rotation.. The WSSA reports: “Weed scientists know that the best defense against weed resistance is to proactively use a combination of agronomic practices, including the judicious use of herbicides with alternative modes of action either concurrently or sequentially” (WSSA, 2010b).

2.6 SEXUALLY COMPATIBLE RELATIVES INCLUDING CONSPECIFIC FERAL AND VOLUNTEER ALFALFA

2.6.1 Native sexually compatible relatives

There are no sexually compatible native relatives of alfalfa present in the U.S. (Mallory-Smith and Zapiola, 2008; Van Deynze et al., 2008, p. 7). No native members of the genus Medicago are found in North America (USDA APHIS, 2009, p. 20).

2.6.2 Feral and volunteer alfalfa

Feral crops are those that have become de-domesticated. Based on available data, de-domestication has occurred in only a few crops. These feral crops are of minor importance compared with other weeds (Gressel, 2005). In North America, the feral plants that cause much of the economic damage are imported horticultural plants; for example, Japanese privet, Japanese honeysuckle and kudzu (Gressel, 2005).

For purposes of this ER, unmanaged alfalfa planted for pasture, grazing or road-side reclamation (and similar uses) is also considered feral as, once established, they receive no or minimal agronomic inputs (e.g., clipping). Cultivated and feral alfalfa populations source to the same *Medicago sativa* L. germplasms that were repeatedly introduced to North America over a 400 year period.

Rogan and Fitzpatrick (2004) summarize the extent of feral populations in six major alfalfa-producing States—California, Washington, Idaho, Wyoming, Nevada, and Montana—confirming that minor feral populations do exist in areas where alfalfa seed or forage is produced (USDA APHIS, 2009, p. 22). Compared to cultivated alfalfa, feral alfalfa occurs at a relatively low density and scale. Kendrick et al. (2005) performed a biogeographic survey of five states (California, Idaho, Pennsylvania, South Dakota, and Wisconsin) in 2001 and 2002 and found that feral plants were not present or were sparse in most agricultural areas. Approximately 22 percent of the surveyed sites had dispersed or patches of feral alfalfa within 1.25 miles of cultivated alfalfa (Kendrick et al. 2005; Van Deynze et al., 2008). Relative to the geographies in which only forage is grown, areas with seed production fields were found to have fewer feral alfalfa plants growing in roadsides. Using herbicides or mechanical means, feral alfalfa can be and is controlled by certified alfalfa seed growers as a standard method to help assure isolation from other sources of pollen during varietal seed production (AOSCA, 2009).

Feral, or naturalized, alfalfa populations can escape agricultural fields and multiply by natural regeneration throughout the U.S. Feral alfalfa can be found at air fields, canals, cemeteries, ditch banks, fence rows, highways, irrigation ditches, pipelines, railroads, rangeland, right-of-ways, roadsides, and wastelands. Alfalfa plants that are not part of cropping systems generally have no regular external inputs like irrigation, herbicides, insecticides, and fertilizers. All feral alfalfa in the U.S., like alfalfa under cultivation, originated from introduced varieties.

In general, survival without management inputs requires feral plant populations to have traits that may differ from those of cultivated plants. The most common traits include:

- variety of pollinators,
- continuous seed production,
- considerable seed output,
- seeds produced in several habitats,
- seed dispersal over short and long distances,
- seed dormancy (ability to form a seedbank),
- broad germination requirements,
- discontinuous germination,
- rapid vegetative growth,
- ability to withstand competition,
- tolerance to unfavorable biotic and abiotic conditions, and
- rapid flowering

A portion of alfalfa seeds may be temporarily impervious to water; these are “hard” seeds. The hard seeds may decay in soil or lay un-germinated (dormant) for a period of time (e.g., a few weeks to several years). Gradually, the hard seed coat ages and the seed will germinate or decay. Alfalfa develops small fragile seedlings that if successfully established may become volunteers in subsequent crops or in unmanaged areas. Hard seed likely contribute few volunteer plants after one year, as, alfalfa seeds generally do not persist for more than one year in field soil (Albrecht et al., 2008). Data for persistence of hard seed in seed production fields is given and discussed in Van Deynze et al. (2008), this confirms Albrecht et al. where studies were done in forage plantings in the Midwest. To guard against hard seed carryover, seed growers take steps to eliminate residual alfalfa volunteers prior to planting (Putnam and Undersander, 2009, attached as Appendix I). AOSCA varietal purity standards (2009) require land history of 2 or 4 years without alfalfa cultivation, for the Certified and Foundation alfalfa seed generations, respectively. Little to no secondary seeds are formed on hay crop stems because they are harvested in their juvenile stage (weeks before any new, viable seed is formed). A mature alfalfa stand is highly competitive and highly autotoxic to fragile, emerging secondary seedlings. Therefore, secondary seedlings are a very unlikely avenue for effective gene flow into existing solid-seeded alfalfa plantings. The autotoxic reaction and inter-plant competition severely limit germination and seedling vigor of alfalfa sown or dropped into existing or newly terminated alfalfa stands. Solid-seeded cultivated alfalfa fields do not successfully self-seed. Attempts to thicken existing alfalfa stands by deliberately inter-planting new seed into them typically fail, which is why most agronomists do not recommend the practice (Canevari et al., 2000; USDA APHIS, 2009, p. 18-19, 100).

Several scientists have reported that volunteer GT plants could become a problem in rotational crops when both rotational crops are GT, however none provided specific information or data (e.g., Cerdeira and Duke, 2006; Owen and Zelaya, 2005; York et al, 2004; NRC, 2010). RRA volunteers would be expected to be more of concern in crops grown for seed, such as corn and soybeans. Volunteer alfalfa plants—whether conventional or RRA—are controlled by use of mechanical means (e.g., tillage) or by application of several registered non-glyphosate broad-leaf herbicides. Feral alfalfa can also be controlled using these practices, or with glyphosate.

2.7 FOOD, FEED AND OTHER ALFALFA USES

Both food (sprouts, dietary supplements, and herbal or homeopathic medicine) and animal feed (hay, haylage, or silage) are derived from alfalfa.

Alfalfa forage, primarily harvested as hay or haylage, is used as a source of fiber and protein in animal diets. Most alfalfa forage is fed to dairy or beef cattle, but can also be an important part of the diet for horses, sheep and goats.

A small fraction of alfalfa seeds are used to produce sprouts for human consumption. Any alfalfa seed for sprouts must be certified as having been produced to food-grade specifications and therefore food-grade seed is grown and distributed in an entirely separate channel from that for general use, non-food-grade planting seeds. Food-grade seeds for sprouts are produced throughout the world, but the major suppliers are Canada, Italy, U.S. and Australia. Sprouts are cultivated from clean raw (non-coated, untreated) seeds in controlled environment sprouting chambers for approximately 5 to 10 days before sale to consumers.

FDA and equivalent regulatory bodies in Japan, Korea, Canada, Australia/New Zealand, etc., have granted full approval for the use of RRA as a food (see Section 3.11). Monsanto and FGI have developed the RRA varieties for field planting purposes (only), and as such the companies do not intend nor allow (give license to) any seed growers or seed purchasers to use RRA varieties for food-grade sprout production (Hubbard, 2008; USDA APHIS, 2009, p. 18).

2.8 PHYSICAL AND BIOLOGICAL ISSUES

The affected environment for land use, air quality, water quality, ecology, threatened and endangered species, and other sensitive wildlife is the alfalfa producing areas and the seed producing regions. The affected environment for climate is global, as impacts on climate change are a global issue.

2.9 SOCIOECONOMICS AND HEALTH

The affected environment for socioeconomic issues includes those individuals who could potentially be economically impacted if their food or agricultural products are adversely affected by RRA, and those who could be economically impacted if RRA becomes a deregulated article. Potential impacts to the first group are discussed primarily in Section 3.10 and impacts to the second group are discussed in Section 3.15. The potential for health impacts to individuals who may come into contact with RRA or alfalfa seeds or other products derived from RRA is discussed in Sections 3.10 and 3.14. Health effects of potential exposure to herbicides are discussed in Section 3.14.

SECTION 3.0 ENVIRONMENTAL CONSEQUENCES

3.1 PLANT PATHOGENIC PROPERTIES AND UNINTENDED EFFECTS

APHIS previously determined, based on scientific analysis and in accordance with its obligations under the PPA, that RRA does not exhibit plant pathogenic properties (USDA APHIS, 2009).

APHIS considered the potential for the transformation process, the introduced DNA sequences, or their expression products to cause or aggravate plant disease symptoms in RRA and its progeny or in other plants.

APHIS also considered whether data indicate that unintended effects would arise from the genetic engineering of these plants. APHIS considered information from the scientific literature as well as data provided by Monsanto/FGI in their petition that was developed from their field trials (USDA APHIS, 2009).

Based on the analysis summarized below, there are no impacts resulting from plant pathogenic properties, introduced or aggravated disease symptoms, or unintended effects under any of the alternatives. Details of the Monsanto/FGI studies are included in the petition (Rogan and Fitzpatrick, 2004).

3.1.1 Background

Plant genetic modification

Plant genetic modification by humans ranges from the simple approach of directed selection – where seeds of plants with desired traits are saved and replanted – to complex methods such as the use of rDNA (see definitions on next page). APHIS regulations define genetic engineering as genetic modification through the use of rDNA technology.[40] Crossing (and then recrossing) two sexually compatible plants by taking the pollen from one plant and brushing it onto the pistil of another remains the mainstay of modern plant breeding (IM/NRC, 2004). Both more traditional, "conventional breeding" and rDNA methods can involve changes in the frequency, sequence, order, and regulation of genes in a plant and can use many of the same enzymes. However, with conventional breeding all the tens of thousands of genes in the plant are involved, and with the rDNA method only a few genes are involved. In classical breeding, crosses can be accomplished only between closely related species, and therefore only traits that are already present in those species can be targeted. In contrast, the rDNA approach can

[40] 7 C.F.R. § 340.1.

use genes from any living organism, thus opening the door to vast potential in trait development (Lemaux, 2008, p. 774; AMA, 2000).

Other examples of plant genetic modification include cell fusion (the protective cell wall is stripped and cells are fused by some external force) and induced mutagenesis (inducing mutations in seeds by ionizing radiation or carcinogenic chemicals) (Ronald and Adamchak p. 88). Mutagenic techniques, which have been in use since the late 1920s, create random mutations and are limited by their inability to target a desired trait (FDA, 1992; Lundqvist, 2009, p. 39).

Agrobacterium

Agrobacterium tumefaciens (*Agrobacterium*) is a soil microbe that has been called "nature's own genetic engineer" because of its ability to transfer a fragment of its own DNA into a host plant (AMA, 2000). (See definitions at right.) The transferred DNA is stably integrated into the plant DNA, and the plant incorporates and expresses the transferred genes. The transferred DNA (T-DNA) reprograms the host plant cells to grow into callus tissue and produce certain amino acid derivatives that are a food source for the *Agrobacterium*. On a macro scale, the callus tissue growth is called crown gall disease. In the early 1980s scientists developed strains of *Agrobacterium* with T-DNA that lacked the disease-carrying genes ("disarmed" *Agrobacterium*). *Agrobacterium* transformation system has been utilized in the development of a large number of genetically engineered plants in commercial production (IM/NRC, 2004, pp. 28-29). The method uses a DNA molecule called a **vector** that serves as a carrier to insert T-DNA that contains specific genetic elements. These genetic elements are organized into a **gene cassette**, which consists of a gene encoding for a single biological function plus other genetic elements necessary for the expression of that gene when introduced into the plant. Other elements in the gene cassette include a **promoter**, which can be thought of as the "on switch" for the gene encoding for the desired trait; and a targeting sequence, which makes sure the gene product, typically a protein, ends up in the right location within the cell (such as the chloroplast).

Unintended effects from breeding

Most crops naturally produce allergens, toxins or other antinutritional substances; these often serve the plant as natural defense compounds against pests or pathogens (FDA, 1992). Plant breeders may monitor the levels of antinutritional substances relevant to their crop. For example, lignin is an indigestible cell wall component that limits forage digestibility. Alfalfa breeders typically monitor lignin content of plants in their breeding programs.

Scientists from the Institute of Medicine (IM) and the National Research Council (NRC) ranked breeding methods according to their relative likelihood of producing unintended effects, which they hypothesized would correspond to the degree of genetic disruption associated with the method. Selection from a homogeneous population was ranked at one end of the spectrum (less likely to produce unintended effects) and induced mutagenesis (from chemicals or radiation) was ranked at the other end (more likely). *Agrobacterium* transfer of rDNA was among the methods ranked in between (IM/NRC, 2004, Figure ES-1). Recent studies in Europe comparing transgenic and conventional barley suggest that conventional breeding may cause more unintended effects than rDNA methods, likely because of the very large number of genes that are affected in conventional breeding techniques (Sonnewald, 2010).

Glyphosate tolerance

As discussed in Section 2, glyphosate acts by inhibiting the action of the enzyme EPSPS, in plants. EPSPS is a catalyst for a reaction necessary for the production of certain amino acids essential for plant growth. When plants are treated with glyphosate the EPSPS enzyme is inhibited, they cannot produce the amino acids needed for continued growth and eventually die. The EPSPS protein and the reaction it catalyzes are present in all plants and microbes. There are variations in the amino acid sequence of EPSPS among different plants and bacteria. GT is achieved by introducing an EPSPS enzyme, termed CP4 EPSPS, that is not inhibited in the presence of glyphosate. An *Agrobacterium* strain (designated CP4) was the source of the CPR EPSPS gene that encodes for the CP4 EPSPS enzyme (Rogan and Fitzgerald, 2004). The CP4 EPSPS enzyme carries out the same enzymatic reaction in the plant as the native EPSPS; however, when plants that contain the CP4 EPSPS are sprayed with glyphosate, they are able to continue to produce the essential amino acids needed for plant growth. The objective of the genetic modification in RRA was to simplify and improve weed management practices in alfalfa by the addition of the CP4 EPSPS enzyme to confer tolerance to glyphosate (USDA APHIS, 2005).

Transformation system

RRA was developed using a disarmed Agrobacterium-mediated transformation system of sterile alfalfa leaflets. Post-transformation, the Agrobacterium were eliminated from tissues by a 7-week culture on antibiotic-containing medium. Glyphosate was used to select for transformed tissues containing the EPSPS gene construct. This technique of using a disarmed Agrobacterium strains followed by selection has a 20-year history of safe use and has been used for transformation of a variety of plant species and tissues. The plant material used for development of RRA was FGI proprietary alfalfa clone R2336 from a high yielding, fall dormant breeding population. The initial plants, selected for tolerance to glyphosate, were designated J101/J163, and various populations were developed from these events to provide the data presented in the petition (USDA APHIS, 2005).

DNA sequences inserted into RRA

Data supplied in the petition and reviewed by APHIS indicate that the CP4 EPSPS expression cassette inserted into alfalfa events RRA contains the CP4 EPSPS coding sequence under the regulation of the 35S promoter, a heat shock protein intron (HSP70), a chloroplast transit peptide (CTP2) sequence and a E9 3' polyadenylation sequence. The CTP2 CP4 EPSPS coding region used to produce events J101/J163 is the same as that employed in several other RR crops such as soybean, which have been previously reviewed and granted non-regulated status by the USDA. The CP4 EPSPS gene does not cause disease and has a history of safe use in a number of GE plants (e.g., corn, cotton, and soybean varieties).

3.1.2 Evaluation of intended effects

Analysis of inheritance

Data were provided by Monsanto/FGI and reviewed by APHIS that demonstrate stable integration and inheritance of the EPSPS gene cassette over several breeding generations. Statistical analyses show that GT is inherited as a dominant trait in a typical Mendelian manner (M).

Analysis of gene expression

Monsanto/FGI collected data on EPSPS protein concentrations from field trials conducted at several locations. The companies determined EPSPS protein concentrations using standard laboratory techniques. EPSPS concentrations on a fresh weight basis averaged 257 micrograms (µg)/gram in plants with event J101, 270 µg/gram in plants with event J163, and 252 µg/gram in plants from the population containing both events J101/J163. EPSPS is ubiquitous in plants and microorganisms and has not been associated with hazards from consumption or to the environment. Crops that contain this protein and have been granted non-regulated status have included corn, soybean, cotton, rapeseed, and sugar beet (USDA APHIS, 2010a). In 2009, significant acreages of corn (59 million acres or 68 percent of the total), upland cotton (6.3 million acres or 71 percent of the total) and soybean (70.5 million acres or 91 percent of the total) grown in the U.S. were planted with herbicide tolerant varieties (USDA NASS, 2010c). Although these acreages include all herbicide tolerant varieties, GT ones (containing CP4 EPSPS) predominate. All have also undergone FDA review (FDA, 2010).

Analysis of the intended trait

Monsanto/FGI conducted numerous field trials to evaluate RRA in different environments. Standard field trials evaluated (1) agronomic performance, (2) disease and pest resistance performance, and (3) seed multiplication. Agronomic practices used to prepare and maintain each field trial were characteristic of each representative region. Where the glyphosate herbicide Roundup® was used in trials, no negative impacts from application were noted (Rogan and Fitzpatrick, 2004).

3.1.3 Evaluation of possible unintended effects

Disease and pest susceptibility

On the basis of pest and disease susceptibility data reviewed by APHIS, RRA populations were no different from control or conventional alfalfa populations in the prevalence of or response to diseases or pests. Since the deregulation of RRA in 2005, there have been no reports of any change in disease or pest interactions in RRA compared to conventional alfalfa (USDA APHIS 2009).

During field trials from 1999 to 2003 and after deregulation of RRA in 2005, RRA has been grown over a broad geographic distribution of sites in the U.S. This has exposed RRA to a wide range of naturally occurring diseases. The principal alfalfa diseases in the U.S. affect the foliar, crown, root, vascular, and seedling health of alfalfa plants. Fungi are the primary pathogen type involved in most alfalfa diseases. Nematodes, bacteria, viruses, and other microbes can also reduce alfalfa production. The major economic diseases that occurred during field trials included: seedling damping-off (fungal genera such as *Pythium*, *Phytophthora*, *Aphanomyces*); foliar diseases (fungal genera such as *Leptosphaerulina*, *Colletotrichum*, *Peronospora*, *Phoma*, *Stemphylium*, *Cercospora*, and stem nematodes like *Ditylenchus*); and root rots, vascular wilts and crown diseases (fungal genera such as *Phytophthora*, *Aphanomyces*, *Verticillium*, *Fusarium*, *Phoma*, and bacterial wilt caused by *Clavibacter*) (USDA APHIS, 2009).

The major insect pest species affecting alfalfa vary between regions in the U.S. During field trials and after deregulation of RRA in 2005, RRA has been exposed to a wide range of naturally occurring insect pests. The principal economic insects included: potato leafhoppers

(*Empoasca fabae*), aphids [pea (*Acyrthosiphon pisum*), blue (A. kondoi) and spotted alfalfa aphids (*Therioaphis maculata*)], alfalfa weevil (*Hypera postica*), lygus bugs (*Lygus* species), other plant bug species (family *Miridae*) and alfalfa caterpillars (various Lepidopteran species). The disease and pest susceptibility observations for the field trials were provided to APHIS. These observations consistently showed no significant differences in the disease and insect susceptibility between events J101/J163 (or synthetic populations developed using both events) and the conventional control lines or commercial reference varieties. Although occasional differences were noted at some field sites, there were no concurrent trends of differences across field sites or years. This suggests that these differences were likely due to random variation. Additional disease ratings taken as part of the phenotypic comparative studies also indicate that diseases and pest incidence are unchanged in RRA compared to the control and that RRA is not more or less susceptible to pests or diseases than conventional alfalfa. Commercial experience and additional research conducted since the 2005 deregulation decision are consistent with the findings from field trials during the regulated period (USDA APHIS, 2009).

Gene silencing

In evolutionary biology, a homologous trait is one derived from a common ancestor that appears in multiple species. Homology may be manifested on a macro scale, for example, in the similarity in mammal forelimbs, and on a genetic scale, in DNA sequences. Al-Kaff et al. (1998) have noted gene silencing effects when transgenic plants have been infected by a virus with DNA sequence homology to a portion of the introduced genes. The only virus-derived DNA in the introduced gene cassette is the promoter, which is from the figwort mosaic virus. None of the viral diseases of alfalfa is related to figwort mosaic virus (Whitney and Duffus, 1986), so silencing of the EPSPS gene would not be expected and has not been observed.

Compositional changes

The composition of forage produced by RRA plants containing either event J101, J163, or the paired events J101 X J163 was measured and compared to the composition of control and conventional alfalfa forage (Rogan and Fitzpatrick, 2004). Monsanto/FGI analyzed alfalfa for compositional changes as part of their submission to FDA in the consultation process. While FDA uses these data as indicators of possible nutritional changes, APHIS views them as general indicators of possible unintended changes.

Compositional analyses evaluating carbohydrates, protein, ash, minerals, fiber, lignin, fat, and 18 amino acids (a total of 35 different components) identified three statistically different values compared with the control population for J101, seven statistically different values for J163, and 11 statistically different values for the paired J101 X J163 population. However, all analyses fell within the 99 percent tolerance interval developed from the conventional varieties grown in the same locations, providing additional evidence that J101, J163 and the paired J101 X J163 populations do not exhibit unexpected or unintended effects (USDA APHIS, 2005).

3.2 WEEDINESS PROPERTIES AND FERAL CROPS

This section addresses two questions:

1. What are the weediness properties of alfalfa?
2. Is RRA any more likely to become a weed than conventional alfalfa?

For information on feral alfalfa or volunteer alfalfa, refer to Section 2.6.2.

3.2.1 Weediness properties of alfalfa

Alfalfa (*Medicago sativa* L.) is not listed as a serious weed in *A Geographical Atlas of World Weeds* (Holms et al., 1991) or as a weed in *World Weeds: Natural Histories and Distribution* (Holms et al., 1997), *Weeds of the North Central States* (http://www.aces.uiuc.edu/vista/html_pubs/WEEDS/list.html), *Weeds of the Northeast* (Uva et al.,1997), or *Weeds of the West* (Whitson et al., 1992). Alfalfa is not listed as a noxious weed species by the U.S. Federal Government (7 C.F.R. Part 360) and is not listed as a weed in the major weed references (Crockett, 1977; Holm, Pancho et al., 1979; Muenscher, 1980) (USDA APHIS, 2009).

Although feral (free-living) populations of alfalfa are fairly common and volunteers may occur among succeeding crops, alfalfa is not considered a serious weed, a noxious weed, or an invasive species[41] in the U.S. The Interactive Encyclopedia of North American Weeds, Version 3.0, includes alfalfa (NCWSS, 2005). But this reference does not indicate why alfalfa is considered a weed. It may be included based on its potential occurrence as an unwanted volunteer in agricultural settings (USDA APHIS, 2009 p. H-13).

[41] A species that is not native to a particular ecosystem and whose introduction does or is likely to cause economic damage or environmental harm or harm to human health. Executive Order 13112 – Invasive Species (1999); USDA National Agricultural Library, 2010.

3.2.2 RRA and weediness

Some scientists, for example, Ellstrand (2006), have raised the question of "unintended crop descendents from transgenic [GE] crops." Ellstrand states (p. 116): "The possibility of unintended reproduction by transgenic crops has raised questions about whether their descendents might cause problems. These problems have fallen into two broad categories: first, the direct feral descendents of the crops may prove to be new weeds or invasives, and second, that unintended hybrids between transgenic crops and other plants could lead to certain problems." This section discusses the weediness properties of RRA, and addresses the concern of direct descendents of the crop that "may prove to be new weeds or invasives." Hybridization is addressed in several later sections.

Alfalfa does not naturally hybridize with any wild relatives in North America. Having established that there are no related, sexually compatible wild relatives in the U.S., movement of the CP4 EPSPS gene can only occur to cultivated or feral alfalfa populations through pollination by bees, dropped seeds or seed admixtures.

RRA events J101/J163 were field tested in North America from 1999 to 2003 and planted commercially after deregulation in 2005. APHIS reviewed data on characteristics that might relate to or have an effect on increased weediness. These included seed dormancy, seed germination, seedling emergence, seedling vigor, spring stand, spring vigor, seed yield, vegetative growth or plant vigor, plant dormancy, growth habit, flowering properties, and effect on symbiotic organisms (USDA APHIS, 2009). No unusual characteristics were noted that would suggest increased weediness of J101/J163 plants relative to the control populations.

In a separate evaluation, the Canadian Food Inspection Agency (CFIA), whose responsibilities include regulation of the introduction of animal food and plants (including crops) to Canada, reached the same conclusion about the weediness potential of events J101/J163 compared with non-transgenic alfalfa. In 2005, the CFIA authorized the "unconfined release into the environment and livestock feed use of alfalfa events J101/J163" (CFIA, 2005). In its evaluation of events J101/J163, CFIA "determined that stand establishment, enhanced growth, vigour or stand longevity; changes in susceptibility to plant pests and diseases common to alfalfa; increases in forage and seed yield and increases in seed dormancy were within the normal range of expression of these traits currently displayed by commercial alfalfa varieties" (CFIA, 2005). The CFIA reached the following conclusions (CFIA, 2005):

> No competitive advantage was conferred to these plants, other than that conferred by tolerance to glyphosate herbicide. Tolerance to Roundup®

agricultural herbicides will not, in itself, render alfalfa weedy or invasive of natural habitats since none of the reproductive or growth characteristics were modified.

The above considerations, together with the fact that the novel traits have no intended effects on alfalfa weediness or invasiveness, led the CFIA to conclude that alfalfa events J101/J163 have no altered weed or invasiveness potential compared to currently commercialized alfalfa.

3.2.3 Impacts

Alternative 1: No Action

Under Alternative 1, there would be no impacts from RRA on weediness properties of alfalfa or feral alfalfa because new RRA would not be grown commercially.

Alternative 2: Partial Deregulation of RRA

APHIS has concluded that alfalfa does not exhibit weediness properties, and that RRA does not exhibit any altered weediness properties when compared with conventional alfalfa. Therefore, Alternative 2 would not impact the weediness characteristics of alfalfa.

Feral, non-RRA exists throughout the U.S. RRA does not exhibit any increased feral growth potential when compared to conventional alfalfa. Therefore, Alternative 2 would not affect the feral growth potential of alfalfa.

Under Alternative 2, RRA volunteers in crop production would be controlled by mechanical means (e.g., tillage) or by application of one of several registered non-glyphosate herbicides.

3.3 IMPACTS OF RRA FORAGE CROPS ON CONVENTIONAL AND ORGANIC FORAGE CROPS

This section considers the possibility of impacts from RRA forage crops on conventional and organic forage crops through gene flow (refer to Section 2.3 for a general discussion of gene flow), or by mixing in harvesting or transportation.

3.3.1 Pollen sources in forage production fields

As discussed in Section 2.3, alfalfa is a short-lived perennial crop plant that peaks in forage yield during the second and third year. In the hay production fields, alfalfa is grown for its high nutritional value for cattle and horses. The nutritional value is at its highest during the plant's young vegetative state. As the plant approaches full flower, its nutritional value decreases. Therefore, alfalfa grown for hay is managed to limit growth to the juvenile state. Most alfalfa hay in the U.S. is harvested before 10 percent of the stems have one or more open flowers. Thus, most forage fields are cut before most plants have produced any pollen and prior to when they could be pollinated. This practice is widely recommended so that hay production and nutritional quality of the hay are optimized to maximize the farmer's economic productivity (USDA APHIS, 2009, p. 18-19, 100).

3.3.2 Potential for gene flow in forage production fields

Cross-pollination, if it occurred could potentially result in adventitious (inadvertent) production of embryos with the GT gene in a conventional or organic hay production field. Because alfalfa forage is typically managed for high quality and harvested before 10 percent bloom, and RRA forage producers are concerned with high quality, there is little potential for cross-pollination because the availability of pollen is minimized as a consequence of normal harvest activities. Furthermore, as mentioned in Section 3.3, in all but exceptional cases, native populations of bees are insufficient to effect economic levels of alfalfa seed pollination so they are augmented using cultured bee colonies. Unlike seed farmers, forage producers do not stock bees to produce the forage crop because they do not want or need pollination of their fields (USDA APHIS, 2009, p. 94; Rogan and Fitzpatrick, 2004).[42]

Nonetheless, if cross-pollination occurs in forage fields, the inadvertently pollinated plants are without gene flow consequence because they are almost always harvested before developing embryos mature to become viable seed. For effective gene flow from a RRA hay field to a conventional/organic hay field, each of the following must occur: (1) cross pollination between RRA and conventional plants; (2) delayed harvest allowing mature seed to form in the conventional/organic field; (3) mature RRA seed shattering and falling to the ground rather than being removed in forage harvest; (4) successful establishment of the new RRA seedling in the established conventional/organic alfalfa stand. Each of these requirements are unlikely and the combination of all of them happening is remote (Putnam, 2006; Van Deynze et al., 2008). Even in instances where weather or equipment failures delay harvesting of GT or non-RRA hay fields, there is little risk of unwanted GT gene flow into alfalfa production (Van Deynze et al., 2008). Alfalfa hay normally is harvested at or before first flower, 6 to 9 weeks before the ripe seed stage (Putnam, 2006; USDA APHIS, 2009 p.100). Regardless of proximity and management of a potential neighboring RRA hay field, a conventional/organic hay producer can eliminate any risk of potential pollen-mitigated RRA gene flow by simply harvesting prior to ripe seed stage.

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[42] An exception to the foregoing are an unknown number of conventional alfalfa forage producers who inadvertently or by agreement allow a honeybee keeper to forage bees on the alfalfa field to produce a honey crop or brood. (See USDA, 2009 at Appendix O.) This would be unlikely for RRA forage producers because producers generally cut before blooms are useful for honey production. Honeybees would be unlikely to forage on RRA forage fields because bloom would be managed to maintain high quality forage.

3.3.3 Potential consequences of gene flow in forage production fields

As discussed above, because alfalfa hay is harvested well before ripe seed is produced, gene flow into or between RRA and conventional forage crops is expected to be de minimis.

3.3.4 Growing and marketing alfalfa

Dairy farmers would be the most likely users of RRA hay because they often depend on pure alfalfa stands that are free of weeds and grasses, whereas, beef cattle producers and horse owners typically feed their animals a mix of alfalfa-grass hay (Putnam, 2005; USDA APHIS, 2009, p. 17).

The dairy industry has widely accepted biotechnology-derived products, including recombinant bovine somatotropin (rBST) used to increase a cow's milk production, and GT crops such as corn, soybean, canola, and cottonseed meal used in feed. However, organic dairy producers have rejected GT crops and require hay from organically grown (non-RRA) crops. Although organic milk production has grown considerably, it is still less than one percent of the total U.S. production (Miller, 2005; Putnam, 2006). Additionally, some horse owners may prefer using non-RRA feed. However, because many horses are sickened or die from poisonous weeds in hay, many horse owners may choose RRA. Like organic milk production, organic beef production will require non-RRA alfalfa. However, organic beef production is less than one percent of the total beef production industry, and the non-organic beef industry is not expected to be sensitive to RRA (NCBA, 2005; Putnam, 2006).

Less than two percent of U.S. alfalfa hay production is exported (NAFA, 2008b). The export of alfalfa hay is of particular economic interest in the Columbia Basin of Washington and the Imperial Valley of California, where local exporters, supported by local hay producers, have developed this market. Seven states in the western U.S. export approximately 4-5 percent of their production (NAFA, 2008b). The largest importers of U.S. produced alfalfa hay are Japan, South Korea, and Taiwan. RRA has been approved for import into these three countries, and to Canada and Mexico. These five countries together represent over 90 percent of total U.S. hay exports (USDA APHIS, 2009, Table 3-15, p. 55). Although there are no regulatory barriers for the vast majority of this market, customer preference may demand testing for adventitious presence (AP) of the RRA trait in conventional hay sold for export. Protein-based test strips and testing protocol have been developed to test hay destined for AP sensitive markets (Woodward et al., 2006). These low-cost testing methods have been widely adopted by the export industry to service the market segment requiring such tests, successfully avoiding any disruption of this important hay industry segment. (See USDA APHIS, 2009, p. Q-19).

3.3.5 Potential for and consequences of mechanical mixing

Alfalfa has small seeds that are planted, harvested, transported and processed for sale using large equipment designed especially for alfalfa seed crop handling. Seed growers and seed processing companies utilize lot segregation and equipment cleaning routines to remove seeds from equipment. Effective lot identification, segregation and equipment cleaning are practices required for the production of certified quality seeds. Vacuums, compressed air, sweeping, partial or complete disassembly, washing with water, etc. are effective means used to clean planting, harvesting, transportation, seed conditioning and seed treatment/coating equipment before or after use. These widely-adopted sanitation routines have been successful helping to assure negligible content of off-types, weed seeds, inert and non-crop mixtures (AOSCA, 2009).

As in all other agricultural production practices, there is possibility for mixtures between seed crops due to residual seeds in equipment, seed spillage, planting or lot blending mistakes or other human errors, however, the potential for impact is highly managed and therefore limited. Conventional seed crop handling practices vary widely and depend on the producer’s end product quality targets (e.g., common seed to certified seed markets). Historically (i.e., 20-50 years ago), conventional alfalfa seed has sometimes been transported in trucks or trailers and seed escapes along transportation routes were commonplace. In contrast, first, all RRA seed growers are uniformly obligated under their FGI seed grower contracts to observe certified seed standards for seed identification, segregation and handling (AOSCA, 2009). Second, RRA seed producers are obligated to following the NAFA BMP requirements for contained transportation of seeds, equipment sanitation, and obvious seed lot labeling, etc. (see below). FGI provides training and the secure, labeled seed bins to each RRA grower and monitors compliance to the contract requirements. The NAFA BMP stipulates the following sanitation, identification and segregation requirements that must be followed for all RRA seed production:

> Sanitation requirements. Manage equipment to minimize seed mixture potential between different varieties and or variety types. Growers shall use dedicated equipment for planting and harvesting RRA seed production, when possible. Zero tolerance for seed admixture is not feasible under commercial production conditions; however, grower must take reasonable steps to assure that equipment is clean prior to and after use in the Roundup Ready seed field. *Examples*: Planter inspection, clean-down before and after use; Combine inspection, clean-down thoroughly before and after use; RRA seed bins may only be used for RRA seed; maintain physical separation of varieties in storage; inspect bins before use; Handle all like-trait varieties together; plan for harvest

sequence of fields to maintain best separation of varieties by trait type; Clean all seed handling equipment to avoid mixing RRA and conventional seed; Return unused, unopened stock seed to the contracting seed company for credit; maintain in clean storage areas; When a contract harvester is used for RRA seed harvest, Growers must notify the contract harvester, in advance, that the field to be harvested is RRA (NAFA, 2008a).

Mechanical mixtures between lots in forage harvesting are possible, but mixing is limited in extent by the following common alfalfa forage practices (NAFA, 2008b): (1) Most hay (>75 percent) is harvested and fed on the same farm of production, therefore, growers know the type of variety planted in each field and fields are harvested separately. Fields lots are typically harvested separately and because each field may have a different feed quality level, the harvests are typically placed into separate storage areas for feeding. (2) Hay is not fungible during marketing, that is typically, each hay lot is identified, segregated and traceable to the field of origin during transportation, brokerage and sale. This is especially the case for organically certified crop products which must remain segregated from non-organically produced crops throughout all handling steps. (3) Some GE-sensitive hay marketers or feed processing facilities (meal, cubes, pellets) use commercial testing kits to test for the presence of the RRA trait in hay, thereby, offering a post harvest means to assure RRA hay segregation from non-RRA hay.

3.3.6 Impacts

Alternative 1: No Action

Under Alternative 1, there would be no impacts to growers of organic or conventional hay because RRA hay would not be grown commercially.

Alternative 2: Partial Deregulation of RRA

Based on the above discussions, RRA hay production under Alternative 2 would be expected to result in minimal impact for the following reasons:

- The reproductive biology of the alfalfa plant combined with normal harvest management for alfalfa forage provide for a de minimis likelihood of gene flow from one forage production field to another.
- Hay fields would be cut before seed is produced.
- A combination of geographic restrictions and gene flow mitigation measures (e.g harvest management requirements) significantly reduce the forage-to–seed gene flow interface. Gene flow mitigation measures (MT/SA and Technology Use Guide) are contractually

required for all RRA hay producers. These mitigation measures are practicable, contract-enforced, science-based, and market-driven. They have been designed to enable coexistence by mitigating all or nearly all unwanted gene flow between dissimilar crops and to aid in protecting non-GT, export, and organic hay and seed alfalfa crops. There have been negligible impacts since commercial seed production began in 2005 due to the efficacy of these BMP.

- Low-cost testing procedures are readily available to meet the needs of market requiring such tests.
- The conservative measures associated with this alternative include additional conservative forage/hay production restrictions that will ensure an extremely low likelihood and extent of gene flow from one production field to another.
- The biology, cultivation and marketing practices typically used in conventional alfalfa hay production limit the potential for physical and handling mixture to very low levels. The likelihood and extent of RRA and non-RRA mixtures are highly constrained by RRA seed grower practices stipulated and enforced under RRA seed grower contracts.
- RRA seed bag labeling and a unique purple seed colorant will be required for all RRA seed, which will notify RRA forage growers of the presence of the RRA trait and the limitations for product use. The colorant and bag labeling will reduce the likelihood of inadvertent planting by any organic or non-GE producer.
- As discussed in Section 3.8.1, conventional and organic alfalfa seed will continue to be available.

3.4 IMPACTS FROM RRA FORAGE CROPS ON NATIVE ALFALFA

As discussed in Section 2.6.1, no native members of the genus *Medicago* are found in North America. Therefore, there would be no impacts to native alfalfa under either alternative, because none exists.

3.4.1 Impacts

Because there are no native alfalfa populations in the U.S., there would be no impact with either alternative.

3.5 IMPACTS FROM RRA FORAGE CROPS ON FERAL ALFALFA POPULATIONS

The *M. sativa* species has naturalized populations in all 50 States (USDA APHIS, 2009, p. 23). Synchronous flowering of hay or seed production fields neighboring feral alfalfa will likely lead to cross-pollination. Feral alfalfa has the potential to act as a bridge for gene flow from GT alfalfa crops to non-GT alfalfa crops. First, the RRA hay or seed production field could serve as a pollen donor to the feral non-RRA. The subsequent feral GT offspring could then serve as the pollen donor to the non-GT hay or seed production field. Feral alfalfa near hay and seed fields should be controlled to avoid gene flow to the feral population (USDA APHIS, 2009, p. 101). Feral alfalfa in roadsides, ditchbanks and pastures is commonly controlled by mowing, disking, cultivation or the use of herbicides. Biogeographic survey data documents that, although climate and cropping practices are favorable for seed propagation, feral alfalfa is actually less abundant in seed producing geographies than other regions (Rogan and Fitzpatrick, 2004; Kendrick et al., 2005). Possible explanations for this observation are that, as seed producers follow seed certification standards requiring isolation, they routinely practice effective mitigations to control or prevent feral alfalfa populations (mowing, herbicides, cultivation). Also, alfalfa would not be intentionally planted in species mixtures in roadsides, pastures or rangelands where professional seed production occurs.

The barriers to gene flow into conventional/organic hay fields described in Section 3.3 also apply to pollen-mediated gene flow from RRA forage to feral alfalfa plants. These barriers also apply to pollen-mediated gene flow from feral alfalfa plants to conventional or organic alfalfa forage and will limit potential feral-to-hay gene flow to extremely low levels. Additionally, feral alfalfa will have low seed production plus damage from lygus bug and infection from seed-borne fungi when seed develops under damp conditions. (Putnam and Undersander, 2009 attached as Appendix I). The primary limitations to feral-to-seed gene flow is the relative paucity/abundance of pollen and proximity of pollinators in the field optimally managed for seed production, compared with a low density of feral plants growing some distance away and without the benefit of water, nutrient or pest control inputs (Van Deynze et al., 2008). A further mitigating factor is that Certified seed production requires a minimum 165 ft isolation between the seed production field and any feral alfalfa allowed to flower. Many seed growers have historically produced Certified seed.

3.5.1 Impacts

Alternative 1: No Action

Under Alternative 1, there would be no impacts regarding feral alfalfa because no RRA hay or seed would be produced commercially.

Alternative 2: Partial Deregulation of RRA

Based on the above discussions, Alternative 2 would be expected to result in minimal impact to feral alfalfa for the following reasons:

- The reproductive biology of the alfalfa plant combined with normal harvest management for alfalfa forage provide for a de minimis likelihood of gene flow from an RRA forage production fields to feral alfalfa and from feral alfalfa to conventional or organic forage production fields.
- The proposed limitations on the scope of allowed RRA seed production will be defined and stringently controlled as a means to mitigate the likelihood and possible extent of gene flow to non-RRA crops. The proposed restrictions have been designed to enable coexistence by mitigating all or nearly all unwanted gene flow between dissimilar crops and to aid in protecting non-GT, export, and organic hay and seed alfalfa crops. The restrictions include but are not limited to the following: isolation distance, seed field reporting, labeling, segregation and all other contractually required components of the NAFA BMP. All RRA seed acres will be grown under FGI contracts that require each field to be grown and inspected to meet State Seed Certification requirements including the requirement to isolate the field from other alfalfa within 165 ft.; this, therefore, includes control of feral alfalfa. These mitigation measures are practicable, contract-enforced, science-based, and market-driven. There have been negligible impacts since commercial seed production of RRA began in 2005 in large part due to the demonstrated efficacy of these BMP (NAFA, 2009; Fitzpatrick and Lowry, 2010 attached as Appendix K).
- The conservative measures associated with this alternative include additional conservative seed production and forage/hay production restrictions that will ensure an extremely low likelihood and extent of gene flow from one production field to feral alfalfa from feral alfalfa to conventional or organic forage production fields.

3.6 IMPACTS FROM RRA FORAGE CROPS TO RANGELAND ALFALFA CROPS

Commercially cultivated alfalfa and feral alfalfa populations properly belong to the *M. sativa* complex, a group of closely related subspecies that are reproductively compatible. The most commonly cultivated alfalfa in the world is *M. sativa* subsp. *sativa*, but subspecies *falcata* is also cultivated on a limited basis, primarily under rangeland conditions and in colder regions (USDA APHIS, 2009, p. 30).

Rangeland alfalfa populations might increase if certain ranchers intentionally seed alfalfa to increase hay quality and soil nitrogen (Waggener, 2007; High Plains Midwest Ag Journal, 2008). As has historically been the case, seed producers will remain aware of seeding practices in neighboring rangelands, ditchbanks, pastures, roadsides, or other minimally-managed areas.

Both subspecies *M. sativa* subsp. *sativa* and M. s. subsp. *falcata*, have been historically used to derive alfalfa cultivars in North America. In addition to *M. s.* subsp. *sativa* (purple flowered alfalfa), *M. s.* subsp. *falcata* has been used as a winterhardy germplasm source by alfalfa breeders since at least the early 1950s. Therefore, the potential for natural gene flow between subspecies *sativa* and *falcata* is well documented and well understood (Monsanto-FGI comment to the DEIS Appendix 1 p. 14). It is reasonable to predict that hybridization between rangeland *falcata* subspecies and RRA varieties with mostly *sativa* parentage would occur, but they would present no novel or unstudied risk. The limited number of acres of falcata and the barriers for gene outflow from cultivated hay field sources (Putnam, 2006; Van Deynze et al., 2008) will limit the likelihood and extent of effective gene flow from RRA forage production to any synchronous alfalfa plants naturalized in the rangeland. Additionally, gene flow from a naturalized *falcata x sativa* plant to neighboring conventional or organic forage or production fields would be limited by the expected very low frequency of RRA varieties in rangeland usage and the array of gene flow barriers described in Van Deynze et al. (2008).

3.6.1 Impacts

Alternative 1: No Action

Under Alternative 1, there would be no impacts to rangeland alfalfa because no RRA hay or seed would be produced commercially.

Alternative 2: Partial Deregulation of RRA

Based on the above discussions, Alternative 2 would be expected to result in minimal impact to rangeland alfalfa for the following reasons:

- The reproductive biology of the alfalfa plant combined with normal harvest management for alfalfa forage provide for a de minimis likelihood of gene flow from one forage production field to another.
- Gene flow mitigation measures (MT/SA, FGI Stewardship Program, and NAFA BMP for RRA Seed Production) are contractually required for all RRA seed producers. These mitigation measures are practicable, contract-enforced, science-based, and market-driven. They have been designed to enable coexistence by mitigating all or nearly all unwanted gene flow between dissimilar crops and to aid in protecting non-GT, export, and organic hay and seed alfalfa crops. There have been negligible impacts since commercial seed production began in 2005 due to the efficacy of these BMP (NAFA, 2009; Fitzpatrick and Lowry, 2010).
- Glyphosate is minimally used in rangeland situations, and therefore there would be no selective advantage for RRA plants in the rangeland. (USDA APHIS, 2009, p. 98-99).
- The conservative measures associated with this alternative include additional conservative seed production and forage/hay production restrictions that will ensure an extremely low likelihood and extent of gene flow from one production field to another.
- As discussed in Section 3.8.1, conventional and organic alfalfa seed will continue to be available.

3.7 IMPACTS FROM RRA FORAGE CROPS TO CONVENTIONAL OR ORGANIC ALFALFA SEED PRODUCTION AREAS

There is potential for cross-pollination due to synchronous flowering in a RRA forage crops and adjacent non-RRA seed crops. As seed producers follow AOSCA isolation distances for seed certification, gene flow will be minimized because gene flow decreases exponentially with distance from crop (Van Deynze et al., 2008) (see also discussion in Section 2.3). Research from Teuber et al. (2007) showed that hay-to-seed gene flow is low if the AOSCA certified seed isolation distance of 165 ft from sexually compatible crops is observed. In that study, at a distance of 165 ft, the extent of gene flow to nearby seed fields was less than 0.5 percent even when neighboring alfalfa hay fields were harvested at 20 or 50 percent bloom. (Hay fields are typically harvested before 10 percent bloom.) When the isolation distance from the edge of the seed crop to neighboring alfalfa forage fields was increased to 350-600 ft, the gene flow decreased to a mean of 0.01 percent (Van Deynze et al., 2008).

3.7.1 Impacts

Alternative 1: No Action

Under Alternative 1, there would be no impacts from RRA forage crops to conventional or organic seed production crops because no RRA hay or seed would be produced commercially.

Alternative 2: Partial Deregulation of RRA

Based on the above discussions, Alternative 2 would be expected to result in minimal impact from RRA forage crops to conventional and organic seed production areas the following reasons:

- Alfalfa forage production fields are generally cut prior to 10 percent bloom and before seed is allowed to set.
- Gene flow mitigation measures (MT/SA and Technology Use Guide) are contractually required for all RRA hay producers. These mitigation measures are practicable, contract-enforced, science-based and market-driven. They have been designed to enable coexistence by mitigating all or nearly all unwanted gene flow between dissimilar crops and to aid in protecting non-GT, export, and organic hay and seed alfalfa crops. There have been negligible impacts since commercial seed production began in 2005 due to the efficacy of these BMP.
- Under Restriction Enhancement A of the proposed measures, in states where alfalfa seed production fields were historically (2007) or are currently present, if the RRA forage field is located within 165 ft of a commercial, conventional, seed production field, the RRA grower must harvest forage before 10 percent bloom. This restriction is the science- and market-based, industry recognized isolation distance for certified alfalfa seed crops, and the potential and extent of gene flow of 10 percent bloom hay to nearby seed crops is de minimis at a distance of 165 ft (Teuber and Fitzpatrick, 2007; Van Deynze et al., 2008).
- Additionally, in states where there is more than 100,000 lbs. of annual alfalfa seed production, additional restrictions apply by county to further reduce the potential for gene flow. In counties without seed production, RRA forage growers must report the GPS location of all RRA fields. Under Restriction Enhancement C, in counties with seed production, no new RRA forage plantings are allowed.

- As discussed in Section 3.8.1, conventional and organic alfalfa seed will continue to be available.

3.8 IMPACTS FROM RRA SEED PRODUCTION

3.8.1 Cross-pollination

The greatest potential for cross-pollination and mixing among crop species occurs in seed production because that is where pollination is intended to, and does, occur (see description in Section 2.1.2). The relationships between isolation distance, pollinator species and pollen-mediated gene flow in alfalfa seed production has been studied extensively (Van Deynze et al, 2008). This science informed the current industry standards for isolation in NAFA Best Practices for RRA Seed Production (www.alfalfa.org) and was validated in 2008 and 2009 in large scale surveys of adventitious presence of the RRA trait in conventional seed (Fitzpatrick and Lowry, 2010). Physical mixing of seeds can occur during harvesting, seed cleaning, packaging, and transport. These activities are also governed by NAFA Best Practices for RRA Seed Production, and are components of adventitious presence evaluated in the annual third party audit/validation conducted on commercial seed lots.

The production of non-RRA alfalfa seed and forage both rely on continued availability of non-RRA parent seed, with non-detectable levels of the RRA trait. There is a clear consensus in the industry that there will always be a market (domestic and international) for non-RRA varieties developed and produced in the U.S. There is no reason to believe that industry and/or university alfalfa breeders will not continue to develop varieties for these markets. The production of Breeder seed generation (Syn1) alfalfa seedstock is often done in a screen cage to exclude incoming pollinators, so there should be no new incremental effort required to avoid low level gene flow from neighboring RRA seed or hay production. The production of Foundation (Syn2) alfalfa seedstock requires adherence to AOSCA standards, which include extraordinary isolation from all neighboring alfalfa (seed, hay or uncultivated sources). The standard Foundation seed required isolation of 900 ft is often sufficient to eliminate gene flow from neighboring RRA alfalfa seed or hay production, but occasionally very low levels of adventitious presence are found. When a non-detect standard for Foundation seed is adopted by the breeder, use of an additional isolation distance would decrease the risk of low level gene flow. As a general practice of stringent quality control, Breeder and Foundation seed is routinely evaluated for trueness-to-type, including a lack of off-types. In the event of a low incidence of an off-type, such as presence of the RRA trait in conventional alfalfa, breeders routinely cull the off-type plants and repeat the variety seed increase (APHIS, 2009, Appendix V). Adherence to

AOSCA standards for certified seed production and attention to detail in quality control of seedstocks has been a successful strategy for high quality U.S. seed production by American seed companies (Monsanto/FGI Comments to draft EIS at p. 6-7). Additionally, in cooperation with several U.S. alfalfa seed companies, AOSCA (2010) has developed a new seed production protocol for the production of alfalfa seed. The new protocol is tailored to meet the needs of seeds destined for export, organic and other sensitive market channels where biotechnology traits are expressly excluded. Meeting the specific and incremental requirements of this "special" AOSCA certification program allows the seed producer to label the seed with a statement certifying adherence to the AOSCA program (Monsanto/FGI Comments to draft EIS at p. 5; NAFA, 2008b; NAFA, 2008c; NAFA, 2008d).

3.8.2 Seed Mixing

The biology, cultivation and marketing practices typically used in conventional alfalfa seed and hay production limit the potential for physical and or handling mixtures to very low levels. The likelihood and extent of RRA and non-RRA mixtures are negligible and highly constrained by RRA seed grower practices stipulated and enforced under RRA seed grower contracts. Organic or other GE sensitive hay producers will opt to plant non-GE seeds and will follow their routines for maintaining segregation between hay lots. The impacts to non-RRA markets are expected to be negligible, especially because all RRA seed and hay growers must manage their crop according to their obligations under contracts, licensing, seed certification standards and or segregation standards for organic crops.

RRA is compositionally similar to seed and forage from conventional alfalfa. Therefore, from a food and or feed safety perspective, the impact of mixtures between RRA and non-RRA seeds or forage is negligible. However, as discussed elsewhere in this document (Sections 3.3.4, 3.3.5, 3.15 and 4.10) and extensively throughout the DEIS (USDA APHIS, 2009), there is a segment of consumers and markets that due to their rejection of GE crops or traces thereof, may experience socio-economic concerns and nominal (and voluntary) GE mitigation/avoidence costs (e.g., testing costs).

3.8.3 Impacts

Alternative 1: No Action

Under Alternative 1, there would be no impact from RRA seed production on organic or conventional alfalfa seed production because no RRA hay or seed would be produced commercially.

Alternative 2: Partial Deregulation of RRA

Under the partial deregulation alternative, there would be no or negligible impacts to growers of organic or conventional alfalfa seed for the following reasons:

- Gene flow mitigation measures (FGI Stewardship Program, and NAFA BMP for RRA Seed Production) are contractually required for all RRA seed producers. The isolation distances and other mitigation measures required by the NAFA BMP are practicable, contract-enforced, science-based and market-driven. They have been designed to enable coexistence by mitigating all or nearly all unwanted gene flow between dissimilar crops and to aid in protecting non-GT, export, and organic hay and seed alfalfa crops. There have been negligible impacts since commercial seed production began in 2005 due to the efficacy of these BMP. The eight RRA seed grower consortia authorized to plant under partial deregulation would meet or exceed the NAFA BMP parameters with enhanced additional isolation requirements. The minimum required isolation from conventional, commercial seed fields will be 4 miles and 1 mile when honeybees or leafcutter bees are the managed pollinating species, respectively. The potential for gene flow at the NAFA BMP isolation is de minimis (Van Deynze et al., 2008), and the proposed increase to the isolation requirement would further ensure de minimis gene flow potential from RRA seed fields to conventional seed crops should they be present.
- The biology, cultivation and marketing practices typically used in conventional alfalfa seed production limit the potential for physical and handling mixture to very low levels. The likelihood and extent of RRA and non-RRA mixtures are highly constrained by RRA seed grower practices stipulated and enforced under RRA seed grower contracts.
- Conventional and organic alfalfa seed will continue to be readily available to growers.

3.9 LIVESTOCK PRODUCTION SYSTEMS

RRA alfalfa will be used in livestock production systems as feed for livestock. Therefore, its only potential impacts to livestock production systems would be related to animal feed, which is discussed in Section 3.10.

3.10 FOOD AND FEED

Both food (sprouts, dietary supplements, and herbal or homeopathic medicine) and animal feed (hay, haylage, or silage) are derived from alfalfa. In this section we summarize the large body of scientific evidence that has been developed that supports the conclusion that food and feed derived from RRA are as safe and healthy as food and feed derived from conventional alfalfa. While the evidence has largely been developed by Monsanto and/or FGI, it has been evaluated and peer reviewed by FDA and by panels of government scientists from Canada, Japan, Australia, New Zealand, Mexico, Korea, and the Philippines, all of whom have approved, or recommended for approval, the use of products from RRA in their countries.

We begin with a summary of FDA's authority and policy under the FFDCA with regard to ensuring the safety of food and feed derived from genetic engineering, documenting each element FDA evaluated in its consultation process. We then summarize the evaluations and conclusions of several other international scientific oversight groups.

3.10.1 FDA authority and policy

FDA policy statement. In 1992, the FDA issued a policy statement clarifying its interpretation of the FFDCA regarding foods (including animal feed) derived from new plant varieties, including plants developed by genetic engineering. The purpose of the policy is "to ensure that relevant scientific, safety, and regulatory issues are resolved prior to the introduction of such products into the marketplace" (FDA, 1992). FDA is the "primary federal agency responsible for ensuring the safety of commercial food and food additives, except meat and poultry products" and "FDA has ample authority under the FFDCA safety provisions to regulate and ensure the safety of foods derived from new plant varieties, including plants developed by new techniques. This includes authority to require, where necessary, a premarket safety review by FDA prior to marketing of the food" (FDA, 1992). Under section 402(a)(1) of the FFDCA, a food is adulterated and thus unlawful "if it bears or contains an added poisonous or deleterious substance that may render the food injurious to health or a naturally occurring substance that is ordinarily injurious" (FDA, 1992).

FDA has the authority to ensure safety of new foods. FDA considers its existing statutory authority under the FFDCA and its implementing regulations "to be fully adequate to ensure the safety of new food ingredients and foods derived from new varieties of plants, regardless of the process by which such foods and ingredients are produced" (FDA, 1992). "The existing tools provide this assurance because they impose a clear legal duty on producers to assure the safety of foods they offer to consumers; this legal duty is backed up by strong enforcement powers; and FDA has authority to require premarket review and approval in cases where such review is required to protect public health" (FDA, 1992).

Developers have the responsibility to evaluate the safety of new foods. "It is the responsibility of the producer of a new food to evaluate the safety of the food and assure that the safety requirement of section 402(a)(1) of the act is met. FDA provides guidance to the industry regarding prudent, scientific approaches to evaluating the safety of foods derived from new plant varieties, including the safety of the added substances that are subject to section 402(a)(1) of the act. FDA encourages informal consultation between producers and FDA scientists to ensure that safety concerns are resolved" (FDA, 1992).

Foods developed by new methods do not present greater safety concerns. "FDA believes that the new techniques are extensions at the molecular level of traditional methods and will be used to achieve the same goals as pursued with traditional plant breeding. The agency is not aware of any information showing that foods derived by these new methods differ from other foods in any meaningful or uniform way, or that, as a class, foods developed by the new techniques present any different or greater safety concern than foods developed by traditional plant breeding" (FDA, 1992).

FDA's goal is to ensure the safety of all food and feed. "The goal of the FDA's evaluation of information on new plant varieties provided by developers during the consultation process is to ensure that human food and animal feed safety issues or other regulatory issues (e.g. labeling) are resolved prior to commercial distribution" (FDA, 1997).

3.10.2 FDA biotechnology consultation note to the file BNF 000084

FDA makes the contents of its biotechnology notification files (BNFs) available on the internet (see reference FDA, 2004; RRA is BNF 000084). FDA documented its RRA consultation with Monsanto/FGI in a note to the file dated December 8, 2004 (FDA, 2004). That information is summarized below.

Characterization, inheritance, and stability of the introduced DNA

Using standard analytical techniques, Monsanto/FGI verified that events J101/J163 contained a single copy of the CP4 EPSPS cassette, and that all components were intact (FDA, 2004; Rogan and Fitzpatrick, 2004).

Monsanto/FGI conducted crosses using conventional breeding techniques. These studies indicate that the introduced trait (glyphosate tolerance) was stably inherited as a dominant trait (FDA, 2004; Rogan and Fitzpatrick, 2004).

Using standard analytical techniques, Monsanto/FGI demonstrated the stable integration of the T-DNA over five generations (Rogan and Fitzpatrick, 2004).

Introduced substance – CP4 EPSPS enzyme

As discussed in Section 3.1.1, EPSPS is a catalyst for a reaction necessary for the production of certain aromatic amino acids essential for plant growth and has a similar function in bacteria and fungi (for example, baker's yeast). While EPSPS is present in plants, bacteria and fungi, it is not present in animals; animals do not make their own aromatic amino acids, but rather obtain them from the foods they consume. Thus, EPSPS is normally present in food and feeds derived from plant and microbial sources (Harrison et al., 1996). There are variations in the genetic makeup (amino acid sequences) of EPSPS among different plants and bacteria. The EPSPS used in Agrobacterium sp. strain CP4 is just one variant of EPSPS. A unique characteristic of CP4 EPSPS is that, unlike EPSPS commonly found in plants, it retains its catalytic activity in the presence of glyphosate (FDA, 2004; Rogan and Fitzpatrick, 2004).

Concentrations in alfalfa. CP4 EPSPS protein levels in sample extracts were measured using standard methods, with the resulting average concentration of approximately 0.02 to 0.03 percent (192 to 317 parts per million) (Rogan and Fitzpatrick, 2004).

Toxicity of CP4 EPSPS. The FDA concluded that "the CP4 EPSPS protein produced by RRA lines J101/J163 was biochemically and functionally equivalent to CP4 EPSPSs produced by other RR crops, and to the family of EPSPS proteins that naturally occur in crops and microbiologically-based processing agents that have a long history of safe consumption by humans and animals" (Hendrickson and Price, 2004). This similarity of the CP4 EPSPS protein to EPSPS's in a variety of foods supports the lack of health concerns and extensive human and animal consumption of the family of EPSPS proteins (Rogan and Fitzpatrick, 2004).

Studies were conducted on mice, using CP4 EPSPS doses of 400, 100, and 40 milligrams (mg) of CP4 EPSPS per kilogram (kg) of body weight per day (mg/kg body wt –d). For a typical 0.03-kg mouse, the 400 mg/kg body wt –d dose equated to 12 mg per mouse per day. The study was designed to reflect a 1,000-fold factor of safety on the highest possible human exposure to CP4 EPSPS, based on assumed exposures to soybean, potato, tomato, and corn at the time the study was done (Harrison et al., 1996). The daily CP4 EPSPS content in the maximum mouse exposure was equivalent to the amount in approximately 160 pounds of RRA. No treatment-related adverse effects were observed, and there were no significant difference in any measured endpoints between the CP4 EPSPS treated mice and the control group (Harrison et al., 1996, p. 735).

Monsanto/FGI also compared the amino acid sequence of CP4 EPSPS to protein sequences in the public domain ALLPEPTIDES database using the FASTA algorithm, and reported no biologically relevant sequence similarities between CP4 EPSPS protein and known toxins were observed (Bonnette, 2004). A peptide is a molecule consisting of several linked amino acids (GMO Safety, 2010a).

Allergenicity. Allergens can be derived from many sources: in animal hair, pollen, insect bites, dust mites, plants, pharmaceuticals, and food. Approximately 20,000 allergens have been identified. Most allergens in food are high molecular weight proteins and are rather resistant to gastric acid and digestive enzymes (GMO Safety, 2010a).

Monsanto searched a comprehensive database of allergens (Hileman et al., 2002) containing sequences of known allergens, for amino acid homology to the CP4 EPSPS protein, and concluded that there was no immunologically significant amino acid sequence homology between the CP4 EPSPS protein and amino acid sequences of allergens in the database (Bonnette, 2004).

At least two studies have been conducted on the mammalian digestibility of CP4 EPSPS. In the first study, the CP4 EPSPS protein was exposed to simulated gastric (stomach) and intestinal fluids that were prepared according to the U.S. Pharmacopoeia (1990). The half-life of the CP4 EPSPS protein was reported to be less than 15 seconds in the gastric fluid, greatly minimizing any potential for the protein to be absorbed in the intestine. The half-life was less than ten minutes in the intestinal fluid (Harrison et al., 1996, p 738). The second study reported similar results (Bonnette, 2004). Specifically, FDA (2004) noted the following from the Monsanto/FGI submmittal: the soil bacterium used to create RRA is not a known allergen or pathogen (does not cause allergic reactions or diseases); the CP4 EPSPS gene and protein lack structural similarities to any allergen (it does not have the same structure as anything that causes allergic reactions).

Food and feed uses of alfalfa

Alfalfa has a long history as a feed source for animals. Greater than 95 percent of alfalfa is used as animal feed.

Human food uses of alfalfa are minor and it is consumed as compressed leaf material for dietary supplements and herbal teas or as fresh sprouts. The seeds germinated for sprouts are produced and marketed in a distinct, food-grade channel from those for field (non-food) purposes (Section 2.7). A small fraction of alfalfa seeds are used to produce sprouts for human consumption. Any alfalfa seed for sprouts must be certified as having been produced to food-grade specifications and therefore food-grade seed is grown and distributed in an entirely separate channel from that for general use, non-food-grade planting seeds. Food-grade seeds for sprouts are produced throughout the world, but the major suppliers are Canada, Italy, U.S. and Australia. Sprouts are cultivated from clean raw (non-coated, untreated) seeds in controlled environment sprouting chambers for approximately 5 to 10 days before sale to consumers.

FDA and equivalent regulatory bodies in Japan, Korea, Canada, Australia/New Zealand, etc., have granted full approval for the use of RRA as a food (see Section 3.11). Monsanto and FGI have developed the RRA varieties for field planting purposes (only), and as such the companies do not intend nor allow (give license to) any seed growers or seed purchasers to use RRA varieties for food-grade sprout production (Hubbard, 2008; USDA APHIS, 2009, p. 18). The FGI mandated purple seed coating for all commercial RRA seed helps mitigate unintended use of RRA seed for sprouts.

Alfalfa is the principal forage for cattle and horses because of its high nutritional content. The nutritional content of alfalfa is highest in young vegetative alfalfa plants and decreases as plants approach full flower. Dairy cows are generally fed the highest quality alfalfa hay (vegetative to bud stage). Beef cattle, horses, heifers, and non-lactating dairy cows are fed hay that is higher in fiber and lower in protein. Forms of storage include hay, haylage, and silage. Grazing is sometimes used as an alternative to harvesting alfalfa. However, grazing presents a risk of animal loss due to bloating and difficulties in alfalfa stand maintenance if grazing is continuous (Rogan and Fitzpatrick, 2004).

Honey bee hives commonly use alfalfa and clover as nectar sources. Therefore, managed and wild bee hives are often associated with alfalfa fields (FDA, 2004; USDA, 2009 draft EIS Appendix O).

Compositional analysis

To assess whether alfalfa events J101/J163 are as safe and nutritious as conventional alfalfa varieties, the composition of forage produced by Roundup Ready alfalfa plants containing either event J101, J163, or the paired events J101 X J163 was measured and compared to the composition of control and conventional alfalfa forage. This study was conducted under USDA

Notification Number 01-029-12n. Forage was harvested from plants grown in field trials and analyzed using standard methods or other suitable methods (Monsanto, 2004).

Forage samples were collected from all plots and analyzed for 35 different nutritional components. Compositional analyses of the forage samples included proximates (protein, fat, ash and moisture), acid detergent fiber (ADF), neutral detergent fiber (NDF), lignin, amino acids, and minerals (calcium, copper, iron, magnesium, manganese, phosphorous, potassium, sodium and zinc), as well as carbohydrates by calculation. In all, 35 different components were analyzed to assess the composition of Roundup Ready alfalfa (Rogan and Fitzpatrick, 2004).

Statistical analyses were performed on the compositional data for the RRA containing events J101/J163. As expected, statistically significant differences were observed for the concentration of some of the analytes in comparison to the control. Where values were different, the mean was within the 99 percent tolerance interval developed for the analyte using conventional alfalfa reference varieties. Therefore, it is unlikely that these differences are biologically meaningful. These data are consistent with the conclusion that forage produced by alfalfa plants containing event J101 or J163 is comparable to forage produced by control or conventional alfalfa varieties. These compositional data support the conclusions derived from other phenotypic studies indicating that no biologically meaningful changes were associated with alfalfa populations containing event J101 or event J163 (Monsanto, 2004).

Conclusion

Based on the data submitted, the FDA considered the consultation process to be complete and acknowledged this in Biotechnology Consultation Note to the File BNF No. 000084 (FDA, 2004).

3.10.3 Health Canada approval 2005

Health Canada's Food Directorate has legislated responsibility for premarket assessment of "novel foods." Under Canadian regulations, foods derived from alfalfa lines containing events J101/J163 are considered novel foods because they are derived from a plant that has been GM to exhibit characteristics that were not previously observed in the plant (Health Canada, 2005).

Health Canada conducted a comprehensive assessment of GT alfalfa lines containing events J101/J163 according to its "Guidelines for the Safety Assessment of Novel Foods," reviewing the same information Monsanto/FGI provided to FDA in its consultation, and made the following conclusion (Health Canada, 2005):

> "Health Canada's review of the information presented in support of the food use of glyphosate tolerant alfalfa lines containing events J101/J163 concluded that

> the food use of alfalfa lines containing this event does not raise concerns related to safety. Health Canada is of the opinion that alfalfa lines containing events J101/J163 are as safe and nutritious as current commercial alfalfa varieties."

3.10.4 CFIA approval 2005

The CFIA evaluated GT alfalfa events J101/J163 for use as livestock feed and approved their use in 2005. Based on its evaluation of data provided by Monsanto/FGI, and as summarized in its Decision Document DD2005-53, the CFIA "determined that these plants with a novel trait (PNT) do not present altered environmental risk nor, as a novel feed, do they present livestock feed safety concerns when compared to currently commercialized alfalfa varieties in Canada" (CFIA, 2005).

3.10.5 Japan approval

Japan approved the food use RRA in 2005 and the feed use in 2006. Environmental approval was also granted in Japan in 2006 (Japan Biosafety Clearinghouse, 2010; Center for Environmental Risk Assessment, 2010).

3.10.6 Australia – New Zealand approval

Food Standards Australia New Zealand (FSANZ) is a bi-national government agency with responsibility to develop and administer the Australia New Zealand Food Standards Code. FSANZ approved the food use of RRA in 2006 (FSANZ, 2006). FSANZ found "no public health and safety concerns. On the basis of the available evidence, including detailed studies provided by the Applicant, food derived from GT lucerne J101/J163 is considered as safe and wholesome as food derived from other commercial lucerne varieties." (FSANZ, 2006, p. ii).

3.10.7 Other approvals

RRA was also approved for use as food and/or feed in Mexico in 2005 (Ministry of Health), in the Philippines in 2006 (Department of Agriculture Bureau of Plant Industry), and in Korea in October 2007 (Center for Environmental Risk Assessment, 2010). Environmental approval was granted in Korea in January 2008 (Rural Development Administration).

3.10.8 Impacts

Alternative 1: No Action

Under Alternative 1, there would be no impact from RRA on feed or food, or on consumer choice.

Alternative 2: Partial Deregulation of RRA

Health effects of consumption of RRA. Alfalfa is consumed as both animal feed (hay/haylage) and human food (e.g., alfalfa sprouts). Based on the scientific evidence summarized in this section, health impacts from consuming RRA food or feed are not expected from RRA. Feed derived from RRA is equivalent to feed derived from conventional alfalfa. Although RRA has been found to be equivalent to conventional alfalfa by several international scientific agencies, Monsanto/FGI have determined that RRA will not be licensed for use for any human food purposes.

Health and consumer choice effects of consumption of food or feed derived from RRA. Beef and dairy products may be derived from cattle/cows that have consumed RRA. The Food and Agricultural Organization of the United Nations (FAO), the World Health Organization (WHO), and the Organization for Economic Cooperation and Development (OECD) have made statements regarding the potential for the protein encoded by the transgene (the CP4 EPSPS protein) to transfer to animal-derived products intended for human consumption (FAO/WHO 1991; FDA 1992; OECD 2003). These reports, as well as the studies summarized above in this section have concluded that the CP4 EPSPS protein is equivalent to other forms of the EPSPS protein, and that food and feed containing the CP4 EPSPS protein is as safe and nutritious as the conventional counterparts. As discussed in Section 3.10.1, the half-life of the CP4 EPSPS protein in the digestive system is only a few minutes; no detectable amounts of the CP4 EPSPS protein are expected to be found in beef or dairy products from animals fed RR alfalfa. Although uncommon, fragments of transgenes have been found in dairy and animal products (Flachowsky and others, 2005). If very low levels of transgenic fragments could be infrequently found in dairy products and beef from cattle/cows consuming RRA, presumably they would also be present in the same products, from the use of corn as cattle feed, as most corn grown in the U.S. is genetically engineered. Honey from bees is mostly fructose and glucose; however, possibly it could have minute fragments of transgenic DNA from pollen from RRA. The presence of DNA fragments, GE or otherwise, is not a health issue (on the safety of DNA (FDA, 1992); however, depending on how “non-GE food” is defined, it could affect a consumer’s choice to consume non-GE food. The minute levels that might potentially be found in honey, beef or dairy products would, for example, be far below the threshold standards for non-GE food proposed by the Non-GMO Project (Section 1.5). A consumer with “zero tolerance” for beef or dairy derived from GE products or that might contain minute fragments of transgenes would have the choice of consuming organic honey, beef and dairy products. Presumably that consumer would already be consuming organic beef and dairy products because of the use of GE corn as cattle feed. Market demand will ensure that conventional and organic alfalfa will still be available to the dairy or cattle farmer who wishes to avoid RRA.

Summary. Based on the above analysis, Alternative 2 would be expected to have no or negligible impacts on food or feed, or consumer choices regarding food or feed.

3.11 WEED CONTROL AND GR

3.11.1 Weed control with conventional alfalfa

Weed management is an important aspect of alfalfa production. Some of the negative effects of weeds in alfalfa crops include the following:

- 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) (e.g., common groundsel, fiddleneck, yellow starthistle, and poison hemlock) can make alfalfa hay unmarketable;
- 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);
- some weeds can contribute to off flavors in milk (e.g., wild celery, Mexican tea, creeping swinegrass, and mustards); and
- weeds that contain higher moisture content than alfalfa (e.g., dandelion) can cause bale problems such as mold, off-color hay, and high bale temperatures, which are a fire hazard.

(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; Orloff et al., 2009, attached as Appendix D; USDA APHIS, 2009 pp. 105-06).

Without weeds, alfalfa can grow at a density of about 12 plants per square foot. Heavily weed-infested stands can have less than one alfalfa plant per square foot (Canevari et al., 2007). In California, if weeds are not effectively controlled, they can represent up to 76 percent of the first cutting yields (USDA APHIS, 2009, p. 106).

3.11.2 Weed control with RRA

The following discussion of RRA and weed management was based largely on the technical report, *Effects of Glyphosate-Resistant Weeds in Agricultural Systems* (USDA APHIS 2009, Appendix G, attached as Appendix E of this ER).

RRA can be used by farmers for weed management in alfalfa crops. Its unique characteristics allow for effective weed control throughout the growing season of an alfalfa crop, and, alfalfa and alfalfa farming practices per se have characteristics that will complement the weed control provided by glyphosate and, as such, will aid in the suppression of the development of GR weeds. The ability for alfalfa to fix nitrogen encourages the decision to follow alfalfa in the rotation with a crop that requires additional nitrogen, such as the annual grasses of corn and various cereal crops. These subsequently rotated crops can tolerate a spectrum of herbicides substantially different from the herbicides used in alfalfa. This encourages rotation of crops and herbicides, both of which are highly recommended for reducing the probability of developing herbicide resistant weeds (Orloff et al., 2009; USDA APHIS, 2009, p. 109).

Alfalfa produced for forage purposes (e.g., hay and silage in GE, conventional, or organic production systems) is mowed regularly at a recommended cutting height of 3 inches. This removes all plant material higher than 3 inches including weeds (Orloff et al., 1997), which may not have had time to produce flowers, pollen or seed. This regular removal of all plant mass above 3 in. of the soil surface, including all vegetative weed material, greatly suppresses or eliminates seed production in weed species, and is especially effective in controlling annual weeds (USDA APHIS, 2009, p. 109).

In a RRA farming system for forage, the combination of broad spectrum weed control from glyphosate (which should lead to more vigorous alfalfa competition), and regular mowing, which reduces the likelihood that any GR weeds in the RRA field have had time to produce pollen or set seed, greatly decreases the probability of the development of GR weeds. In some parts of the western U.S., alfalfa produced with irrigation requires multiple herbicide applications to control repeated influx of weed seed introduced with irrigation water. In most cases the use of one or more non-glyphosate herbicides with increased residual activity will be required to provide effective weed control (Orloff et al., 2009, attached as Appendix D). In seed production, although an early spring or late fall mowing sometimes occurs, in-season mowing only occurs once, as one seed crop is removed each year; thus, there is a potential for greater weed seed production compared to alfalfa forage production. However, in order to maximize yield for a seed crop and minimize weed seed content, alfalfa seed production (including RRA seed production) currently receives significantly higher cultural and herbicide inputs (beyond glyphosate only) to reduce weed cover than in alfalfa forage production. Glyphosate can only be applied in alfalfa seed production when plants are in the vegetative state. Other herbicides will be used to control weeds during the longest part of the growing season. These additional herbicides with other modes of action will also work to reduce weed seed production and minimize glyphosate-resistant weeds in the seedbank of fields where RRA is grown for seed (USDA APHIS, 2009, p. 109).

3.11.3 Herbicide-resistant weeds

A number of genetic, biological/ecological, and operational factors are involved in determining if a weed species will evolve a resistance to any herbicide (Georghiou and Taylor, 1986; Neve, 2008). Genetic factors include the frequency of genes in a weed species that promotes resistance to a particular herbicide, the ability and rate of changes to genes to cause resistance, the way genes for resistance are passed down to offspring, and the fitness of the plant (and these genes) in the presence and absence of an herbicide. Biological and ecological factors include how the weed species reproduces (selfing or outcrossing), seed production capacity, seed bank turnover, and amount of gene flow within and between populations (Maxwell and Mortimer, 1994; Jasieniuk et al., 1996; Neve, 2008). The genetic factors and biological/ecological factors involved highlight that different species may present different risks of resistance, depending on the genetics of the weed and the biology of the plant. Operational factors involved in the evolution of weed resistance include the type of chemistry and how the herbicide kills plants (e.g. mode-of-action), the frequency with which the herbicide is applied, and the dose and pattern of herbicide application.

Alfalfa weed management, including major weeds in alfalfa, herbicides used, herbicide mode of action, and herbicide resistance, was discussed in Sections 2.5. Measures to reduce herbicide resistance were also discussed in Section 2.5.

3.11.4 GR weeds

As discussed in Section 2, herbicide resistance is not a unique or new phenomenon. The development of weeds resistant to a particular herbicide mode of action is an issue that growers have faced for decades. As with other herbicide modes of action, not all weeds respond the same to glyphosate, and some species naturally vary in their tolerance to the herbicide.

Because of the nature of glyphosate and its history of use, generally speaking, there is a reduced potential that there will be a selection for weed resistance, compared to other herbicides. Glyphosate is a nonselective, foliar-applied, broad spectrum, post-emergent herbicide compared to many other herbicide groups. It operates by binding to a specific enzyme in plants thereby interfering with the plant's required metabolic process. Glyphosate is the only herbicide that binds with this enzyme, and therefore it is highly specific (Cole, 2010, p. 5; Orloff, 2009, p. 6, attached as Appendix D).

Accordingly, while glyphosate has been used extensively for over three decades, there have been relatively few cases of resistance development, as compared to many other herbicides and when considering the substantial glyphosate-treated acreage worldwide (approximately 1 billion acres) and the total number of weeds that the herbicide can control. In the U.S., there are ten weed species where GR biotypes are known to exist in certain areas of the country (19 weeds have been reported to have developed GR at some location worldwide). These resistant weeds represent a relatively small minority of the overall weed population. For example, in 2009, approximately 135 million of the 173 acres of corn, soybeans and cotton in the U.S. were planted with a herbicide tolerant variety, with the most common tolerance trait being glyphosate tolerance (USDA NASS, 2009a). At the same time, only about 6 percent of the total planted corn, soybean and cotton acres in the U.S. are estimated to have some level of presence of weeds resistant to glyphosate (Ian Heap as reported by WSSA, 2010b). As discussed above, the characteristics of glyphosate itself reduce the potential for the development of herbicide resistance as compared to other herbicide families. As such, certain herbicide families have been classified according to their risk of resistant weed development. Beckie (2006) lists ALS and ACCase inhibiting herbicides as "High" risk for resistance development, while glyphosate is considered a "Low" risk herbicide for the development of herbicide resistant weeds. ALS and ACCase inhibiting herbicides are commonly used in conventional alfalfa production, and weeds resistant to these two herbicide groups are widely distributed across alfalfa growing regions of the U.S. RRA can help delay resistance to these herbicides by adding to the diversity of herbicide modes of action in alfalfa production.

Use of herbicides with different modes of action, either concurrently or sequentially, is an important defense against weed resistance (WSSA, 2010b). "Use of a single product or mode of action for weed management is not sustainable. Some of the best and most sustainable approaches to prevent resistance include diversified weed management practices, rotation of modes of action and especially the use of multiple product ingredients with differing modes of action" (WSSA, 2010b). In addition, cultural practices such as cultivation or mowing are effective weed resistance management operations.

The WSSA reports higher levels of awareness among growers regarding the need to minimize the potential for development of GR: "In a market research study that surveyed 350 growers in 2005 and again in 2009, in response to the question, 'are you doing anything to proactively minimize the potential for resistance to glyphosate to develop,' 67 percent said yes in 2005 and 87 percent said yes in 2009" (David Shaw, as reported in WSSA, 2010). "In a 2007 survey of 400 corn, soybean and cotton growers, resistance management programs were often or always used by 70 percent or more of all three grower groups" (Frisvold and Hurley as reported by WSSA, 2010b). There is widespread information available from universities and other sources regarding GR. Public universities (i.e. University of California, North Dakota State University, University of Minnesota), herbicide manufacturers (i.e. www.weedresistancemanagement.com, www.resistancefighter.com) and crop commodity groups (i.e. National Corn Growers Association, American Soybean Association) have internet web sites with information on prevention and management of herbicide resistance. Monsanto's TUG (attached to this document as Appendix A) provides specific management practices for the prevention of glyphosate resistant weeds. Additionally, the UC's Integrated Pest Management website (http://www.ipm.ucdavis.edu/PGM/weeds_common.html) and at the UC Weed Research and Information Website (http://wric.ucdavis.edu/information/information.html) provide information on weed identification and specific weed management practices (Orloff et al., 2009; attached as Appendix D).

Alfalfa growers have strong financial and practical interests in managing weeds effectively and preemptively to reduce the development of herbicide resistance in order to maximize yield potential. The development of GR weeds harms the economic return per acre for the individual farmer and the entire alfalfa industry (Orloff et al., 2009, attached as Appendix D).

As such, strategies and recommendations to delay the development of GR weeds have been developed for alfalfa (Orloff et al., 2009, attached as Appendix D; TUG, attached as Appendix A). In general, weed scientists recommend the following to mitigate the risk of herbicide resistance in alfalfa: (1) Apply integrated weed management practices. Use multiple herbicide modes-of-action with overlapping weed spectrums in rotation, sequences, or mixtures; (2) Use full recommended rate and proper application timing for the hardest to control weed species present in the field; (3) Scout fields after herbicide application to ensure control has been achieved; (4) Avoid allowing weeds to reproduce by seed or to proliferate vegetatively; (5) Monitor site and clean equipment between sites; (6) Start with a clean field and control weeds early by using a burndown treatment or tillage in combination with a preemergence residual herbicide as appropriate; (7) Use cultural practices such a cultivation and crop rotation, where appropriate; and (7) Use good agronomic principles that enhance crop competitiveness. (HRAC, 2009). Similarly, the TUG recommends scouting for weeds; starting with a clean field using a burndown herbicide application or tillage; controlling weeds when they are small; crop rotation with opportunities for other modes of action; crop rotation; and "the right herbicide product at the right rate and at the right time." (TUG, p. 10, attached as Appendix A). All RR technology users, including alfalfa growers, are contractually obligated through the MT/SA to follow the TUG. RRA seed growers are also required by the NAFA BMP to "[m]anage weeds and volunteers using integrated weed control strategies (e.g., conventional practices supplemented with Roundup agricultural herbicide formulations applied according to the label for alfalfa seed production)" (NAFA, 2008).

Table 2-5 in Section 2.4.2 lists weeds known to be found in alfalfa and the biotypes known to be glyphosate resistant. Since 1998, 14 new GR weeds have been found globally. Nine of these have glyphosate resistant biotypes in the U.S. Of these nine, four species are known to be common in alfalfa fields.

3.11.5 Impacts

Alternative 1: No Action

Under Alternative 1, there would be virtually no effect on the potential for weeds to develop resistance to glyphosate, given that glyphosate use is minimal with conventional alfalfa. However, under Alternative 1, the impact of weeds resistant to other herbicides is likely to continue to increase as growers would continue to use conventional weed control methods, including other herbicide modes of action.

As discussed above, glyphosate use in alfalfa can be an effective tool against weeds resistant to non-glyphosate herbicides, such as ALS-inhibitors and ACCase-inhibitors. Weed resistance to glyphosate is not as common as resistance to many other herbicides (Orloff et al., 2009, p. 6, attached as Appendix D).

Alternative 2: Partial Deregulation of RRA

Under Alternative 2, impacts, if any, with respect to the development of GR weeds due to increased use of glyphosate associated with RRA crop production are expected to be very small. First, as discussed above, the nature of glyphosate itself makes it less likely that new GR weed populations will develop in alfalfa as a result of the use of glyphosate in RRA. Specifically, there is a relatively low rate of resistance in weeds to glyphosate relate to the widespread use of this chemical. (Orloff et al., 2009, p. 6; attached as Appendix D). Because of this differential in weed resistance between glyphosate and other herbicides, the introduction of this additional mode of weed control may have a net positive effect on weed resistance in alfalfa production. Second, there is a high level of awareness about the potential for GR weeds and many readily available resources to assist growers with management strategies (e.g., Orloff et al., 2009). Third, because herbicide resistance is a heritable trait, it takes multiple growing seasons for herbicide tolerant weeds to emerge and become the predominant biotype in a specific area (Cole, 2010a, p. 4). Researchers have concluded that even if growers completely relied on only one herbicide, it is likely to take at least five years for an herbicide-resistant weed population to develop (Kniss, 2010a, p. 4; Beckie, 2006, Neve, 2008; Werth et al., 2008). This is a reason why crop monitoring and follow up by weed scientists in cases of suspected resistance are important parts of all herbicide resistance stewardship programs. Fourth, RRA growers are required to abide by the following requirements, which will operate to mitigate the risk of glyphosate weed resistance in RRA:

- Read and follow all herbicide use directions and recommendations;
- Follow all stewardship practices outlined in Monsanto's TUG (Appendix A) which includes weed resistance management practices; and
- • Follow the Weed Resistance Management Guidelines to minimize the risk of resistance development (see Monsanto's TUG, p. 4; http://www.weedresistancemanagement.com/guidelines.html).

3.12 PHYSICAL

The assessment of impact to land use in the sections below considers the impacts to land use or current cultivation practices under the no action alternative and the proposed partial deregulation alternative.

3.12.1 Land Use

Alternative 1: No Action

Under Alternative 1, there would be no impact to land use or current cultivation practices. There would be no new planting of RRA for commercial purposes. It is anticipated that existing alfalfa acres would continue to be planted with non-RRA or non-alfalfa crops.

Alternative 2: Partial Deregulation of RRA

Under Alternative 2, it is expected that RRA would be planted on existing alfalfa acreage for hay or seed production provided that the proposed partial deregulation measures discussed in Section 1.1.3 above are followed. Appendix G charts the anticipated adoption of RRA under Alternative 2. However, the impact of this alternative on the overall amount of land devoted to alfalfa cultivation is expected to be minimal, as under this alternative, land currently used for alfalfa seed or hay production would continue to be used in the same manner. Alfalfa production is largely a market-driven decision rather than a technology-driven decision. (USDA-APHIS, 2009, p. 157). The availability of a new weed control option is not expected to impact current land use management. However, since glyphosate controls a broad range of weeds, farmers may choose to plant RRA on fields with greater weed potential. If the life span of RRA can be extended longer than current alfalfa stand lifespans, this might impact land use decisions regarding crop rotation practices, but is not expected to change the nature of land use into or out of agricultural production.

3.12.2 Air Quality and Climate

The assessment of impacts to air quality and climate in the sections below considers impacts to air quality and climate practices under the no action alternative and the proposed partial deregulation alternative. Under Alternative 1, existing alfalfa acreage will continue to be planted with non-RRA or non-alfalfa crops.

Alternative 1: No Action

The no action alternative would result in an adverse impact to air quality and climate. The continued regulation of RRA would result in continued planting of conventional and/or organic alfalfa. Non-RRA requires greater tillage for weed control than does RRA. Weed control in non-RRA is usually primarily accomplished by pre-plant tillage to prepare a weed-free seed bed, and/or by clipping targeted to stop weed growth and competition (with or without crop harvest). As glyphosate is a crop-safe, broad spectrum herbicide, it is possible that additional alfalfa acres, like other herbicide tolerant crops, would be established using no-till methods. Comparatively, the tillage associated with non-RRA establishment requires greater use of farm machinery which results in greater greenhouse gas emissions.

Alternative 2: Partial Deregulation of RRA

As previously stated, the partial deregulation of RRA is expected to result in an increase in the total acreage of RRA crops. This would be accompanied by increased glyphosate application and decreased tillage of alfalfa fields. Because glyphosate is non-volatile (i.e., does not evaporate readily) at normal temperatures and is not considered an atmospheric contaminant (EPA, 1993), the increased application of glyphosate is not expected to result in adverse impacts to air quality. If glyphosate is applied aerially, any potential drift-related impacts can be minimized by utilizing recognized practices for managing the potential for off target movement (i.e., using of specific nozzle types, limiting applications to conditions less favorable for drift). The overall impacts from aerial application are expected to be minimal because only around two percent of glyphosate is applied aerially in the U.S. (USDA APHIS, 2009). The decreased tillage of alfalfa fields under this alternative would have a net positive effect on air quality and climate by reducing the operation of farm machinery and the associated greenhouse gas emissions. Emissions related to global warming, ozone depletion, summer smog and carcinogenicity, among others, were found to be lower in GT crop systems than conventional systems (Bennett et al., 2004).

3.12.3 Water Quality

The assessment of impacts to water quality in the sections below considers impacts on surface water quality and groundwater. Under Alternative 1, alfalfa acres will continue to be planted with non-RRA or non-alfalfa crops.

Alternative 1: No Action

Surface water. Alternative 1 would have an adverse impact on surface water quality. Under this alternative, growers would continue to plant conventional and organic alfalfa, resulting in the continued reliance on tilling and/or multiple herbicides for weed control. The adverse impact would be due to the continued generation of runoff containing: 1) herbicides with greater environmental impact than glyphosate; and/or 2) particulate matter derived from increased tillage and soil erosion. Tillage causes widespread soil disturbance resulting in erosion and topsoil loss, with a corresponding increase in sedimentation and turbidity in streams. This erosion can also transport herbicides used on the fields into the surface waters. The usage of a GT cropping system such as RRA allows for cultivation with reduced tillage.

Groundwater. Alternative 1 would result in an adverse impact to groundwater. Adverse impacts would result from the continued use of multiple herbicides to control weeds. The vast majority of growers would continue to plant conventional alfalfa, resulting in the use of multiple herbicides for weed control. Several non-glyphosate herbicides have a higher potential to leach into groundwater, which results in groundwater contamination.

Alternative 2: Partial Deregulation of RRA

Surface water. Partial deregulation would result in increased planting (increased acreage) of RRA. The associated increase in application of glyphosate for weed control would reduce the impact on surface water quality by facilitating the adoption of conservation tillage methods and reducing the use of other herbicides with greater potential for adverse impact. Conservation tillage reduces disturbance of the soil and associated soil erosion from wind and water, and is facilitated by use of a GT cropping system such as RRA. The net effect would be lower amounts of herbicide and suspended sediment in runoff, which would improve water quality in streams and lakes (Wiebe and Gollehon, 2006).

Groundwater. The increased application of glyphosate under Alternative 2 would have a positive effect on groundwater quality by reducing the use of other herbicides that more readily leach into groundwater.

3.13 BIOLOGICAL

Potential environmental effects of pesticide use are carefully considered as a part of the FIFRA pesticide registration process. Prior to the approval of a new pesticide or a new use of that pesticide (including a change in pesticide application rates and/or timing) and before reregistering an existing pesticide, EPA must consider the potential for environmental effects and make a determination that no unreasonable adverse effects to the environment will be caused by the new pesticide, new use or continued use.

To make this determination, EPA requires a comprehensive set of environmental fate and ecotoxicological data on the pesticide's active ingredient (40 C.F.R. Part 158). EPA uses these data to assess the pesticide's potential environmental risk (exposure/hazard). The required data include both short- and long-term hazard data on representative organisms that are used to predict hazards to terrestrial animals (birds, nontarget insects, and mammals), aquatic animals (freshwater fish and invertebrates, estuarine and marine organisms), and nontarget plants (terrestrial and aquatic).

Information regarding the impacts of glyphosate on the biological environment is summarized below. Additional information on this topic is also being considered in the USDA APHIS Draft Environmental Impact Statement (DEIS) on the Deregulation of Glyphosate Tolerant Alfalfa (Docket No. APHIS-2007-0044) (USDA APHIS, 2009).

3.13.1 Animal and plant exposure to glyphosate

Glyphosate is a non-selective herbicide with post-emergence activity on essentially all annual and perennial plants. As discussed in Section 3.1.1, this activity is due to inhibition of EPSPS, an enzyme involved in aromatic amino acid synthesis. As with any herbicide, a risk exists that spray drift could pose issues for plants on the borders of the target field. However, EPA takes the potential for spray drift into account when conducting the risk assessment it uses to establish pesticide application rates and direction for use, which are designed to minimize spray drift risks. Glyphosate binds tightly to agricultural soils and is not likely to move offsite dissolved in water. Moreover, glyphosate is not readily taken up from agricultural soil by plants. This limits the impact of glyphosate use on non-target plants, including aquatic plants.

Alternative 1: No Action

Plants. Under the no action alternative, RRA would remain regulated, and growers of conventional alfalfa would continue to use multiple herbicides for weed control. Many of the non-glyphosate herbicides are selective herbicides that kill only particular groups of plants such as annual grasses, perennial grasses, or broadleaf weed species. Therefore, growers of conventional alfalfa use more than one herbicide to achieve satisfactory weed control. In addition, some of the other herbicides are applied at greater volumes compared to glyphosate.

The continued use of other herbicides would result in potential adverse impacts to non-target plants. The herbicides used in conventional alfalfa production have been found, in general, to have more significant environmental impacts than glyphosate (USDA APHIS, 2009). This is consistent with the EPA decision to grant reduced risk status for glyphosate use in RRA. Comparison of results from terrestrial and aquatic plant studies with predicted exposure from herbicide use suggests that most of the herbicides used in conventional alfalfa systems may have greater adverse effects than glyphosate on aquatic or terrestrial plant species.

Animals. Under this alternative RRA would remain regulated, and growers of conventional alfalfa would continue to use an array of herbicides for weed control. Many of the herbicides used in conventional alfalfa production have been found to have higher toxicity to certain animal species than glyphosate. Animal species within and adjacent to fields of conventional alfalfa would continue to be exposed to these more toxic herbicides. The amphibian habitat in watersheds where conventional and organic alfalfa are grown would continue to be impacted by higher levels of tillage, soil erosion, sedimentation in runoff, and turbidity in ponds, lakes, and rivers than would otherwise be the case if RRA were grown.

Under this alternative, alfalfa growers will continue to have difficulty controlling certain weed species that sicken, poison or reduce growth of horses, cattle and other livestock. Livestock illness and suffering related specifically to consumption of toxic weeds in alfalfa forage would remain unchanged. Economic losses associated with veterinary service costs and livestock productivity losses would remain unchanged.

Alternative 2: Partial Deregulation of RRA

Plants. With partial deregulation, the acreage of RRA and the associated use of glyphosate would increase. The increased glyphosate use would be accompanied by a corresponding decrease in the use of other herbicides that have a higher potential to impact non-target plant life. So this alternative would have an overall positive effect on terrestrial and aquatic plants. The EPA has concluded that glyphosate use on RRA poses reduced risk compared to the use of other herbicides for weed control.[43] As is the case with aerial application of any herbicide, terrestrial and aquatic plants in the vicinity of alfalfa fields may be incidentally exposed to glyphosate by spray drift. However, if aerial applications are minimized and/or appropriate spray drift reduction practices are utilized, this risk to non-target plants would be reduced; recall that EPA has determined that no unreasonable adverse effects occur from spray drift of glyphosate when applied according to label directions. Each year there are millions of acres of GT crops that are treated with glyphosate with minimal impact to adjacent non-target terrestrial plants including crops, when appropriate drift minimization measures are practiced.

Because glyphosate binds strongly to soil particles and has no herbicidal activity after binding to soil, no effects on aquatic plants will result from surface water runoff from glyphosate use on RRA. Conservation tillage and no tillage practices have the potential to mitigate impacts to aquatic plants through decreasing soil-laden runoff.

[43] A reduced risk decision is made at the use level based on a comparison between the proposed use of the pesticide and existing alternatives currently registered on that use site. A list of decisions regarding Reduced Risk Status can be found at: http://www.epa.gov/opprd001/workplan/reducedrisk.html

Animals. With partial deregulation, the acreage of RRA and the associated use of glyphosate would increase. The increased glyphosate use would be accompanied by a corresponding decrease in the use of other herbicides that have a higher potential to impact animals.

Based on the data available on glyphosate usage, chemical fate, and toxicity, glyphosate is not expected to pose an acute or chronic risk to the following categories of wildlife (EPA, 1993):

- Birds;
- Mammals;
- Terrestrial Invertebrates;
- Aquatic Invertebrates;
- Fish; and
- Soil Microorganisms.

Glyphosate is practically non-toxic to slightly toxic to birds, freshwater fish, marine and estuarine species, aquatic invertebrates and mammals and practically non-toxic to honey bees (which are used to assess effects on non-target insects in general) (EPA, 1993). Glyphosate has a low octanol-water partition coefficient, indicating that it has a tendency to remain in the water phase rather than move from the water phase into fatty substances. Therefore, it is not expected to accumulate in fish or other animal tissues.

As a part of the reregistration evaluation under FIFRA, EPA conducted an ecological assessment for glyphosate. This assessment compared the results from toxicity tests with glyphosate conducted with various plant and animal species to a conservative estimate of glyphosate exposure in the environment (Estimated Environmental Concentration (EEC)). In the Reregistration Eligibility Decision (RED) for glyphosate (EPA, 1993), the exposure estimates were determined assuming an application rate of 5.0625 lb active ingredient per acre (ai/A), which exceeds 3.75 lb a.e./A, the maximum EPA labelled use rate for a single application for agricultural purposes. When the EECs were calculated for aquatic plants and animals, the direct application of this rate (5.0625 lb a.e./A) to water was assumed. Based on this assessment, EPA concluded that effects to birds, mammals, fish and invertebrates are minimal based on available data (EPA, 1993).

The glyphosate end-use products used in agriculture contain a surfactant to facilitate the uptake of glyphosate into the plant (Ashton and Crafts, 1981). Depending on the surfactant used, the toxicity of the end-use product may range from practically nontoxic to moderately toxic to fish and aquatic invertebrates (EPA, 1993). For this reason, the 1993 Glyphosate RED stated that some formulated end-use products of glyphosate needed to be labeled as “Toxic to fish” if they were labeled for direct application to water bodies. Due to the associated hazard to fish and other aquatic organisms, glyphosate end-use products that are labeled for applications to water bodies generally do not contain surfactant, or contain a surfactant approved for direct application to water bodies.

Possible adverse impacts to amphibians resulting from the deregulation of RRA may be offset by the shift from other herbicides used in alfalfa cultivation, which are considered to have higher environmental impacts in general. Additionally, amphibian habitat in watersheds where RRA is produced could be improved through conservation tillage, resulting in decreased soil erosion, decreased sedimentation in runoff, and decreased turbidity in ponds, lakes, and rivers fed by surface waters.

Glyphosate can theoretically be toxic to microorganisms because it inhibits the production of aromatic amino acids through the shikimate pathway. However, field studies show that glyphosate has little effect on soil microorganisms, and, in some cases, field studies have shown an increase in microbial activity due to the presence of glyphosate (USDA FS, 2003).

Glyphosate itself is slightly toxic to amphibians; however, amphibians exhibited greater sensitivity to Roundup® formulations than to glyphosate tested as an acid or isopropylamine (IPA) salt. This could be due to the surfactant (POEA) used in agricultural formulations, which has been found to be more toxic to amphibians and other aquatic animals than the herbicide itself (Lajmanovich et al., 2003). Some researchers have suggested that, in combination with POEA, Roundup® could cause extremely high rates of mortality to amphibians that could lead to eventual population declines (Relyea, 2005). However, the testing methods of the Relyea (2005) study have been called into question due to the high exposure doses, which exceed application rates of glyphosate (regulated by FIFRA), as well as the fact that this Roundup® product is not approved for use in an aquatic setting (USDA APHIS, 2009). Considering the potential for aquatic exposure to glyphosate formulations from terrestrial uses, EPA recently evaluated the effect of glyphosate and its formulations on another amphibian species, the California red-legged frog, and concluded that aquatic exposure to glyhphosate or its formulations posed no risk to this threatened species (EPA, 2008). Because EPA considered a wide range of application rates in their evaluation for the red-legged frog, this conclusion can also be applied to amphibians exposed to glyphosate from applications on GT alfalfa.

3.13.2 Threatened and endangered species

Alternative 1: No Action

Under this alternative RRA would remain regulated, and growers of conventional alfalfa would continue to use a multitude of herbicides for weed control. Many of the herbicides used in conventional alfalfa production have been found to have higher toxicity to certain animal species than glyphosate. Threatened and endangered species within and adjacent to fields of conventional alfalfa would continue to be exposed to these more toxic herbicides. The amphibian habitat in watersheds where conventional and organic alfalfa are grown would continue to be impacted by higher levels of tillage, soil erosion, sedimentation in runoff, and turbidity in ponds, lakes, and rivers than would otherwise be the case if RRA were grown.

Alternative 2: Partial Deregulation of RRA

Under partial deregulation, the acreage of RRA would likely increase with a concomitant increase of glyphosate use for weed control. Based on the information presented below, there is no expected impact based on the ecological safety assessment conducted for glyphosate discussed below (Mortensen et al., 2008) and growers implementation of glyphosate application practices required by Monsanto that are designed to protect threatened or endangered species.

Monsanto recently performed an updated assessment of the impact to threatened and endangered species of glyphosate application to GT crops. The results of this assessment were submitted to USDA as Monsanto Report No. RPN-2007-227 (Mortensen et al., 2008). Monsanto also prepared an endangered species assessment for terrestrial plants that was submitted to USDA (Honegger et al., 2008). The findings of these assessments are as follows:

- Threatened or endangered terrestrial or semi-aquatic plant species are not at risk from ground applications of glyphosate at rates less than 3.5 lb active ingredient per acre (ai/A). Since the maximum single application rate before or after crop emergence in GT alfalfa is 1.55 lb ai/A, no listed plant species are predicted to be at risk from ground application of glyphosate to RRA.
- • Threatened or endangered terrestrial or semi-aquatic plant species are not at risk from aerial applications of glyphosate at rates less than 0.70 lb ai/A. Since rates above 0.7 lb ai/A are needed to control a number of weed species, buffers for aerial application have been proposed by Monsanto (using an EPA-accepted drift model) to permit aerial application at rates up to 1.55 lb ai/acre while still predicting no impact on plant growth at the edge of the buffer. Monsanto has developed a web site, www.Pre-Serve.org, to

provide growers a means to determine if threatened or endangered plant species are potentially at risk from glyphosate applications that they are planning on GT crops. The requirement for growers to consult this web site has been incorporated into the Monsanto Technology/Stewardship Agreement and Technology Use Guide, an agreement that growers sign when purchasing any Monsanto GT seed. Through the implementation of the Pre-Serve web site and its mandated use by growers, threatened and endangered plant species are protected from potential effects from glyphosate use on RRA.

- Other taxa (including birds, mammals, insects, fish, amphibians, aquatic invertebrates, and aquatic plants) are not at risk from the use of glyphosate herbicides in alfalfa production. In addition, other taxa are not at risk from indirect effects resulting from habitat alteration from the use of glyphosate.

Amphibians use a wide range of aquatic habitats for their breeding sites and could be exposed to glyphosate in surface water. Considering the potential for aquatic exposure to glyphosate formulations from terrestrial uses, EPA recently evaluated the effect of glyphosate and its formulations on the California red-legged frog (CRLF). EPA concluded that aquatic exposure to glyphosate and its formulations posed no risk to this threatened species (EPA, 2008). As a part of the endangered species effects assessment for the California red-legged frog, EPA evaluated the effect of glyphosate at application rates up to 7.95 lb ai/A. Based on this assessment, the application of glyphosate at the maximum, single, in-crop application rate specified on the EPA-approved label for RRA (1.55 lb ai/A) would have no effects on threatened and endangered species of fish, amphibians, birds, or mammals.

Although not specifically discussed in the assessment, it can also be determined that there would be no effects of glyphosate or its formulations on threatened or endangered vascular aquatic plants and aquatic invertebrates (EPA, 2008). For terrestrial invertebrates, it was determined that there were no effects on non-endangered species. Although not specifically stated in the CRLF assessment, exposure levels from spray drift to threatened or endangered invertebrates adjacent to RR alfalfa fields are below the level[44] that would result in a conclusion of risk. Additional information has been provided to EPA to also support a conclusion of no risk for small terrestrial invertebrates that might be present in the field at the time of glyphosate application. For terrestrial plants, the potential for effects on non-endangered species was assessed, and using the endpoints and EECs provided, it could be determined that there would

[44] Screening level drift assumptions are one percent for ground applications and five percent for aerial applications.

be no effects on terrestrial plants from ground applications at the maximum single in-crop application rate for RRA.

3.13.3 Potential impact of exposure to RRA

APHIS analyzed the potential impacts to threatened and endangered species from directly contacting, consuming, or hybridizing with RRA and/or their progeny. This analysis considered the effect of production of RRA on designated critical habitat or habitat proposed for designation. The results are as follows:

- RRA is not expected to become more invasive in natural environments or have any difference in effect on critical habitat than their parental non-GT line in the absence of glyphosate selection.
- Analysis of forage samples from several locations demonstrates that RRA is compositionally and nutritionally equivalent to other alfalfa varieties currently on the market. It is not expected to have adverse nutritional effects on any threatened and endangered species that feeds upon it. The RRA CP4 EPSPS protein does not have toxic or pathogenic effects that would affect threatened and endangered species or their critical habitat.
- RRA is not expected to form hybrids with any state or federally listed threatened or endangered species of plant or any plant species proposed for federal listing.

Based on this assessment, APHIS could not identify any difference between the impacts from exposure to RRA and the impacts from exposure to other alfalfa varieties (conventional and organic varieties). Consequently, there would be little or no differences between Alternatives 1 and 2 in terms of the exposure of threatened and endangered species to RRA.

3.14 HUMAN HEALTH AND SAFETY

3.14.1 Consumer health and safety

Because RRA is compositionally and nutritionally identical to non-RRA and because alfalfa forage and seed are not directly consumed by humans, the main issue regarding consumer health and safety is potential dietary exposure to glyphosate herbicide residues. The general public may be exposed to herbicides used on RRA if they consume animal commodities arising from livestock fed on the treated alfalfa. For the reasons described below, this risk is very small, and there would be little or no differences between Alternatives 1 and 2 in terms of the impact of regulation or partial deregulation of RRA on consumer health and safety.

Consumption of adjacent crops impacted by spray drift is a theoretically possible route of exposure, but is not a normal part of dietary risk assessment (EPA, 2000). The predominant route of potential dietary glyphosate exposure to consumers linked to RRA is via consumption of meat / milk from livestock fed on the treated alfalfa. EPA's procedures to estimate dietary exposure fully account for these processes (EPA, 2000; EPA, 1993). EPA has determined that there is a reasonable certainty that no harm will result from aggregate exposure to glyphosate residues (71 Fed. Reg. 76180 (Dec. 20, 2006)). According to the RED (EPA, 1993), glyphosate has relatively low oral and dermal acute toxicity and has been placed in Toxicity Category III for these effects (Toxicity Category I indicates the highest degree of acute toxicity, and Category IV the lowest). The acute inhalation toxicity study was waived because glyphosate is nonvolatile and because adequate inhalation studies with end-use products exist and show low toxicity.

Glyphosate is already used for weed control with conventional alfalfa and other GT crops, including GT corn, GT soybeans, and GT cotton. In addition, it is registered for use in weed control with several fruits and vegetables, and tolerances are established in the consumable commodities of these crops. The current upper estimates of exposure risk for glyphosate are based on highly conservative fruit and vegetable intake rates with an assumed high estimated amount of glyphosate residue. The current aggregate dietary risk assessment completed by EPA concludes there is no concern for any subpopulation regarding exposure to glyphosate, including the use on many fruits and vegetables (71 Fed. Reg. 76180 (Dec. 20, 2006)). Moreover, the potential exists for decreases in the applications and subsequent residues of more toxic herbicides if RRA is partially deregulated.

The use of glyphosate does not result in adverse effects on development at non-maternally toxic doses, reproduction, or endocrine systems in humans and other mammals (EPA, 1993; WHO, 2004; ECETOC, 2009). Under present and expected conditions of use, glyphosate does not pose a health risk to humans (EPA, 1993). Additionally, the nature of glyphosate residue in plants and animals is adequately understood, and studies with a variety of plants indicate that uptake of glyphosate from soil is limited. The material that is taken up is readily translocated throughout the plant. In animals, most ingested or absorbed glyphosate is eliminated in urine and feces. As discussed in Section 3.10, no impacts from consumption of food or feed containing the CP4 EPSPS protein would be expected.

3.14.2 Hazard identification and exposure assessment for field workers

The main issue regarding the health and safety of field workers and RRA is potential worker exposure to glyphosate used for weed control. For the reasons described below, the health risk from field worker exposure to glyphosate is small when used in accordance with labeling. There would be little or no differences between Alternatives 1 and 2 in terms of the impact of regulation or partial deregulation of RRA on field worker health and safety.

Glyphosate is already used for weed control with conventional alfalfa and other GT crops, including GT corn, GT soybeans, and GT cotton. In addition, it is registered for use in weed control with several fruits and vegetables. So the potential for field worker exposure to glyphosate will continue to exist whether RRA is regulated or deregulated.

With regard to subchronic and chronic toxicity, one of the more consistent effects of exposure to glyphosate at high doses is reduced body weight gain compared to controls. Body weight loss is not seen in multiple subchronic studies, but has at times been noted in some chronic studies at excessively high doses ≥ 20,000 ppm in diet (WHO, 2004). Other general and non-specific signs of toxicity from subchronic and chronic exposure to glyphosate include changes in liver weight, blood chemistry (may suggest mild liver toxicity), and liver pathology (USDA FS, 2003). Glyphosate is not considered a carcinogen; it has been classified by EPA as a “Group E carcinogen”, which means that it shows evidence of non-carcinogenicity for humans (EPA, 1993).

EPA’s human health analysis considers both the applicator and bystander as having the potential for exposure to glyphosate. Based on the toxicity of glyphosate and its registered uses, including use on GT crops, EPA has concluded that occupational exposures (short-term dermal and inhalation) to glyphosate are not of concern because no short-term dermal or inhalation toxicity endpoints have been identified for glyphosate (71 Fed. Reg. 76180 (Dec. 20, 2006)).

Additional evidence to support the EPA conclusion can be found in the *Farm Family Exposure Study*, a biomonitoring study of pesticide applicators conducted by independent investigators (Acquavella et al., 2004). This biomonitoring study determined that the highest estimated bodily adsorption of glyphosate as the result of routine labeled applications of registered glyphosate-based agricultural herbicides to crops, including GT crops, was approximately 400 times lower than the reference dose (RfD) established for glyphosate. Furthermore, investigators determined that 40 percent of field workers (applicators) did not have detectable exposure on the day of application, and 54 percent of the field workers had an estimated bodily adsorption of glyphosate more than 1000 times lower than the RfD (Acquavella et al., 2004). Use patterns and rates for RRA are typical of most glyphosate agronomic practices. Therefore, the partial deregulation of RRA would not significantly increase the exposure risk to pesticide applicators.

Finally, the biomonitoring study also found little evidence of detectable exposure to individuals on the farm who were not actively involved with or located in the immediate vicinity of application of glyphosate-based herbicides to crops. Considering the similarity of the use pattern and application rates of the glyphosate products in this study compared to those registered for use on RRA and GT crops in general, bystander exposure attributed to the use of glyphosate on GT crops is expected to be negligible.

Based on the above information, the use of currently registered herbicide products containing glyphosate in accordance with the EPA labeling requirements will not pose unreasonable risks or adverse effects to field workers or bystanders. In general, the herbicidal activity of glyphosate is due primarily to a metabolic pathway that does not occur in humans or other animals, and, thus, this mechanism of action is not directly relevant to the human health risk assessment. EPA considers glyphosate to be of low acute and chronic toxicity by the dermal route of exposure. Glyphosate is considered a Category IV dermal toxicant and is expected to cause only slight skin irritation (USDA APHIS, 2009).

3.15 SOCIAL AND ECONOMIC IMPACTS OF THE PROPOSED PARTIAL DEREGULATION

APHIS has studied the potential socioeconomic impacts of fully deregulating RRA (USDA APHIS, 2009, pp. 125-145 & Appendix S). Although the types of potential socioeconomic impacts discussed in the draft EIS under full deregulation would remain the same as under this proposed partial deregulation, the scale (extent and scope) of each impact would be significantly more limited. The proposal restricts (excludes) forage planting of RRA within county-level proximity to 99.5 percent of the U.S. alfalfa seed crop production areas and it would place highly stringent isolation conditions and other requirements on a small, pre-defined group of RRA seed producers.

Simply stated, protection of conventional and organic seed purity has been identified as an important component for the coexistence of GE, conventional and organic agricultural crops, including alfalfa. As it is primarily a geographically-structured approach parsed to the county level by seed vs. forage crop production criteria, the partial deregulation is intended to preclude the possibility for socio-economic impacts (favorable or unfavorable) specifically inter-related with gene flow into >99.5 percent of the U.S. alfalfa seed crop. The remaining approximately 0.5 percent of the seed crop is also unlikely to be impacted because when and if grown in local proximity to a RRA forage crop (<165 ft), the RRA forage producers would be required to mitigate the amount of available RRA pollen by cutting the RRA hay crop prior to 10 percent bloom.

USDA has clearly endorsed coexistence of GE, conventional and organic growers, crops and markets. During the period in which USDA/APHIS finalizes a court-ordered EIS and prepares a record of decision on the deregulation of RRA, the terms of the proposed Partial Deregulation cautiously parse out the areas of primary “gene flow interface” between RRA and conventional alfalfa, enabling immediate RRA grower benefits without interfering with conventional and organic crops and markets. The proposed partial deregulation conditions will enable, without restriction, the continued supply of conventional variety seeds and basic generation seeds for export, organic or domestic use. It would also allow producers to choose to use or not use RRA on approximately seventy-eight percent (78%) of U.S. forage production acres and enable a nominal number of RRA seed growers on seed production acres where extraordinary isolation exists. The actual adoption of the technology by forage growers is anticipated to be some fraction of the eligible (allowed) alfalfa acreage total in each region of the U.S. (Appendix G). Those most likely to adopt the technology are those producers serving dairy herd forage needs. However, pending completion of an EIS and a final deregulation decision, this partial deregulation would not uniformly enable all forage or seed growers the choice to participate in the socio-economic benefits of the technology, and moreover, in future years, it is possible that RRA seed supplies could fall short of RRA seed demand or that forage market inequities might develop between competing geographies with and without the technology.

It is likely that through improvements to weed management, the widespread adoption of the RRA technology by growers could result in economic benefits related to the quantity and improved forage quality of U.S. hay supplies (see below). Forage producers and dairy producers may most directly benefit from more abundant supplies of dairy quality forage with fewer weeds. Organic forage, dairy, and other food producers would also be likely to economically benefit from increased market share related to the newly-heightened market differentiation between organic and non-organic dairy and forage production strategies, e.g., the organic dairy food customer base may increase if a proportion of conventional consumers begin to purchase organic foods due to a negative perception of GE alfalfa. Since the RRA crops were first grown (2005-2007) the organic dairy sector has experienced market growth. According to several independent analyses (Putnam and Undersander, 2009, attached as Appendix I; Van Deynze et al., 2008; NAFA, 2008d; Putnam, 2006; Putnam, 2007), organic forage supplies and organic farming practices are unlikely to be at economic risk, adversely impacted, or materially affected by the deregulation or growing of RRA. Simple, minimal/no-cost effective methods are available to organic and conventional forage producers wishing to avoid RRA irrespective of their neighbor's choice to grow RRA seed or hay crops. Specifically, organic or non-GE forage producers need only to cut their hay before seed ripens, purchase non-GE planting seeds qualified for organic use and maintain organic hay lot segregation; i.e., follow current routine farm plans required by the NOP. Organic dairy or livestock producers will continue to grow and/or purchase only organically qualified (identity-preserved, segregated) feedstuffs; i.e., follow current routine farm plans required by the NOP. A minority, approximately 3 to 5 percent, of total alfalfa production may be sensitive to GE traits (Putnam, 2007). Therefore, it may be reasoned that a similar percentage of U.S. alfalfa forage growers would opt to take these nominal steps to avoid RRA trait presence in their conventional hay crops.

Forage production. Benefits to farm socio-economics include improvements to grower profitability, consistent and abundant on-farm forage supply, and, the ease and flexibility of weed control.

As indicated above, in the defined geographies where RRA forage production would be allowed with restrictions for new plantings (Table 1-1 and Appendix B of this ER), forage producers would have a new tool available for weed management throughout the life of the stand. Forage producers (n=201) who have previously commercially used the RRA technology report an average increase in productivity of 0.9 total acres per year (T/A/yr) which translates to approximately $100 acre per year (A/year) incremental crop value at an average hay price of $110 total (T) (RRA Satisfaction Study, Market Probe, 2008, attached as Appendix H). Over the life of the stand (e.g., 3 to 5 years), the approximate incremental value of RRA forage production is $300 to $500 per acre (A).

Like growers of other GE crops, many growers of RRA also report experiencing intangible social benefits (see examples of Public Comments to draft EIS included in Appendix F). Specifically, growers report that the RRA technology improves their farming experience in that weed control is easier, simpler, more reliable (less risk of failure), herbicide timing is more flexible and crop injury (stress) is lessened. They also acknowledge the lessened risk to water sheds and to herbicide applicators (self, family and employees) compared to several other herbicide choices. Relative to their economic benefits and risks, currently available weed management strategies may not be implemented at all because they can be expensive, ineffective on target weeds, restricted in use due to environmental or worker safety issues, difficult to apply at the correct time for good control, and some measures reduce alfalfa crop yield or stand longevity more than the weeds (e.g., early clipping, companion and cover crops). RRA growers note that the RRA technology is especially beneficial for weed control during the early seedling establishment period when the new planting can be at risk of failure (complete loss) due to unchecked weed competition. Although there are many reasons why alfalfa plantings fail in the first year, growers who adopt RRA would likely have less exposure to economic risk and intangible uncertainty associated with the possibility of losing their valuable planting inputs, meanwhile ensuring a more consistent supply of nutritious forage for livestock than the alfalfa growers not adopting the technology.

Seed Production. Socio-economic benefits related to RRA seed production include: improved profitability for RRA seed growers; the benefits described above associated with improved weed control; and a seed supply of new RRA varieties targeting new production niches, thus enabling the forage benefits described herein.

The seed producer consortia outlined in Table 1-2 have several things in common. These growers all produced RRA seed in 2006, 2007, 2008 and/or 2009. They will receive FGI training on RRA Seed Production Best Practices and will be monitored by FGI for compliance as required by the NAFA BMP and the proposed conditions for partial deregulation. These growers also all produce seed in a setting that allows substantial isolation from conventional alfalfa seed production. Table 1-2 shows the existing isolation, and the minimum required isolation required in future years under the terms of this partial deregulation. In all cases the required isolation exceeds the NAFA RRA Seed Production Best Practices.

Pollen-mediated gene flow is inversely proportional to isolation distance, and varies by introduced pollinator species. Any new RRA seed production with the growers and production areas outlined in Table 1-2 will have a minimal impact on conventional or organic seed production targeted for either U.S. or export markets.

SECTION 4.0 CUMULATIVE IMPACTS

This section discusses the cumulative impacts that may be associated with Alternative 2, when combined with other recent past, present, and reasonably foreseeable future actions within the affected environment. Cumulative impacts that will occur are expected to be negligible.

Cumulative impacts occur when the effects of an action are added to the effects of other actions occurring in a specific geographic area and timeframe. The cumulative impact analysis follows CEQ's guidance: Considering Cumulative Effects Under the National Environmental Policy Act (CEQ, 1997). The steps associated with the analysis include:

- Specify the class of actions for which effects are to be analyzed.
- Designate the appropriate time and space domain in which the relevant actions occur.
- Identify and characterize the set of receptors to be assessed.
- Determine the magnitude of effects on the receptors and whether those effects are accumulating.

4.1 CLASS OF ACTIONS TO BE ANALYZED

This analysis addresses regional and national actions that may have impacts that may accumulate with those of the proposed partial deregulation measures.

4.2 GEOGRAPHIC AND TEMPORAL BOUNDARIES FOR THE ANALYSIS

As described in Section 2, over the past 60 years, the number of alfalfa hay acres harvested annually in the U.S. has ranged between 20.7 million acres (2010) and 29.8 million acres (1957), with peak tonnage of hay production in the mid-1980s (USDA ERS, 2010a). In 2006, 20.9 million acres of alfalfa was harvested for forage. (In contrast, 122.1 acres of alfalfa was harvested for seed.) Alfalfa is grown for forage throughout the U.S. Based on 2008 production data by county, the four major U.S. alfalfa producing regions include the north-central, west, northeast, and south, with the north-central and the west regions being the highest producing regions in the U.S.

Under this proposal, we anticipate that any future alfalfa planting under partial deregulation will conform to the geographic use restrictions described herein, with the exception of a minimal number of acres (e.g. less than 100 acres) that may be produced under APHIS permit. In the event this proposal is granted, the small and declining number of RRA acres planted under APHIS permit will not have incremental cumulative impact on any of the resource areas.

Activities relevant to the cumulative impacts analysis have been identified from reviews of information available from government agencies, such as NEPA documents, land-use and natural resource management plans, and from private organizations. Not all actions identified in this analysis would have cumulative impacts on all resource areas.

4.3 RESOURCES ANALYZED

Issues evaluated in this cumulative impacts analysis include some of the resource areas discussed in Sections 2 and 3 including land use, air quality and climate, water quality, biological, and human health and safety. In addition, specific topics analyzed include: cumulative impacts related to any possibility of development of glyphosate resistant weeds, and cumulative impacts of potential increased glyphosate usage with the cultivation of GT crops.

4.4 CUMULATIVE IMPACTS RELATED TO THE DEVELOPMENT OF GLYPHOSATE RESISTANT WEEDS

Glyphosate offers many benefits to the grower as a weed control product. Glyphosate controls a broad spectrum of grass and broadleaf weed species present in U.S. production fields, has flexible use timings, and when used in GT crops, has a very high level of crop safety. As the adoption of GT crops has grown, the use of glyphosate has increased over the past several years. As discussed in Section 3, with the increased use of glyphosate, there is also the potential for increased selection pressure for the development of new glyphosate-resistant weed populations and/or new glyphosate-resistant weed species.

As discussed in Section 2.4, there is a low probability for the development of new glyphosate-resistant weed populations and/or development of new resistance weed species from the use of glyphosate herbicides in conjunction with plantings of RR alfalfa. The expected use pattern of herbicides, including glyphosate, in alfalfa and the alfalfa production practices (e.g. frequent mowing) provides a basis for retarding the development of new resistance. It also provides a basis for managing resistance that may be present from movement of a resistant weed seed into an alfalfa field or cross-pollination from a resistant weed to a sexually compatible weed within an alfalfa field.

As discussed in Section 3.11.14, market research studies indicate that growers of glyphosate-tolerant crops are increasingly taking measures to minimize the potential for development of glyphosate resistance. Based on the adoption of these measures by growers of other GT crops such as GT corn, GT soybeans, and GT cotton (Frisvold et al., 2009), similar adoption of these measures by GT alfalfa growers is anticipated. In all three of these other GT crops, growers are adopting best management practices, in particular the more frequent use of complementary herbicides in a glyphosate-based weed management programs in corn (Givens et al., 2009; Frisvold et al., 2009). The key best management practices recommended by industry and academics to control against weed resistance are as follows : a) identifying weeds and monitoring for escapes to determine if current practices need to be modified to achieve acceptable levels of weed control, b) using proper herbicide rates and timing, c) using crop rotation to facilitate use of different modes of action over time, d) using agronomic management practices to supplement herbicide weed control, e) alternating herbicides with different modes of action, and e) tank mixing herbicides of different modes of action (HRAC, 2009; Orloff et al., 2009; Monsanto, 2010a).

Increased glyphosate use is not expected in the major GT crops (corn, soybeans and cotton), as GT usage in these crops is high and likely not to increase beyond current levels. As discussed above and in Section 3.11, there is a high level of awareness among growers of these crops of the need to minimize the potential for development of glyphosate resistance, and evidence that growers are implementing management practices to prevent the development of glyphosate resistant weeds.

These management practices for all glyphosate-tolerant crops, combined with the specific alfalfa weed management practices discussed in Section 2.4, will together help minimize the cumulative potential for development of glyphosate resistant weeds under Alternative 2. Thus, Alternative 2 is not expected to contribute to cumulative adverse impacts on the development of glyphosate-resistant weeds.

4.5 CUMULATIVE IMPACTS OF POTENTIAL INCREASED GLYPHOSATE USAGE

The increase in glyphosate used under the proposed interim measures described in this ER (Alternative 2), would be minimal. Assuming a 50 percent market share, the amount of glyphosate applied to RRA would be 1,627,500 lb a.e (0.5 x 21 million total alfalfa acres X 1.55 lb a.e./A). Calculating from Table N-3 on page N-16 in the draft EIS, total use of glyphosate on corn, cotton, soybean, and wheat is equal to 126,308,000 lbs. Therefore, even if glyphosate is used on 50 percent of total alfalfa acres, the glyphosate use on alfalfa would be 1.3 percent of the glyphosate used on these four major crops.

According to the USDA ERS (2009), U.S. farmers have adopted genetically engineered crops widely since their introduction in 1996. Soybeans and cotton genetically engineered with herbicide-tolerant traits have been the most widely and rapidly adopted GE crops in the U.S., followed by insect-resistant cotton and corn. Figure 4-1 shows the percentage of acres of genetically engineered crops in the U.S. between 1996 and 2009. Appendix G charts data from Monsanto/FGI of the anticipated adoption of RRA under Alternative 2 over a 10 year period.

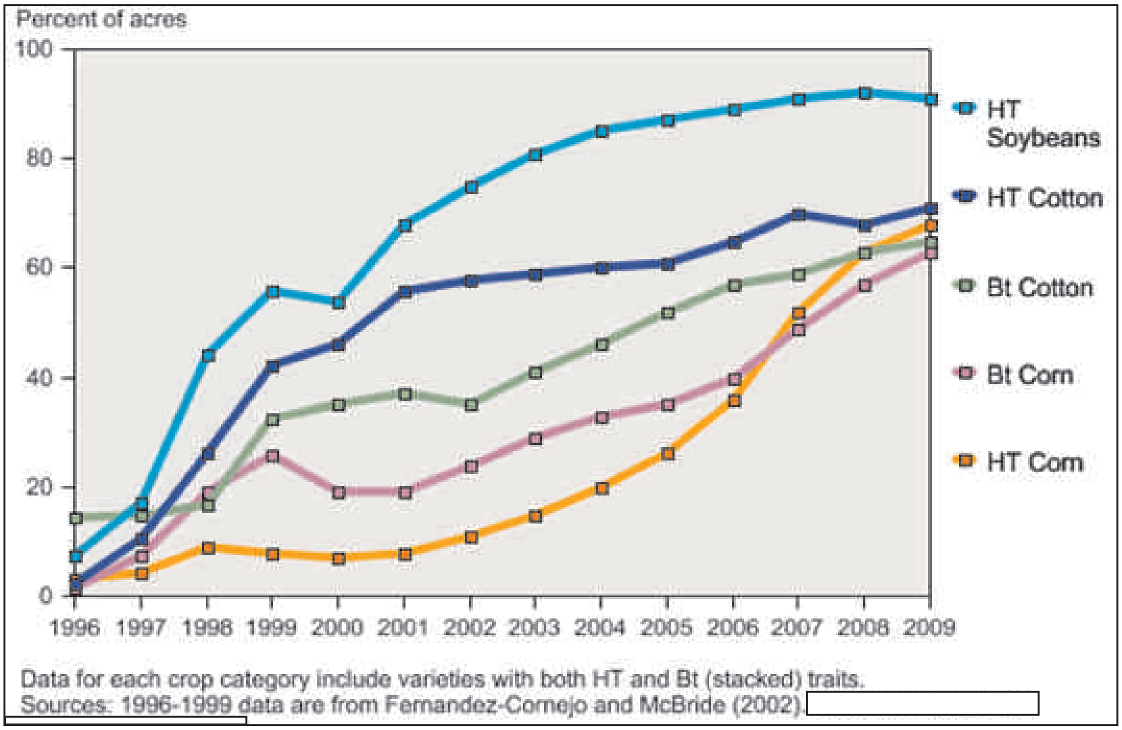

Figure 4-1 Growth in Adoption of Genetically Engineered Crops in U.S.
Source: Graph from USDA ERS, 2009

Herbicide-tolerant crops, which are engineered to survive application of specific herbicides that previously would have damaged the crop, provide farmers with a broader variety of options for effective weed control. Based on USDA survey data, herbicide tolerant soybeans went from 17 percent of U.S. soybean acreage in 1997, to 68 percent in 2001 and 91 percent in 2009. Plantings of herbicide tolerant cotton expanded from approximately 10 percent of U.S. acreage in 1997 to 56 percent in 2001 and 71 percent in 2009. The adoption of herbicide tolerant corn was slower in previous years, but has reached 68 percent of U.S. corn acreage in 2009 (USDA ERS, 2009).

Corn growers use the largest volume of herbicides. Approximately 96 percent of the 62.2 million acres used for growing corn in the 10 major corn-producing States were treated with more than 164 million pounds of herbicides in 1997 (USDA ERS, 2009). Soybean production in the U.S. also uses a large amount of herbicides. Approximately 97 percent of the 66.2 million soybean acres in the 19 major soybean-producing States were treated with more than 78 million pounds of herbicides in 1997 (USDA ERS, 2009). Cotton production relies heavily on herbicides to control weeds, often requiring applications of two or more herbicides at planting and postemergence herbicides later in the season (Culpepper and York, 1998). Close to 28 million pounds of herbicides were applied to 97 percent of the 13 million acres devoted to upland cotton production in the 12 major cotton-producing States in 1997 (USDA ERS, 2009).

Pesticide use on corn and soybeans has declined since the introduction of GE corn and soybeans in 1996. Several studies have analyzed the agronomic, environmental, and economic effects of adopting GE crops, including actual pesticide use changes associated with growing GE crops (McBride and Brooks, 2000; Fernandez-Cornejo, Klotz-Ingram, and Jans, 1999, 2002; Giannessi and Carpenter, 1999; Culpepper and York, 1998; Marra et al., 1998; Falck-Zepeda and Traxler, 1998; Fernandez-Cornejo and Klotz-Ingram, 1998; Gibson et al., 1997; ReJesus et al., 1997; Stark, 1997). Many of these studies have concluded that herbicide use is reduced with herbicide-tolerant varieties (USDA ERS, 2009).

Studies conducted by the USDA shows an overall reduction in pesticide use related to the increased adoption of GE crops. Based on the adoption of GE crops between 1997 and 1998 (except for herbicide-tolerant corn, which is modeled for 1996-97), the decline in pesticide use was estimated to be 19.1 million acre-treatments, 6.2 percent of total treatments (USDA ERS, 2009). Most of the decline in pesticide acre treatments was from less herbicide used on soybeans, which accounts for more than 80 percent of the reduction (16 million acre-treatments) (USDA ERS, 2009).

The adoption of herbicide-tolerant crops such as RRA, GT soybeans, and GT corn results in the substitution of glyphosate for previously used herbicides. The GT crops allow farmers to limit and simplify herbicide treatments based around use of glyphosate, while a conventional weed control program can involve multiple applications of several herbicides. In addition, and more importantly, herbicide-tolerant crops often allow farmers to use more benign herbicides (USDA ERS, 2009).

There are known benefits associated with the use of glyphosate herbicides compared to herbicides currently used by alfalfa producers. Glyphosate has documented favorable characteristics with regard to risk to human health, non-target species, and the environment (Malik et al., 1989; Williams et al., 2000). Glyphosate is classified by the EPA as Group E (evidence of non-carcinogenicity for humans) (57 Fed. Reg. 8739 (Mar. 12, 1992)). In 1998, the EPA granted Reduced Risk status for an expedited review of the submitted residue data package supporting the use of glyphosate.

Petitions for non-regulated status are pending for additional events or lines of GT soybean, corn, sugar beets, and creeping bentgrass (USDA APHIS, 2010). If deregulated, the production of new GT crops would lead to increased glyphosate application, and in the instances that it is cultivated in or near the same geographic areas where RRA is produced, this could lead to a cumulative impact on non-target plants impacted by glyphosate. However, given that these acres are already being used for agricultural production (in the case of corn and soybeans, most likely through a RR cropping system), these plants are likely already exposed to glyphosate or other pesticides.

Studies of the relationship between genetically engineered crops and herbicide use has shown that an increase in GT crops can result in a decrease in mechanical tillage (Brimner et al., 2005; Fernandez-Cornejo, 2006; Gianessi and Reigner, 2006; Kleter et al., 2007; Sankula, 2006; Johnson et al., 2008). The potential cumulative impact from this reduction in mechanical tillage is discussed in the following sections.

4.6 CUMULATIVE IMPACTS ON LAND USE, AIR QUALITY AND CLIMATE

As discussed in Section 2, alfalfa acreage has fluctuated little for the past 60 years, although acreage has generally been declining since the mid-1980s. Acreage used for alfalfa would not be expected to be impacted by increased RRA plantings. Therefore, as discussed in Section 3, Alternative 2 is not expected to impact land use directly or indirectly, other than the anticipated shift of certain acreage from conventional or organic alfalfa production to RRA production as a result of a partial deregulation (See Appendix G charting anticipated adoption of RRA under Alternative 2), and no cumulative impacts on land use are anticipated from Alternative 2.

As discussed in Section 3, Alternative 2 is expected to have positive impacts on air quality and climate, primarily resulting from reduced tillage. Consequently, Alternative 2 is not expected to have any adverse cumulative impacts on air quality or climate.

4.7 CUMULATIVE IMPACTS ON WATER QUALITY

As discussed in Section 3, the advent of GT crops and the use of post-emergent herbicides that could be applied over a crop during the growing season have facilitated the use of conservation tillage farming practices, since weeds could be controlled after crop growth without tilling the soil (USDA ERS, 2009). The use of GT crops (particularly soybeans) has intensified that trend since it often allows a more effective and less costly weed control regime than using other post-emergent herbicides (USDA ERS, 2009; Carpenter and Gianessi, 1999).

The impact of conservation tillage (including no-till, ridge-till, and mulch-till) in controlling soil erosion and soil degradation is well documented (Edwards, 1995; Sandretto, 1997). By leaving substantial amounts of plant matter over the soil surface, conservation tillage 1) reduces soil erosion by wind; 2) reduces soil erosion by water; 3) increases water infiltration and moisture retention; 4) reduces surface sediment and water runoff; and 5) reduces chemical runoff (USDA ERS, 2009).

Glyphosate may potentially be found in surface water runoff when erosion conditions lead to the loss of surface particles. However, as discussed in Section 3, partial deregulation of GT crops typically leads to an increase in conservation tillage and no tillage systems, which results in less mechanical disturbance of the soil during alfalfa cultivation and thereby decrease the loss of surface soil. Consequently, given that glyphosate binds strongly to soil particles and has no herbicidal activity after binding to soil, no-tillage and conservation tillage are expected to further reduce the likelihood of any impact of surface water runoff (Wiebe and Gollehon, 2006). Therefore, no cumulative adverse impacts to surface water or groundwater are anticipated.

4.8 CUMULATIVE BIOLOGICAL IMPACTS

For non-target terrestrial species, available ecological assessments in EPA RED (EPA, 2003) documents or registration review summary documents provide the support that the use of glyphosate represents reductions in chronic risk to birds compared to benfluralin, norflurazon, paraquat, sethoxydim, and trifluralin, and in acute risk to small mammals in comparison to bromoxynil, EPTC, and paraquat. For other alfalfa herbicide products, as well as glyphosate, no significant risks to birds or other non-target terrestrial species were indicated in the available information.

For non-target aquatic species, Tables 4-1, 4-2, and 4-3 provide summaries of the estimated exposure and hazard information for the traditional herbicides used in conventional alfalfa production, and present quantitative comparisons of the derived Risk Quotients. Exposure, defined as the EEC, was calculated for all products using the assumptions (assuming aerial application) of 5 percent drift of spray applied to a one-acre field onto water and 5 percent runoff from 10 treated acres into a one-acre pond six feet in depth. Herbicide treatments were based on the maximum single application rate for alfalfa taken from product labels. Hazard information (LC50 or EC50) for each active ingredient was taken from the EPA Ecotoxicology One-Liner Database (if available) or other EPA source documents and summarized in Tables 4-1, 4-2, and 4-3 as the upper and lower values from the range of values reported. Hazard information for the end-use formulated products is generally not readily available; thus, this analysis is a comparison based solely on the active ingredients. Any label warnings and other available hazard and/or risk descriptions for non-target aquatic species are also included. The Risk Quotient is determined for each active ingredient by dividing the EEC by the hazard (LC50 or EC50) value.

Plants potentially at risk from the use of glyphosate are potentially at risk from the use of any herbicide. Like most herbicides, plants are highly sensitive to glyphosate. Monsanto has developed a program named Pre-Serve to address the use of glyphosate, including aerial spraying, in areas where threatened plants may be located. Following use instructions on the EPA-approved label and use limitations described in Pre-Serve would address any such risk of exposure. Federal law requires pesticides to be used in accordance with the label. Conservation tillage and no tillage practices provide additional assurance that the impact to aquatic plants is reduced by decreasing soil-laden runoff.

The EPA-approved labels for products containing 2,4-DB, celthodim, sethoxydim, and trifluralin include warnings of toxicity or adverse effects to fish, and/or aquatic invertebrates and/or aquatic plants. Risk Quotients that exceed the Trigger Value of 0.5 for aquatic animals and 1.0 for aquatic plants are highlighted in bold text in Tables 4-1, 4-2, and 4-3 as exceeding a Level of Concern, based on EPA Ecological Effects Rejection Analysis and Deterministic Risk Characterization Approach. Current alfalfa herbicide products containing benfluralin, bromoxynil, diuron, hexazinone, metribuzin, norflurazon, paraquat, terbacil, and trifluralin are shown to exceed these Levels of Concern. As supported by the EPA designation of reduced risk for application of glyphosate to alfalfa, glyphosate is a more environmentally preferred herbicide compared to other herbicides currently used in alfalfa production since glyphosate is generally less toxic and has favorable degradation properties.

Table 4-1. Comparison of Potential Effects of Glyphosate and Alfalfa Herbicides on Freshwater Fish

Active Ingredient	Max. lb/acre (single appl.)	EEC[1] (ppm)	Fish LC_{50} (a.i.)[2] Range (ppm)		Fish Risk Quotient[3] Range		Classification / Label Warnings
			low	high	worst	best	
Glyphosate	1.55	0.052	45	140	0.001	0.0004	
2,4-DB	1.7	0.057	2	16.8	0.029	0.003	Toxic to fish
Benfluralin 4	1.5	0.051	NA	0.0317		**1.6**	
Bromoxynil 4	0.375	0.013	0.023	0.17	**0.55**	0.07	
Clethodim	0.25	0.008	19	33	0.0004	0.0003	
Diuron	2.4	0.081	0.71	14.2	0.11	0.006	
EPTC	3.9	0.131	11.5	27	0.011	0.005	
Hexazinone	1.5	0.051	> 100	274	< 0.0005	0.0002	
Imazamox	0.047	0.002	> 94	> 122	< 0.00002	< 0.00001	
Imazethapyr	0.094	0.003	> 112	423	< 0.00003	0.000007	
Metribuzin	1	0.034	42	> 100	0.0008	< 0.0003	
Norflurazon	0.98	0.033	8.1	16.3	0.004	0.002	
Paraquat	0.8	0.027	> 1	156	< 0.027	0.0002	
Pronamide	2	0.067	72	350	0.0009	0.0002	
Sethoxydim	0.47	0.016	170	265	0.0001	0.0001	Toxic to aquatic organisms.
Terbacil	1.2	0.040	46.2	112	0.0009	0.0004	
Trifluralin[4]	2	0.067	0.0084	0.210	**8.0**	0.32	Extremely toxic to freshwater, marine and estuarine fish.

NA = information not available

1 EEC refers to the Estimated Environmental Concentration, which assumes that a one-acre pond, six feet deep receives 5% drift from a one-acre field and 5% runoff from a 10-acre field.

2 Aquatic LC50 values obtained from the 2010 EPA Ecotoxicology One-Liner Database, except where Footnote 4 is indicated.

3 Risk Quotient is EEC/LC50. Risk Quotient **Bolded** if > 0.5 = Level of Concern [criteria from EPA Ecological Effects, Rejection Analysis]. Risk Quotients >0.1 result in classification for Restricted Use (http://www.epa.gov/oppefed1/ecorisk_ders/toera_risk.htm#Deterministic).

4 Toxicity values are from the available Reregistration Eligibility Documents, United States Environmental Protection Agency.

Table 4-2. Comparison of Potential Effects of Glyphosate and Alfalfa Herbicides on Freshwater Aquatic Invertebrates

Active Ingredient	Max. lb/acre (single appl.)	EEC[1] (ppm)	Invertebrate EC_{50} (a.i.)[2] Range (ppm)		Invertebrate Risk Quotient[3] Range		Classification / Label Warnings
			low	high	worst	best	
Glyphosate	1.55	0.052	134	780	0.0004	0.00007	
2,4-DB	1.7	0.057	NA	25		0.002	
Benfluralin 4	1.5	0.051	NA	0.0218		**2.3**	
Bromoxynil 4	0.375	0.013	0.011	0.096	**1.1**	0.1	
Clethodim 5	0.25	0.008	NA	20.2		0.0004	
Diuron	2.4	0.081	0.16	1.1	**0.51**	0.07	
EPTC	3.9	0.131	3.5	66	0.040	0.002	
Hexazinone	1.5	0.051	178	> 1000	0.0003	< 0.00005	
Imazamox	0.047	0.002	> 94.3	> 122	< 0.00002	< 0.00001	
Imazethapyr	0.094	0.003	> 109	> 1000	< 0.00003	< 0.000003	
Metribuzin	1	0.034	4.2	> 65	0.008	0.0005	
Norflurazon	0.98	0.033	5.3	15	0.006	0.002	
Paraquat	0.8	0.027	NA	1.2		0.020	
Pronamide	2	0.067	> 4	> 6	< 0.02	< 0.01	
Sethoxydim	0.47	0.016	NA	78		0.0002	Toxic to aquatic organisms.
Terbacil	1.2	0.040	65	> 1000	0.0006	< 0.00004	
Trifluralin [4]	2	0.067	0.56	2.2	0.12	0.03	Extremely toxic to aquatic invertebrates.

NA = information not available or not applicable

1. EEC refers to the Estimated Environmental Concentration, which assumes that a one-acre pond, six feet deep receives 5% drift from a one-acre field and 5% runoff from a 10-acre field.
2. Aquatic Invertebrate EC50 values obtained from the 2010 EPA Ecotoxicology One-Liner Database, except where Footnote 4 is indicated.
3. Risk Quotient is EEC/EC50. Risk Quotient **Bolded** if > 0.5 = Level of Concern [criteria from EPA Ecological Effects, Rejection Analysis]
4. Toxicity values are from the available Reregistration Eligibility Documents, United States Environmental Protection Agency.
5. EC50 value is from a study using a 25.6% ai concentration.

Table 4-3. Comparison of Potential Effects of Glyphosate and Alfalfa Herbicides on Aquatic Plants (Algae and Duckweed)

Active Ingredient	Max. lb/acre (single appl.)	EEC[1] (ppm)	Aquatic Plant EC_{50} (a.i.)[2] Range (ppm)		Aquatic Plant Risk Quotient[3] Range		Classification / Label Warnings
			low	high	worst	best	
Glyphosate	1.55	0.052	0.8	38.6	0.065	0.001	
2,4-DB	1.7	0.057	NA	> 0.932		< 0.061	
Benfluralin [4]	1.5	0.051	NA	0.1		0.51	
Bromoxynil [4]	0.375	0.013	0.051	> 0.63	0.25	< 0.02	
Clethodim	0.25	0.008	1.34	11.4	0.006	< 0.0007	May pose hazard to federally listed endangered plants.
Diuron	2.4	0.081	0.0024	0.095	**30**	0.85	
EPTC	3.9	0.131	1.36	41	0.097	0.003	
Hexazinone	1.5	0.051	0.0068	0.21	7.4	0.2	
Imazamox	0.047	0.002	0.011	> 0.038	0.14	< 0.042	
Imazethapyr	0.094	0.003	0.0081	59.2	0.4	0.00005	
Metribuzin	1	0.034	0.008	0.16	**4.2**	0.21	
Norflurazon	0.98	0.033	0.0097	0.058	**3.4**	0.57	
Paraquat	0.8	0.027	0.00055	2.84	**50**	0.009	
Pronamide	2	0.067	0.76	> 4	0.09	< 0.017	
Sethoxydim	0.47	0.016	>0.27	5.6	<0.059	0.003	Toxic to aquatic organisms.
Terbacil	1.2	0.040	0.011	0.14	**3.7**	0.29	
Trifluralin	2	0.067	0.015	5	**4.5**	0.01	

NA = information not available or not applicable.

1 EEC refers to the Estimated Environmental Concentration, which that a one-acre pond, six feet deep receives 5% drift from a one-acre field and 5% runoff from a 10-acre field.

2 Aquatic EC50 values obtained from the 2010 EPA Ecotoxicology One-Liner, unless Footnote 4 is indicated.

3 Risk Quotient is EEC/EC50. Risk Quotient **Bolded** if > 1.0 = Level of Concern [criteria from EPA Ecological Effects, Rejection Analysis].

4 Toxicity values obtained from the available Reregistration Eligibility Documents, United States Environmental Protection Agency.

4.9 CUMULATIVE IMPACTS ON HUMAN HEALTH AND SAFETY

Where pesticides may be used on food or feed crops, EPA sets tolerances (maximum pesticide residue levels) for the amount of the pesticide residues that can legally remain in or on foods. EPA undertakes this analysis under the authority of the Federal Food, Drug, and Cosmetic Act (FFDCA). Under the FFDCA, EPA must find that such tolerances will be safe, meaning that there is a reasonable certainty that no harm will result from aggregate exposure to the pesticide chemical residue. This finding must be made and the appropriate tolerance established before a pesticide can be registered for use on the particular food or feed crop in question (USDA APHIS, 2009).

Another potential impact of the use of glyphosate on human health is pesticide applicator exposure related to the increased glyphosate usage. Biomonitoring of pesticide applicators conducted by independent investigators has shown that bodily adsorption of glyphosate as the result of routine, labeled applications of registered glyphosate-based agricultural herbicides to crops, including to RRA, was thousands of times less than the allowable daily intake level established for glyphosate (Acquavella et al., 2004). Given similarity in use pattern and rates, the commercialization of RRA will not significantly increase the exposure risk to pesticide applicators. Furthermore, EPA, the European Commission, the WHO, and independent scientists have concluded that glyphosate is not mutagenic or carcinogenic, not a teratogen nor a reproductive toxicant, and that there is no evidence of neurotoxicity associated with glyphosate (EPA, 1993; EC, 2002; WHO, 2004; Williams et al., 2000).

Bystander exposure to glyphosate as a result of pesticide application to RRA would be negligible, since such applications would occur in an agricultural setting in relatively rural alfalfa fields, not in an urban setting. A biomonitoring study found little evidence of detectable exposure to individuals on the farm who were not actively involved with or located in the immediate vicinity of application of glyphosate-based herbicides to crops (Acquavella et al., 2004) Considering the similarity of the use pattern and application rates of the glyphosate products in this study compared to those registered for use on RRA and GT crops in general, bystander exposure attributed to the use of glyphosate on GT crops is expected to be negligible.

4.10 CUMULATIVE SOCIAL AND ECONOMIC IMPACTS

As discussed above in Sec. 3.15, the potential for gene flow from RRA seed acreage to conventional or organic alfalfa could have an adverse economic impact on conventional or organic growers who expect to receive a premium for their crops in markets that demand non-

RRA products. The partial deregulation measures proposed in Alternative 2, including isolation distances associated with seed production, are specifically designed to render the risk of any such impacts de minimis. Moreover, the reproductive biology of the alfalfa plant combined with normal harvest management for alfalfa forage provide for a de minimis likelihood of gene flow from one forage production field to another. Those producing organic or non-GE hay are likely required to maintain cultivation standards required by the NOP or identity preservation contracts that provide additional assurances against gene flow. While some of these growers may enter into contractual agreements that require testing for the presence of GE plant material, those tests are simple and inexpensive. Hay failing to meet contractual standards may still be sold as commodity hay.

It is anticipated that growers who plant RRA under Alternative 2 will experience economic benefits related to the quantity and improved forage quality of U.S. hay supplies. Growers have reported other socio-economic benefits, including greater flexibility, safety, ease and simplicity of weed control. APHIS has studied the potential socioeconomic impacts of fully deregulating RRA (USDA APHIS, 2009, pp. 125-145 & Appendix S).

4.11 SUMMARY OF POTENTIAL CUMULATIVE IMPACTS

When considering the impact that the use of glyphosate could have on the human environment in conjunction with other GT crops already being cultivated in the same affected environments, the facts suggest that increased use of glyphosate on acreage that shifts from conventional or organic alfalfa production to RRA production will have little, if any, additive effect. Alternatively, this new use of glyphosate has the potential to reduce risks to the affected environment from the use of other, more harmful, herbicides on these limited acreages. This is supported by the assessment of the hazards associated with glyphosate when compared to other available herbicides used for weed control in alfalfa production. Subsequently, there is no reasonably anticipated adverse cumulative impact on human health or the environment from the use of glyphosate associated specifically with Alternative 2.

SECTION 5.0 REFERENCES

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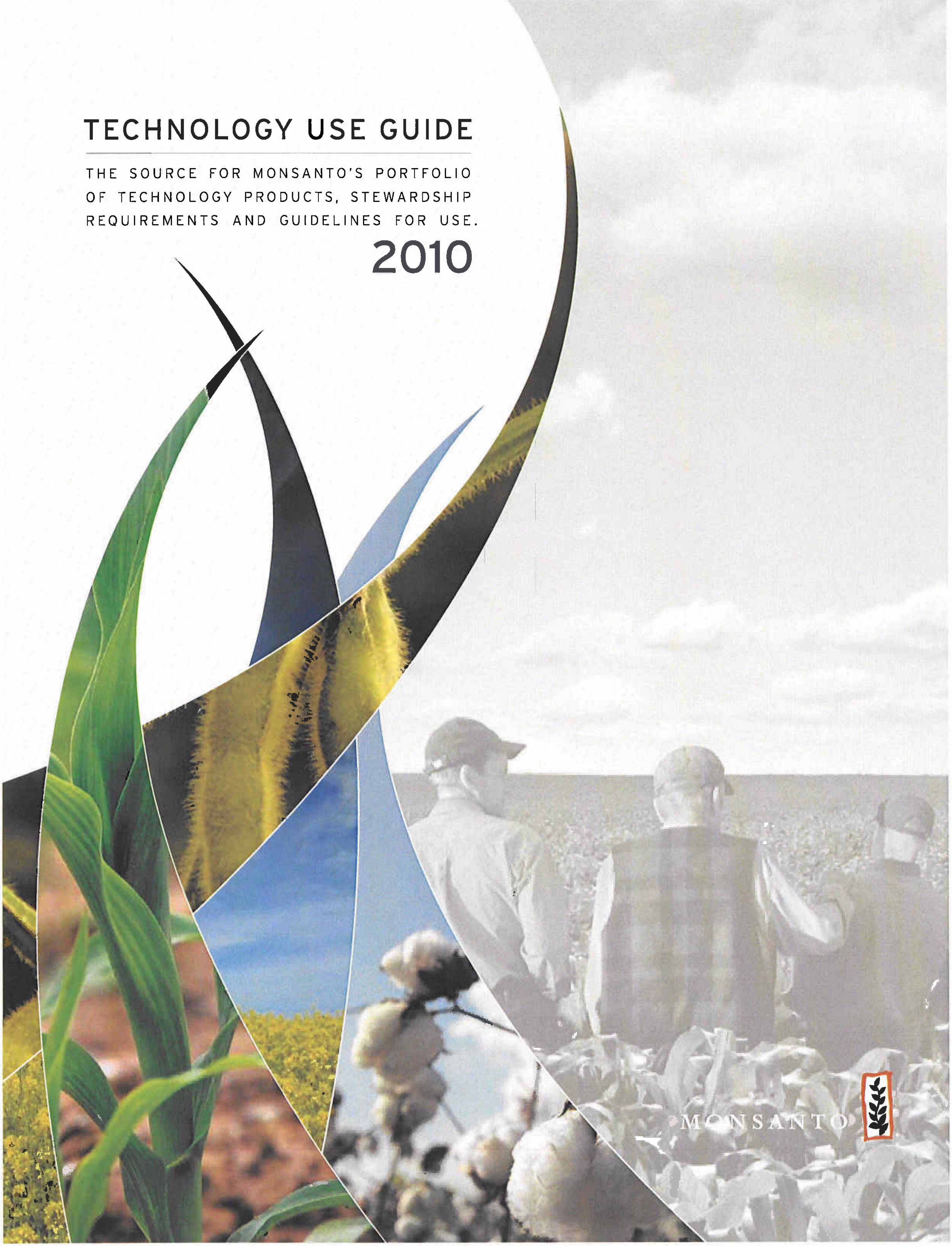
Appendix A

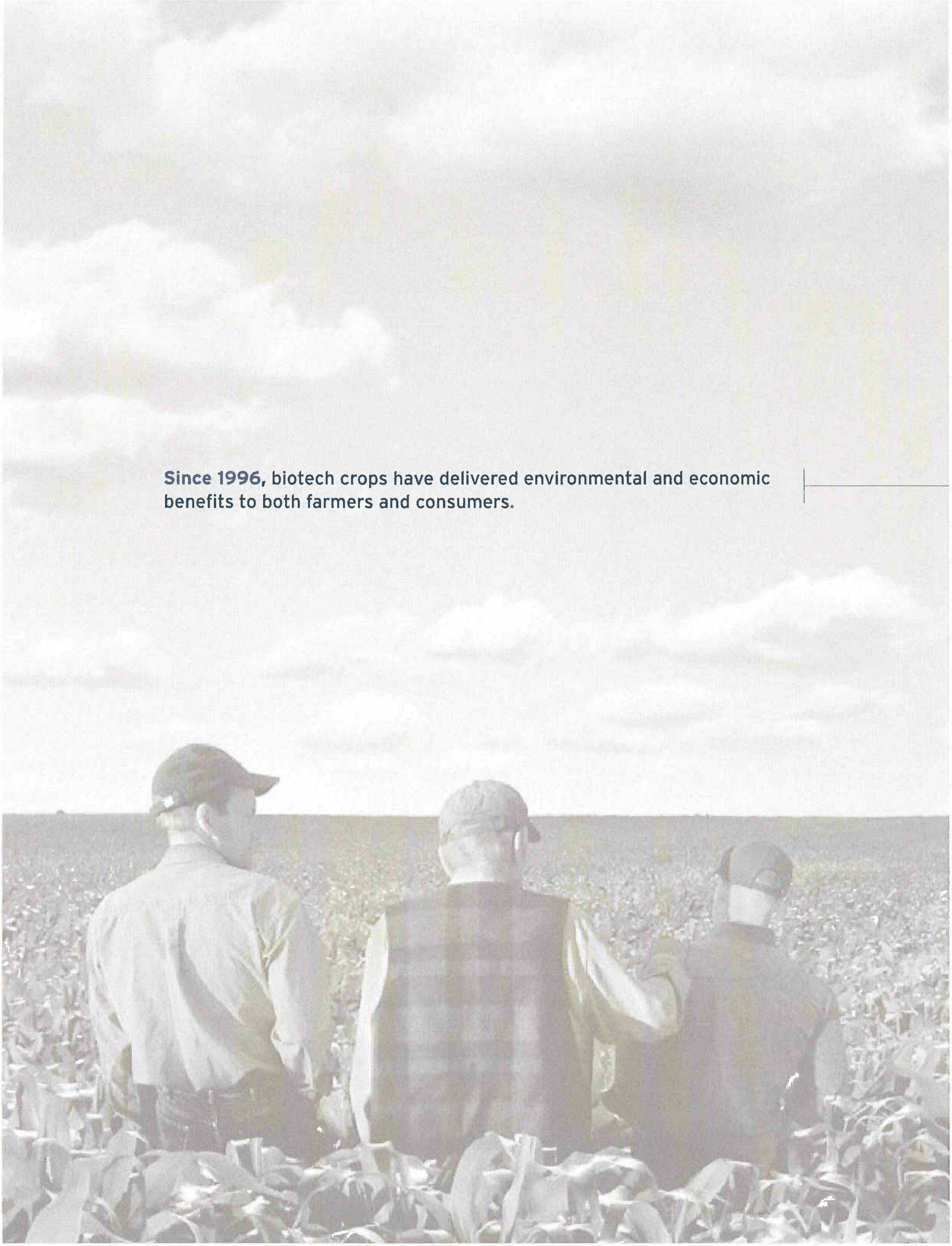
Monsanto Technology and Stewardship Agreement (MT/SA) and Accompanying Technology Use Guide (TUG)

TECHNOLOGY USE GUIDE

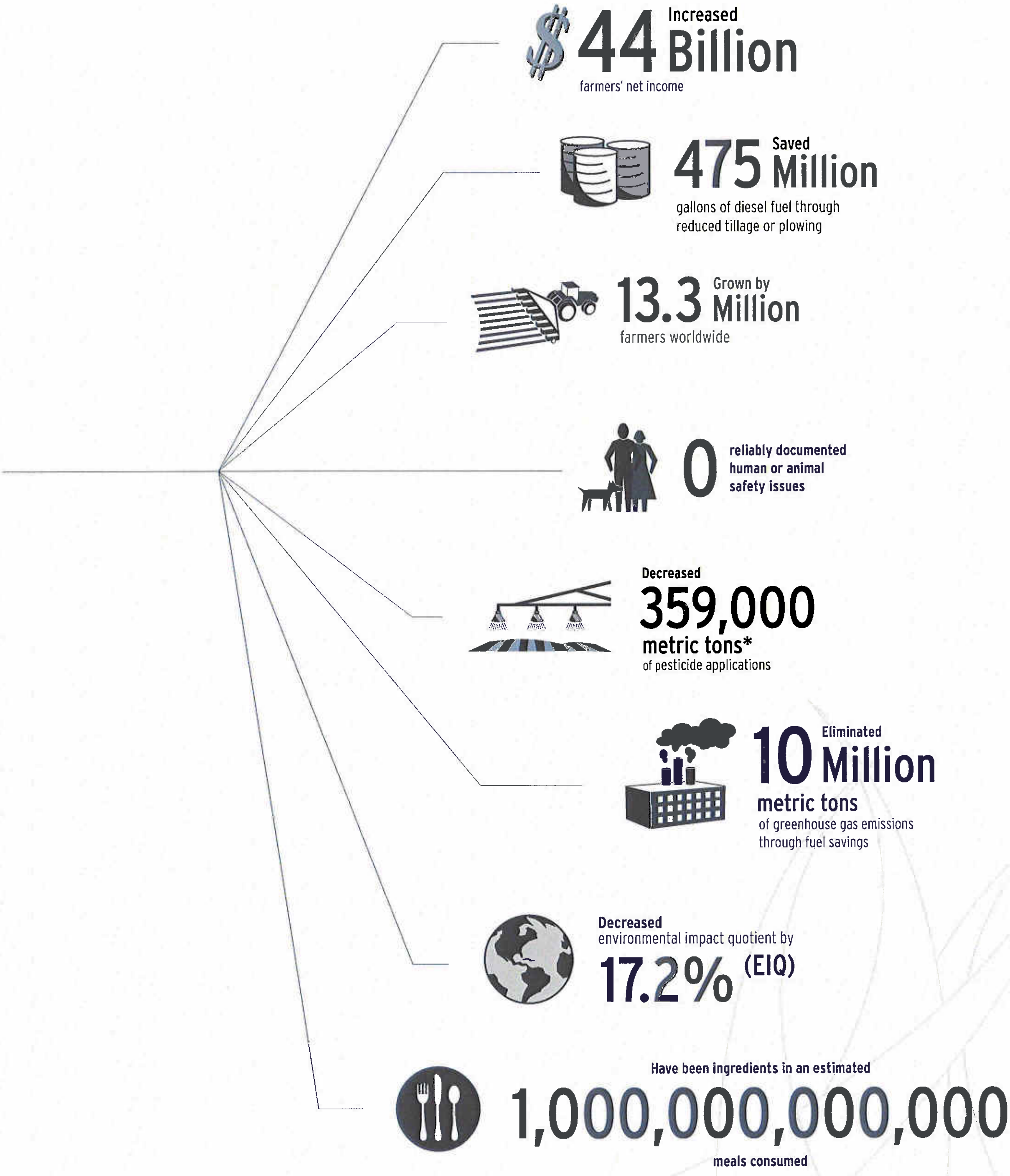
THE SOURCE FOR MONSANTO'S PORTFOLIO OF TECHNOLOGY PRODUCTS, STEWARDSHIP REQUIREMENTS AND GUIDELINES FOR USE.

2010





Since 1996, biotech crops have delivered environmental and economic benefits to both farmers and consumers.



Source: www.biotech-gmo.com

*Pesticides registered by the U.S. EPA will not cause unreasonable adverse effects to man or the environment when used in accordance with label directions.

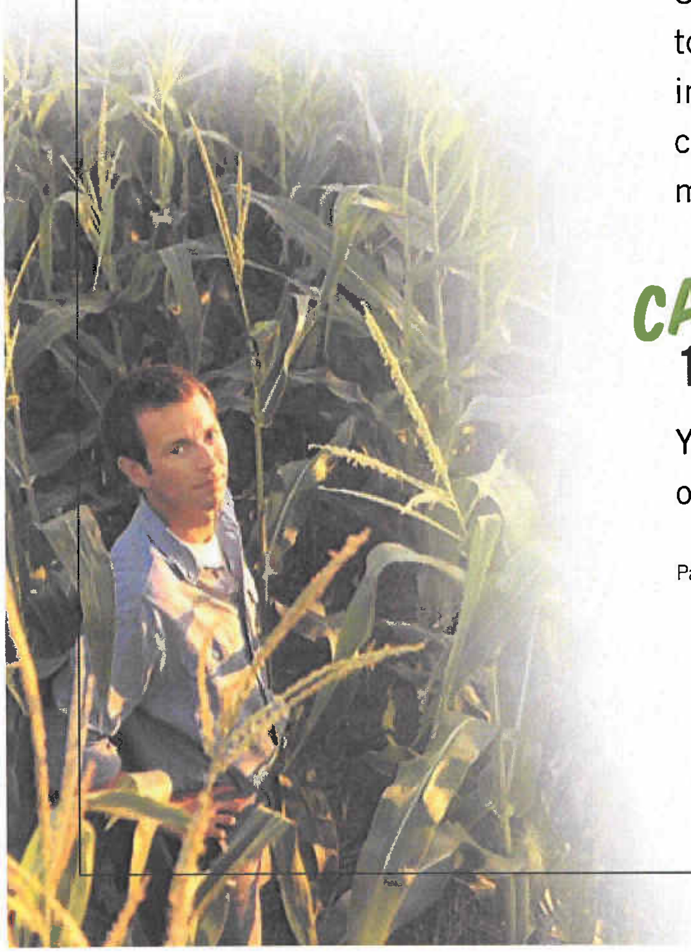
Re:NEW

YOUR ABILITY TO ENHANCE YOUR CROPS TODAY!

It's time to ReNEW your license

If you haven't renewed your Monsanto Technology/Stewardship Agreement (MTSA) in the past nine months, **take care of it today!**

Signing the MTSA ensures you'll have access to current and next-wave technologies. These innovations will enhance plant drought tolerance, cold tolerance, nitrogen use efficiency, yield and much more!



CALL

1-800-768-6387, Option 3

You'll then have the option to complete the process online or through conventional mail.

Paper MTSA's will continue to be accepted.

Introduction

This 2010 Technology Use Guide (TUG) provides a concise source of technical information about Monsanto's current portfolio of technology products and sets forth requirements and guidelines for the use of these products. As a user of Monsanto Technology, it is important that you are familiar with and follow certain management practices. Please read all of the information pertaining to the technology you will be using, including stewardship and related information. Growers must read the Insect Resistance Management (IRM)/Grower Guide prior to planting for important information on planting and IRM.

This technical guide is not a pesticide product label. It is intended to provide additional information and to highlight approved uses from the product labeling. Read and follow all precautions and use instructions in the label booklet and separately published supplemental labeling for the Roundup® agricultural herbicide product you are using.

Included in this guide is information on the following:

If you have any questions, contact your Authorized Retailer or Monsanto at 1-800-768-6387.

A Message About Stewardship - SEED AND TRAITS

Monsanto Company is committed to enhancing farmer productivity and profitability through the introduction of new agricultural biotechnology traits. These new technologies bring enhanced value and benefits to farmers, and farmers assume new responsibilities for proper management of these traits. Farmers planting seed with biotech traits agree to implement good stewardship practices, including, but not limited to:

- Reading, signing and complying with the Monsanto Technology/Stewardship Agreement (MTSA) and reading all annual license terms updates before purchase or use of any seed containing a trait.
- Reading and following the directions for use on all product labels.
- Following applicable stewardship practices as outlined in this TUG.
- Reading and following the IRM/Grower Guide prior to planting.
- Observing regional planting restrictions mandated by the U.S. Environmental Protection Agency (EPA).
- Complying with any additional stewardship requirements, such as grain or feed use agreements or geographical planting restrictions, that Monsanto deems appropriate or necessary to implement for proper stewardship or regulatory compliance.
- Following the Weed Resistance Management Guidelines to minimize the risk of resistance development.
- Complying with the applicable IRM practices for specific biotech traits as *mandated* by the EPA and set forth in this TUG.
- Utilizing all seed with biotech traits only for planting a single crop.
- Selling crops or material containing biotech traits only to grain handlers that confirm their acceptance, or using those products on farm.
- Not moving material containing biotech traits across boundaries into nations where import is not permitted.
- Not selling, promoting and/or distributing within a state where the product is not yet registered.

CROP OR MATERIAL HANDLING STEWARDSHIP STATEMENT

Monsanto Company is a member of Excellence Through Stewardship® (ETS). Monsanto products are commercialized in accordance with ETS Product Launch Stewardship Guidance, and in compliance with Monsanto's Policy for Commercialization of Biotechnology-Derived Plant Products in Commodity Crops. This product has been approved for import into key export markets with functioning regulatory systems. Any crop or material produced from this product can only be exported to, or used, processed or sold in countries where all necessary regulatory approvals have been granted. It is a violation of national and international law to move material containing biotech traits across boundaries into nations where import is not permitted. Growers should talk to their grain handler or product purchaser to confirm their buying position for this product. Excellence Through Stewardship® is a registered trademark of Biotechnology Industry Organization.

WHY IS STEWARDSHIP IMPORTANT?

Each component of stewardship offers benefits to farmers:

- Signing the MTSA provides farmers access to Monsanto's biotech trait seed technology.
- Following IRM guidelines guards against insect resistance to *Bacillus thuringiensis (B.t.)* technology and therefore enables the long-term viability of this technology, and meets EPA requirements.
- Proper weed management maintains the long-term effectiveness of glyphosate-based weed control solutions.
- Utilizing biotech seed only for planting a single-commercial crop helps preserve the effectiveness of biotech traits, while allowing investment for future biotech innovations which further improves farming technology and productivity.

Practicing these stewardship activities will enable biotechnology's positive agricultural contributions to continue.

Farmers' attitudes and adoption of sound stewardship principles, coupled with biotechnology benefits, provide for the sustainability of our land resources, biotechnology and farming as a preferred way of life.

SEED PATENT INFRINGEMENT

If Monsanto reasonably believes that a farmer has planted saved seed containing a Monsanto biotech trait, Monsanto will request invoices and records to confirm that fields in question have been planted with newly purchased seed. If this information is not provided within 30 days, Monsanto may inspect and test all of the farmer's fields to determine if saved seed has been planted. Any inspections will be coordinated with the farmer and performed at a reasonable time to best accommodate the farmer's schedule.

If you have questions about seed stewardship or become aware of individuals utilizing biotech traits in a manner other than as noted above, please call 1-800-768-6387. Letters reporting unacceptable or unauthorized use of biotech traits may be sent to:

Monsanto Trait Stewardship
800 N. Lindbergh Boulevard NC3C
St. Louis, MO 63167

For more information on Monsanto's practices related to seed patent infringement, please visit: www.monsanto.com/seedpatentprotection.

Provide Anonymous or Confidential reports as follows:

"Anonymous" reporting results when a person reports information to Monsanto in such a way that the identity of the person reporting the information cannot be identified. This kind of reporting includes telephone calls requesting anonymity and unsigned letters.

"Confidential" reporting results when a person reports information to Monsanto in such a way that the reporting person's identity is known to Monsanto. Every effort will be made to protect a person's identity, but it is important to understand that a court may order Monsanto to reveal the identity of people who are "known" to have supplied relevant information.

You're buying more than just seed. You're getting value today and innovation for tomorrow.
COMMITMENT. INNOVATION. PERFORMANCE.

The Beyond the Seed Program was launched by the American Seed Trade Association (ASTA) to raise awareness and understanding of the value that goes beyond the seed. The future success of U.S. agriculture depends upon quality seed delivered by an industry commitment to bring innovation and performance through continued investment. For more information about seed technology, visit ASTA's Beyond the Seed Program at www.beyondtheseed.org.

Genuity™ Unites the Best Traits*

As a purchaser of Monsanto biotech trait products, your investment helps fuel the research and development engine that leads to the discovery and delivery of new technologies for agriculture. Current and future Genuity™ traits are designed to deliver high yield potential, maximize return on seed investments and consistently deliver future trait innovations.

CORN

Higher yields come from quality grain. Genuity™ VT Triple PRO™ was the next generation of corn technology available for the 2009 growing season. Genuity™ VT Triple PRO™ provides dual modes of action against above-ground pests such as corn earworm, European and southwestern corn borers, sugarcane borer, southern cornstalk borer and fall armyworm. Reduced kernel damage from corn earworm means the potential for reduced Aflatoxin contamination. Genuity™ VT Triple PRO™ dual modes-of-action also allows for a reduction in refuge acres required in southern cotton-growing regions while providing long-term effectiveness and consistency.

GENUITY™ SMARTSTAX™

Scheduled for launch in 2010, Genuity™ SmartStax™ is the most-advanced, all-in-one corn trait system that controls the broadest spectrum of above- and below-ground insects and weeds. Genuity™ SmartStax™ provides control of corn earworm, European corn borer, southwestern corn borer, sugarcane borer, fall armyworm, western bean cutworm, black cutworm, western corn rootworm, northern corn rootworm and Mexican corn rootworm. Genuity™ SmartStax™ contains Roundup Ready® 2 Technology and LibertyLink® herbicide tolerance. Genuity™ SmartStax™ also allows for a reduction in refuge acres in the corn belt from 20% down to 5% for above- and below-ground refuge. Genuity™ SmartStax™ is also approved for a 20% refuge in the cotton belt.

SOYBEAN

Genuity™ Roundup Ready 2 Yield® soybeans are taking yield to a higher level. They were developed to provide farmers with the same simple, dependable and flexible weed control and crop safety they've come to rely on with the first-generation Roundup Ready® soybean system, but with higher yield potential. This is possible because of advanced insertion and selection technologies.

COTTON

Genuity™ Roundup Ready® Flex and Genuity™ Bollgard II® offer the ultimate combination of peace of mind and flexibility. They contain unrivaled built-in worm control to stop the most leaf- and boll-feeding worm species, including bollworms, budworms, armyworms, loopers, saltmarsh caterpillars and cotton leaf perforators. Protecting just one additional boll per plant can result in significantly higher lint yield. The convenience and savings from fewer or no sprays for worms can make a big difference when it comes to the bottom line.

SPECIALTY

Genuity™ Roundup Ready® alfalfa: Bred from an innovative germplasm pool, it offers outstanding weed control, excellent crop safety and preservation of forage quality potential.

Genuity™ Roundup Ready® canola: Offers excellent control of broadleaf weeds and grasses, even in tough weather conditions. Also features excellent crop safety and broad application flexibility.

Genuity™ Roundup Ready® sugarbeets: Excellent in-plant tolerance to over-the-top applications of labeled Roundup agricultural herbicides. Offers outstanding weed control, excellent crop safety and preservation of yield potential.

*See pages 16 and 17 for additional traits.

NOTE: Farmers must read the IRM/Grower Guide prior to planting for information on planting and Insect Resistance Management.

Monsanto's New Generation of Technologies

As Monsanto continues to develop new generations of technologies, several of our newer technologies are migrating to the Genuity™ brand. These products and their new logos are presented below.

YieldGard VT Triple PRO → genuity™ VT Triple PRO

CORN

Roundup Ready 2 YIELD → genuity™ Roundup Ready 2 Yield

SOYBEANS

Roundup Ready FLEX COTTON → genuity™ Roundup Ready Flex

Bollgard II → genuity™ Bollgard II

Bollgard II with Roundup Ready Cotton → genuity™ Bollgard II + Roundup Ready COTTON

Bollgard II with Roundup Ready flex → genuity™ Roundup Ready Flex / Bollgard II

COTTON

Roundup Ready ALFALFA (Grow the Feed, Not the Weeds.) · Roundup Ready CANOLA · Roundup Ready SUGARBEETS → genuity™ Roundup Ready

SPECIALTY

Insect Resistance Management
Planting Refuges, Preserving Technology

An **EFFECTIVE** IRM program is a vital part of responsible product stewardship for insect-protected biotech products. Monsanto is committed to implementing an effective IRM program for all of its insect-protected *B.t.* technologies in all countries where they are commercialized, including promoting farmer awareness of these IRM programs. Monsanto works to develop and implement IRM programs that strike a balance between available knowledge and practicality, with farmer acceptance and implementation of the plan as critical components.

The U.S. EPA requires that Monsanto implement, and farmers who purchase insect-protected products follow, an IRM plan.* IRM programs for *B.t.* traits are based upon an assessment of the biology of the major target pests, farmer needs and practices, and appropriate pest management practices. These **mandatory regulatory programs** have been developed and updated through broad cooperation with farmer and consultant organizations, including the National Corn Growers Association and the National Cotton Council, extension specialists, academic scientists, and regulatory agencies.

*In some areas, a natural refuge option is available for Bollgard II. See the current IRM/Grower Guide for details.

The IRM programs for planting seeds containing *B.t.* traits contain several important elements. One key component of an IRM plan is a refuge. A refuge is simply a portion of the relevant crop (corn or cotton) that does not contain a *B.t.* technology for the control of the insect pests which are controlled by the planted technology(ies). The lack of exposure to the *B.t.* proteins means that there will be susceptible insects nearby to mate with any rare resistant insects that may emerge from *B.t.* products. Susceptibility to *B.t.* products is then passed on to offspring, preserving the long-term effectiveness of the technology.

Farmers who purchase seeds containing *B.t.* traits must plant an appropriately designed refuge. Refuge size, configuration, and management is described in detail in the sections on those products in the 2010 IRM/Grower Guide.

Failure to follow IRM requirements and to plant a proper refuge may result in the loss of a farmer's access to Monsanto technologies. Monsanto is committed to the preservation of *B.t.* technologies. Please do your part to preserve *B.t.* technologies by implementing the correct IRM plan on your farm.

MONITORING PROGRAM

The U.S. EPA requires Monsanto to take corrective measures in response to a finding of IRM non-compliance. Monsanto or an approved agent of Monsanto must monitor refuge management practices. The MTSA signed by a farmer requires that upon request by Monsanto or its approved agent, a farmer must provide the location of all fields planted with Monsanto technologies and the locations of all associated refuge areas as **required**, to cooperate fully with any field inspections, and allow Monsanto to inspect all fields and refuge areas to ensure an approved insect resistance program has been followed. All inspections will be performed at a reasonable time and arranged in advance with the farmer so that the farmer can be present if desired.

IRM GUIDELINES

Farmers must read the current IRM/Grower Guide prior to planting for information on planting and IRM. If you do not have a copy of the current IRM/Grower Guide, you may downloaded it at www.monsanto.com, or you may call 1-800-768-6387 to request a copy by mail.

RESPECT THE REFUGE®

RESPECT THE REFUGE®

Monsanto considers product stewardship to be a fundamental component of customer service and responsible business practices. As leaders in the development and stewardship of Roundup® agricultural herbicides and other products, Monsanto invests significantly in research to continuously improve the proper uses and stewardship of our proprietary herbicide brands.

This research, done in conjunction with academic scientists, extension specialists and crop consultants, includes an evaluation of the factors that can contribute to the development of weed resistance and how to properly manage weeds to delay the selection for weed resistance. Visit **www.weedtool.com** for practical, best practices-based information on reducing the risk for development of glyphosate-resistant weeds. Developed in cooperation with academic experts, the website provides options for managing the risk on a field-by-field basis.

Glyphosate is a Group 9 herbicide based on the mode of action classification system of the Weed Science Society of America. Any weed population may contain plants naturally resistant to Group 9 herbicides. The following general recommendations help manage the risk of weed resistance occurring.

WEED RESISTANCE MANAGEMENT PRACTICES:

- Scout your fields before and after herbicide application
- Start with a clean field, using either a burndown herbicide application or tillage
- Control weeds early when they are small
- Add other herbicides (e.g. a selective in-crop and/or a residual herbicide) and cultural practices (e.g. tillage or crop rotation) as part of your Roundup Ready® cropping system where appropriate
- Rotation to other Roundup Ready crops will add opportunities for introduction of other modes of action
- Use the right herbicide product at the right rate and the right time
- Control weed escapes and prevent weeds from setting seeds
- Clean equipment before moving from field to field to minimize spread of weed seed
- Use new commercial seed that is as free from weed seed as possible

Monsanto is committed to the proper use and long-term effectiveness of its proprietary herbicide brands through a four-part stewardship program: developing appropriate weed control recommendations, continuing research to refine and update recommendations, education on the importance of good weed management practices and responding to repeated weed control inquiries through a product performance evaluation program.

GLYPHOSATE-RESISTANT WEEDS

Monsanto actively investigates and studies weed control complaints and claims of weed resistance. When glyphosate-resistant weed biotypes have been confirmed, Monsanto alerts farmers and develops and provides farmers with recommended control measures, which may include additional herbicides, tank-mixes or cultural practices. Monsanto actively communicates all of this information to farmers through multiple channels, including the herbicide label, **www.weedscience.org**, supplemental labeling, this TUG, media and written communications, Monsanto's website, **www.weedresistancemanagement.com**, and farmer meetings.

Farmers must be aware of, and proactively manage for, glyphosate-resistant weeds in planning their weed control program. When a weed is known to be resistant to glyphosate, then a resistant population of that weed is by definition no longer controlled with labeled rates of glyphosate. Roundup® agricultural herbicide warranties will not cover the failure to control glyphosate-resistant weed populations.

Report any incidence of repeated non-performance on a particular weed to your local Monsanto representative, retailer or county extension agent.

Note: Always read and follow all pesticide label requirements.

ROUNDUP BRAND AGRICULTURAL OVER-THE-TOP HERBICIDE PRODUCTS

Read and follow all product labeling before using Roundup agricultural herbicides over the top of products with Roundup Ready Technology.

You may use another glyphosate herbicide, but only if it has federally approved label instructions for use over that specific Roundup Ready crop, and the product and the use label for that Roundup Ready crop has been approved by your specific state. Contact the product manufacturers, the local retailers or the local extension agents for confirmation that the products carry EPA and state approved labeling for this use. **MONSANTO DOES NOT MAKE ANY REPRESENTATIONS, WARRANTIES OR RECOMMENDATIONS CONCERNING THE USE OF GLYPHOSATE PRODUCTS SUPPLIED BY OTHER COMPANIES WHICH ARE LABELED FOR USE OVER ROUNDUP READY CROPS. MONSANTO SPECIFICALLY DENIES ALL RESPONSIBILITY AND DISCLAIMS ANY LIABILITY FOR ANY DAMAGE FROM THE USE OF THESE PRODUCTS IN ROUNDUP READY CROPS. ALL QUESTIONS AND COMPLAINTS CAUSED BY THE USE OF GLYPHOSATE PRODUCTS SUPPLIED BY OTHER COMPANIES SHOULD BE DIRECTED TO THE SUPPLIER OF THE PRODUCT IN QUESTION.**

MONSANTO BRANDS OF SELECTIVE OVER-THE-TOP HERBICIDE PRODUCTS

Herbicide products sold by Monsanto for use over the top of Roundup Ready crops for the 2010 crop season are as follows:

Roundup WeatherMAX® **Roundup PowerMAX®**

Read and follow all product labeling before using Roundup agricultural herbicides over the top of Roundup Ready traits. To learn more about applicable supplemental labels or fact sheets, call 1-800-768-6387.

Tank-mixtures of Roundup agricultural herbicides with insecticides, fungicides, micronutrients or foliar fertilizers are not recommended as they may result in reduced weed control, crop injury, reduced pest control or antagonism. Refer to the Roundup agricultural herbicide product label, supplemental labeling or fact sheets published separately by Monsanto for tank-mix recommendations.

Do not add additional surfactants and/or products containing surfactants to these Roundup agricultural herbicides unless otherwise directed by the label. Other glyphosate products labeled for use in Roundup Ready technologies may require the addition of surfactants, or other additives to optimize performance, that may increase the potential for crop injury. Monsanto will label and promote only fully tested brands that do not require surfactants and other additives for over-the-top applications to Roundup Ready Crops.

GLYPHOSATE ENDANGERED SPECIES INITIATIVE

Before making applications of glyphosate-based herbicide products, licensed farmers of crops containing Roundup Ready technology must access the website **www.pre-serve.org** to determine whether any mitigation requirements apply to the planned application to those crops, and must follow all applicable requirements. The mitigation measures described on the website are appropriate for all applications of glyphosate-based herbicides to all crop lands.

Farmers making only ground applications to crop land with a use rate of less than 3.5 lbs of glyphosate a.e./A are not required to access the website. If a farmer does not have web access, the seed dealer can access the website on behalf of the farmer to determine the applicable requirements, or the farmer can call 1-800-332-3111 for assistance.

RECOMMENDATIONS FOR MANAGING GLYPHOSATE-RESISTANT WEEDS IN ROUNDUP READY CROPS

In certain areas, populations of ryegrass, johnsongrass, marestail, common ragweed, giant ragweed, *Palmer Amaranth* and waterhemp are known to be resistant to glyphosate. For control recommendations for resistant biotypes of these weeds, refer to **www.weedresistancemanagement.com** or call 1-800-768-6387. When approved, supplemental labeling for specific herbicide products can also be viewed on **www.cdms.net** or **www.greenbook.net** or obtained by calling 1-800-768-6387.

Coexistence in agricultural production systems and supply chains is not new. Different agricultural systems have coexisted successfully for many years around the world. Standards and best practices were established decades ago and have continually evolved to deliver high purity seed and grain to support production, distribution and trade of products from different agricultural systems. For example, production of similar commodities such as field corn, sweet corn and popcorn has occurred successfully and in close proximity for many years. Another example is the successful coexistence of oilseed rape varieties with low erucic acid content for food use and high erucic acid content for industrial uses.

The introduction of biotech crops generated renewed discussion of coexistence focused on biotech production systems with conventional cropping systems and organic production. These discussions have primarily focused on the potential economic impact of the introduction of biotech products on other systems. The health and safety of biotech products are not an issue because their food, feed and environmental safety must be demonstrated before they enter the agricultural production system and supply chain.

The coexistence of conventional, organic and biotech crops has been the subject of several studies and reports. These reports conclude that coexistence among biotech and non-biotech crops is not only possible but is occurring. They recommend that coexistence strategies be developed on a case-by-case basis considering the diversity of products currently in the market and under development, the agronomic and biological differences in the crops themselves and variations in regional farming practices and infrastructures. Furthermore, coexistence strategies are driven by market needs and should be developed using current science-based industry standards and management practices. The strategies must be flexible, facilitating options and choice for the farmer and the food/feed supply chain, and must be capable of being modified as changes in markets and products warrant.

Successful coexistence of all agricultural systems is achievable and depends on cooperation, flexibility and mutual respect for each system. Agriculture has a history of innovation and change, and farmers have always adapted to new approaches or challenges by utilizing appropriate strategies, farm management practices and new technologies.

The responsibility for implementing practices to satisfy specific marketing standards or certification lies with that farmer who is growing a crop to satisfy a particular market. Only that farmer is instructed to employ the practices appropriate to assure the integrity of his/her crop. This is true whether the goal is high-oil corn, white/sweet corn or organically produced yellow corn for animal feed. In each case, the farmer is seeking to produce a crop that is supported by a market price and consequently that farmer assumes responsibility for satisfying reasonable market specifications. That said, the farmer needs to be aware of the planting intentions of his/her neighbor in order to gauge the need for management practices.

IDENTITY PRESERVED PRODUCTION

Some farmers may choose to preserve the identity of their crops to meet specific markets. Examples of Identity Preserved (I.P.) corn crops include production of seed corn, white, waxy or sweet corn, specialty oil or protein crops, food grade crops and any other crop that meets specialty needs, including organic and non-genetically enhanced specifications. Farmers of these crops assume the responsibility and receive the benefit for ensuring that their crop meets mutually agreed contract specifications.

Based on historical experience with a broad range of I.P. crops, the industry has developed generally accepted I.P. agricultural practices. These practices are intended to manage I.P. production to meet quality specifications, and are established for a broad range of I.P. needs. The accepted practice with I.P. crops is that each I.P. farmer has the responsibility to implement any necessary processes. These processes may include sourcing seed appropriate for I.P. specifications, field management practices such as adequate isolation distances, buffers between crops, border rows, planned differences in maturity between adjacent fields that might cross-pollinate and harvest and handling practices designed to prevent mixing and to maintain product quality. These extra steps associated with I.P. crop production are generally accompanied by incremental increases in cost of production and consequently of the goods sold.

General Instructions for Management of Pollen Flow and Mechanical Mixing

For all crop hybrids or varieties that they wish to identity preserve, or otherwise keep separated, farmers should take steps to prevent mechanical mixing. Farmers should make sure all seed storage areas, transportation vehicles and planter boxes are cleaned thoroughly both prior to and subsequent to the storage, transportation or planting of the crop. Farmers should also make sure all combines, harvesters and transportation vehicles used at harvest are cleaned thoroughly both prior to and subsequent to their use in connection with the harvest of the grain produced from the crop. Farmers should also make sure all harvested grain is stored in clean storage areas where the identity of the grain can be preserved.

Self-pollinated crops, such as soybeans, do not present a risk of mixing by cross-pollination. If the intent is to use or market the product of a self-pollinated crop separately from general commodity use, farmers should plant fields a sufficient distance away from other crops to prevent mechanical mixture.

Farmers planting cross-pollinated crops, such as corn or alfalfa, who desire to preserve the identity of these crops, or to minimize the potential for these crops to outcross with adjacent fields of the same crop kind, should use the same generally accepted practices to manage mixing that are used in any of the currently grown I.P. crops of similar crop kind.

It is generally recognized in the industry that a certain amount of incidental, trace level pollen movement occurs, and it is not possible to achieve 100% purity of seed or grain in any corn production system. A number of factors can influence the occurrence and extent of pollen movement. As stewards of technology, farmers are expected to consider these factors and talk with their neighbors about their cropping intentions.

Farmers should take into account the following factors that can affect the occurrence and extent of cross-pollination to or from other fields. Information that is more specific to the crop and region may be available from state extension offices.

- Cross-pollination is limited. Some plants, such as potatoes, are incapable of cross-pollinating, while others, like alfalfa, require cross-pollination to produce seed. Importantly, cross-pollination only occurs within the same crop kind, like corn to corn.
- The amount of pollen produced within the field can vary. The pollen produced by the crop within a given field, known as pollen load, is typically high enough to pollinate all of the plants in the field. Therefore, most of the pollen that may enter from other fields falls on plants that have already been pollinated with pollen that originated from plants within the field. In crops such as alfalfa, the hay cutting management schedule significantly limits or eliminates bloom, and thereby restricts the potential for pollen and/or viable seed formation.
- The existence and/or degree of overlap in the pollination period of crops in adjacent fields varies. This will vary depending on the maturity of crops, planting dates and the weather. For corn, the typical pollen shed period lasts from 5 to 10 days for a particular field. Therefore, viable pollen from neighboring fields must be present when silks are receptive in the recipient field during this brief period to produce any grain with traits introduced by the out-of-field pollen.
- Distance between fields of different varieties or hybrids of the same crop: The greater the distance between fields the less likely their pollen will remain viable and have an opportunity to mix and produce an outcross. For wind-pollinated crops, most cross-pollination occurs within the outermost few rows of the field. In fact, many white and waxy corn production contracts ask the farmer to remove the outer 12 rows (30 ft.) of the field in order to remove most of the impurities that could result from cross-pollination with nearby yellow dent corn. Furthermore, research has also shown that as fields become further separated, the incidence of wind-modulated cross-pollination drops rapidly. Essentially, the in-field pollen has an advantage over the pollen coming from other fields for receptive silks because of its volume and proximity to silks.
- The distance pollen moves. How far pollen can travel depends on many environmental factors, including weather during pollination, especially wind direction and velocity, temperature and humidity. For bee-pollinated crops, the farmer's choice of pollinator species and apiary management practice may reduce field-to-field pollination potential. All these factors will vary from season to season, and some factors from day to day and from location to location.
- For wind-pollinated crops, the orientation and width of the adjacent field in relation to the dominant wind direction. Fields oriented upwind during pollination will show dramatically lower cross-pollination for wind-pollinated crops, like corn, compared to fields located downwind.

Advanced breeding and biotechnology have had a major impact on farming production. From 1971 to 1995, average corn yields were increasing at a rate of 1.5 bushels per acre, per year. Since the advent of biotech in 1996, corn yields have increased at a rate of 2.6 bushels per acre, per year, for a total increase of 32 bushels per acre.*

Excellence Through Stewardship

Monsanto Company is a member of Excellence Through Stewardship® (ETS). Monsanto products are commercialized in accordance with ETS Product Launch Stewardship Guidance, and in compliance with Monsanto's Policy for Commercialization of Biotechnology-Derived Plant Products in Commodity Crops. This product has been approved for import into key export markets with functioning regulatory systems. Any crop or material produced from this product can only be exported to, or used, processed or sold in countries where all necessary regulatory approvals have been granted. It is a violation of national and international law to move material containing biotech traits across boundaries into nations where import is not permitted. Growers should talk to their grain handler or product purchaser to confirm their buying position for this product. Excellence Through Stewardship® is a registered trademark of Biotechnology Industry Organization.

IRM GUIDELINES

For specific refuge requirements for *B.t.* corn and cotton, see the current IRM/Grower Guide, sent with this TUG. If you have not received a copy of this Guide, it can be downloaded at **www.monsanto.com**, or call 1-800-768-6387 to request a copy be mailed to you.

RESPECT THE REFUGE®

Insect Resistance Management
Planting Refuges, Preserving Technology

Before opening a bag of seed, be sure to read and understand the stewardship requirements, **including applicable refuge requirements for insect resistance management**, for the biotechnology traits expressed in the seed as set forth in the Monsanto Technology Agreement that you sign. By opening and using a bag of seed, you are reaffirming your obligation to comply with those stewardship requirements.

* USDA Yields were calculated using 3 year rolling averages (32 Yield is 2.6 bu/ac *12 years). 2008 Yield is from Doane Ag Services forecast in April 8, 2008 Quarterly Crop Outlook.

Genuity™ Trait Products and YieldGard® Corn Technologies Product Descriptions

GENUITY™ SMARTSTAX™

Scheduled to launch in 2010, Genuity™ SmartStax™ is the most advanced, all-in-one corn trait system that controls the broadest spectrum of above- and below-ground insects and weeds. Genuity™ SmartStax™ hybrids will contain *B.t.* proteins that represent three separate modes of action for control of lepidopteron, above-ground insect pests, as well as combined modes of action for control of coleopteran, below-ground insect pests. Providing multiple *B.t.* proteins for control will dramatically decrease the probability that insects will become resistant to the traits, resulting in enhanced durability of transgenic insect control via *B.t.* genes. Based on this multiple gene approach, Genuity™ SmartStax™ is approved for reduced refuge in the corn belt from 20% down to 5% for both above- and below-ground pests. The cotton belt refuge for Genuity SmartStax™ is also reduced, from 50% down to 20%.

GENUITY™ VT TRIPLE PRO™

(Formerly YieldGard VT Triple PRO™) — Genuity™ VT Triple PRO™ is available in selected southern corn- and cotton-growing areas. It includes broad-spectrum insect control against corn earworm, European and southwestern corn borers, sugarcane borer, southern cornstalk borer, fall armyworm, western corn rootworm, northern corn rootworm and Mexican corn rootworm. Its advanced control of ear pests can result in higher grain quality and higher-yielding crop potential. The dual mode-of-action of Genuity™ VT Triple PRO™ allows for lower corn borer refuge acres in southern cotton-growing areas compared to other registered *B.t.*-traited products. It includes the same Roundup Ready® 2 Technology as Monsanto's previous product, YieldGard VT Triple. Seed containing Genuity™ VT Triple PRO™ technology is treated with seed-applied insecticide.*

YIELDGARD VT TRIPLE®

YieldGard VT Triple technology combines YieldGard Corn Borer and YieldGard VT Rootworm/RR2® technology into a single plant. YieldGard VT Triple corn hybrids control European and south-western corn borer, sugarcane borer, southern cornstalk borer, western corn rootworm, northern corn rootworm and Mexican corn rootworm. YieldGard VT Triple technology suppresses corn earworm, fall armyworm and stalk borer. By providing in-plant protection against the above insect pests, the genetic yield potential of YieldGard VT Triple corn hybrids is preserved. YieldGard VT Triple corn hybrids also include Roundup Ready 2 Technology. This trait allows a farmer to experience the benefits of utilizing Roundup agricultural herbicides in a weed control system that provides the broadest weed control spectrum available, better application flexibility, and superior crop safety. Seed containing YieldGard VT Triple technology is treated with seed-applied insecticide.*

GENUITY™ VT DOUBLE PRO™

Genuity™ VT Double PRO™ is a new corn technology scheduled for launch in 2010. It includes broad-spectrum insect control against corn earworm, European and southwestern corn borers, sugarcane borer, southern cornstalk borer and fall armyworm. The dual mode-of-action of Genuity™ VT Double PRO™ allows for lower corn borer refuge acres compared to other registered *B.t.*-traited products. Seed containing Genuity™ VT Double PRO™ technology is treated with seed-applied insecticide.*

*A seed-applied insecticide can protect seed, roots and seedlings from insects such as black cutworm, wireworm, white grubs, seed corn maggots, chinch bug and early flea beetles.

YieldGard VT Rootworm/RR2

YIELDGARD VT ROOTWORM/RR2®

YieldGard VT Rootworm/RR2 technology is the current YieldGard stacked-trait product for control of western corn rootworm, northern corn rootworm and Mexican corn rootworm. Protecting the root of the corn plant from feeding by corn rootworm larvae decreases lodging and protects the genetic yield potential of YieldGard VT Rootworm/RR2 corn hybrids. The Roundup Ready 2 Technology allows a farmer to experience the benefits of utilizing Roundup agricultural herbicides in a weed control system that provides the broadest weed control spectrum, better application flexibility and superior crop safety. Seed containing YieldGard VT Rootworm/RR2 technology is treated with seed-applied insecticide.*

YIELDGARD® CORN BORER

YieldGard Corn Borer corn hybrids contain an insecticidal protein from *B.t.* that protects corn plants from European corn borer, southwestern corn borer, sugarcane borer and southern cornstalk borer resulting in full yield potential.

Maximum Insect Protection

YIELDGARD PLUS

YieldGard Plus corn technology combines YieldGard Corn Borer and YieldGard Rootworm technology into a single plan.

YIELDGARD ROOTWORM

YieldGard Rootworm corn hybrids contain an insecticidal protein from *B.t.* that protects corn roots from larval feeding by western, northern and Mexican corn rootworm.

YIELDGARD® CORN BORER WITH ROUNDUP READY® CORN 2

YieldGard Corn Borer with Roundup Ready Corn 2 offers farmers all the benefits of both traits combined in one crop. These hybrids exhibit the same insect protection qualities as YieldGard Corn Borer and, like Roundup Ready Corn 2, are tolerant to over-the-top applications of Roundup® agricultural herbicides.

Maximum Insect Protection

YIELDGARD PLUS WITH ROUNDUP READY CORN 2

YieldGard Plus with Roundup Ready Corn 2 offers farmers all the benefits of all three traits combined in one crop. These hybrids exhibit the same insect protection qualities of YieldGard Corn Borer and YieldGard Rootworm and, like Roundup Ready Corn 2, are tolerant to over-the-top applications of Roundup® agricultural herbicides. Seed containing YieldGard Plus technology is treated with seed-applied insecticide.*

YIELDGARD ROOTWORM WITH ROUNDUP READY CORN 2

YieldGard Rootworm with Roundup Ready Corn 2 offers farmers all the same insect protection qualities as YieldGard Rootworm and, like Roundup Ready Corn 2, is tolerant to over-the-top applications of Roundup agricultural herbicides.

*A seed-applied insecticide can protect seed, roots and seedlings from insects such as black cutworm, wireworm, white grubs, seed corn maggots, chinch bug and early flea beetles.

ROUNDUP READY® Technology in Corn

WEED CONTROL RECOMMENDATIONS

Roundup Ready® Corn 2 (RR2) and corn with Roundup Ready® 2 Technology are equivalent in their tolerance to Roundup agricultural herbicides. Products with Roundup Ready Technology contain in-plant tolerance to Roundup agricultural herbicides.

The Roundup Ready® Technology system's flexibility, broad-spectrum weed control and proven crop safety offer farmers weed control programs that allow them to use the system in the way that provides the greatest benefit. Farmers can select the program that best fits the way they farm. Options include the use of a residual herbicide with a Roundup® agricultural herbicide, tank-mixing other herbicides with Roundup agricultural herbicides where appropriate and a total postemergence program.

AGRONOMIC PRINCIPLES

Corn yield is very sensitive to early-season weed competition. Weed control systems must provide farmers the opportunity to control weeds before they become competitive. The Roundup Ready Technology system provides a mechanism to control weeds at planting and once they emerge. Farmers are provided excellent crop safety and full yield potential, with applications made from planting through 48" of corn height. Drop nozzles must be used between 30" and 48" of corn height. Failure to control weeds with the right rate, at the right time and with the right product, can lead to increased weed competition, weed escapes and the potential for decreased yields. Use other approved herbicide products with Roundup agricultural herbicides if appropriate for the weed spectrum.

<table>
<tr><th>PROGRAM</th><th>INSTRUCTIONS AND USE RATES*</th><th>ADDITIONAL INFORMATION</th></tr>
<tr>
<td>For use where residual herbicides are typically used for early-season weed control:

Residual Herbicide Plus Roundup WeatherMAX®</td>
<td>Use the proper Roundup Ready RATE™ of Bullet®, Degree®, Degree Xtra®, Harness®, Harness Xtra, Harness Xtra 5.6L, Micro-Tech™, or Lariat® (no post) as defined in the table below and the individual product labels, either pre or postemergence to the crop.**

Follow with Roundup WeatherMAX at 16 to 22 oz/A post sequentially after preemergence application or tank-mixed in-crop with the residual. Applications should be made before weeds exceed 4" in height.

Roundup Ready RATEs***
<table>
<tr><td>Harness</td><td>1.5</td><td>Pints</td></tr>
<tr><td>Degree</td><td>3.0</td><td>Pints</td></tr>
<tr><td>Harness Xtra</td><td>1.2</td><td>Quarts</td></tr>
<tr><td>Harness Xtra 5.6L</td><td>1.5</td><td>Quarts</td></tr>
<tr><td>Degree Xtra</td><td>2.0</td><td>Quarts</td></tr>
<tr><td>Micro-Tech</td><td>2.0</td><td>Quarts</td></tr>
<tr><td>Lariat</td><td>2.0</td><td>Quarts</td></tr>
<tr><td>Bullet</td><td>2.0</td><td>Quarts</td></tr>
</table></td>
<td>Use full labeled rate of residual when application is 14 days or more prior to planting or when tough grasses are present, e.g., barnyardgrass, shattercane, seedling johnsongrass, sandbur.

Use a minimum of 2.5 pt/A of Harness on woolly cupgrass and wild proso millet.

Products containing atrazine will provide improved control of cocklebur, giant ragweed, Palmer Amaranth and morningglory.

Tank-mix products such as 2,4-D, dicamba or Status® herbicide with Roundup WeatherMAX for control of glyphosate-resistant marestail (horseweed), Palmer Amaranth and other difficult-to-control weeds.

Use 22 to 32 oz/A of Roundup WeatherMAX* when morningglory or perennial weeds are present or when broadleaf weeds are 4" in height or taller.</td>
</tr>
<tr>
<td>For use where total postemergence programs are effective and sustainable:

Roundup WeatherMAX Sequential</td>
<td>Apply Roundup WeatherMAX at 16 to 22 oz/A before weeds exceed 4" in height and follow with a second application at 16 to 22 oz/A for an additional flush of weeds before they exceed 4" in height.</td>
<td>Use 22 to 32 oz/A of Roundup WeatherMAX when morningglory or perennial weeds are present.

Tank-mix products such as 2,4-D, dicamba or Status herbicide with Roundup WeatherMAX for control of glyphosate-resistant marestail (horseweed), Palmer Amaranth and other difficult-to-control weeds.</td>
</tr>
<tr>
<td>Maximum Use Rates For Roundup WeatherMAX</td>
<td>Products with Roundup Ready 2 Technology In-crop:
• 32 oz/A per single application
• Total: 64 oz/A from emergence through 48" height of corn, drop nozzles must be used from 30" to 48" corn.</td>
<td>Products with Roundup Ready 2 Technology Total Season:
The combined total of preplant, in-crop and preharvest applications of Roundup WeatherMAX can not exceed 5.3 qt/A. The combined total of in-crop and preharvest applications can not exceed 66 oz/A.</td>
</tr>
</table>

*If using another Roundup agricultural herbicide, you must refer to the label booklet or Roundup Ready Corn 2 Technology supplemental label for that brand to determine appropriate use rates. If using Roundup PowerMAX®, application rates are the same as for Roundup WeatherMAX. If using another residual herbicide, follow the labeled use rate instructions applicable to Roundup Ready Corn 2. Follow all pesticide label requirements.

**Atrazine may also be used as a residual herbicide in the Roundup Ready Corn 2 System.

***You may apply up to the full residual herbicide labeled rate for corn.

WEED RESISTANCE MANAGEMENT FOR CORN WITH ROUNDUP READY TECHNOLOGY

Follow all pesticide label requirements and the guidelines below to minimize the risk of developing glyphosate-resistant weed populations in a Roundup Ready Technology system.

- Start clean with a burndown herbicide or tillage. Early-season weed control is critical to yield.
- Apply pre-emergence residual herbicides such as Harness Xtra, Degree Xtra or other residual herbicides at the recommended rate.
- Or apply a pre-emergence residual herbicide at the recommended rate tank-mixed with Roundup WeatherMAX® at a minimum of 22 oz/A in-crop before weeds exceed 4" in height.
- Follow with a postemergence in-crop application of Roundup WeatherMAX at a minimum of 22 oz/A for additional weed flushes before they exceed 4" in height.
- Roundup WeatherMAX may be tank-mixed with other herbicides for postemergence weed control.
- Report repeated non-performance to Monsanto or your local retailer.

RECOMMENDATIONS FOR MANAGING GLYPHOSATE-RESISTANT WEEDS IN PRODUCTS WITH ROUNDUP READY TECHNOLOGY

WEEDS	INSTRUCTIONS AND USE RATES*
Glyphosate-Resistant Marestail (Horseweed)	Start clean with a burndown program or tillage. -Tank-mix Roundup agricultural herbicides with 2,4-D, or dicamba, according to the label directions. In-crop, tank-mix 22 ounces per acre of Roundup WeatherMAX with Clarity® (8 to 16 fluid ounces per acre) or 2,4-D (0.5 to 1.0 lb active ingredient per acre) from corn emergence to the 5-leaf stage of corn growth (approximately 8" tall). Or tank-mix 22 ounces per acre of Roundup WeatherMAX with 5 ounces per acre of Status® herbicide when the corn is 4" to 36" tall (V2 to V10). Marestail should not exceed 6" in height at the time of in-crop application.
Glyphosate-Resistant *Amaranthus* Species **- *Palmer Amaranth*** **- Waterhemp**	Start clean with a burndown program or tillage. Use a residual herbicide such as Harness Xtra, Harness Xtra 5.6L, Degree Xtra or other residual herbicide either preemergence or in-crop for control of *Amaranthus* species. In-crop, tank-mix Roundup WeatherMAX with other herbicides such as 2,4-D, dicamba (Clarity or Banvel®) or Status herbicide to control emerged weeds. Applications of Status herbicide should be made when the corn is between 4" and 36" tall (V2 to V10). Follow all label directions. *Amaranthus* species should not exceed 3" in height at the time of in-crop application.
Glyphosate-Resistant *Ambrosia* Species **- Giant Ragweed** **- Common Ragweed**	Start clean with a burndown program or tillage. Use a residual herbicide such as Harness Xtra, Harness Xtra 5.6L, Degree Xtra or other residual herbicide either preemergence or in-crop for control of *Ambrosia* species. In-crop, tank-mix Roundup WeatherMAX with other herbicides such as 2,4-D, dicamba (Clarity or Banvel) or Status herbicide to control emerged weeds. Applications of Status herbicide should be made when the corn is between 4" and 36" tall (V2 to V10). Follow all label directions. *Ambrosia* species should not exceed 3" in height at the time of in-crop application.
Glyphosate-Resistant Johnsongrass	Start clean with a burndown program or tillage. Use a residual herbicide such as Harness Xtra, Harness Xtra 5.6L, Degree Xtra or other residual herbicide containing atrazine preemergence to reduce the competition from seedling johnsongrass prior to the emergence of corn. In-crop, tank-mix Roundup WeatherMAX with a herbicide such as Accent®, Equip™ or Option® for control of emerged weeds including seedling and rhizome johnsongrass. Follow all label directions of tank-mix partners, especially those related to weed size.

In certain areas, Italian ryegrass is known to be resistant to glyphosate. For control recommendations, refer to **www.weedresistancemanagement.com** or call 1-800-768-6387. When approved, supplemental labeling for specific herbicide products can also be viewed on **www.cdms.net** or **www.greenbook.net.**

*Follow all pesticide label requirements.

Genuity™ Bollgard II® and Bollgard® Cotton Descriptions

GENUITY™ BOLLGARD II® COTTON

Genuity™ Bollgard II® cotton contains two distinct insecticidal proteins from *Bacillus thuringiensis (B.t.)* that increase the efficacy and spectrum of control and reduce the chance that resistance will develop to the *B.t.* insecticidal proteins, relative to Bollgard® cotton. Genuity™ Bollgard II® cotton normally provides excellent, season-long control of tobacco budworm, pink bollworm and cotton bollworm. Genuity™ Bollgard II® cotton provides good protection against fall armyworm, beet armyworm, cabbage and soybean loopers and other secondary leaf- or fruit-feeding caterpillar pests of cotton. Applications of insecticides to control these insects are substantially reduced with Genuity™ Bollgard II® cotton.

BOLLGARD® COTTON

Bollgard cotton contains a single insecticidal protein from *B.t.* that provides good control against three major lepidopteran insect pests of cotton. Specifically, Bollgard cotton provides excellent, season-long control of tobacco budworm and pink bollworm, and suppression of cotton bollworm. When the above-mentioned insect larvae feed on Bollgard cotton plants, the *B.t.* protein protects the plants from damage by reducing larval survival. Under high infestation, application of insecticides may be necessary to protect Bollgard cotton.

BOLLGARD PHASE OUT

The U.S. Environmental Protection Agency has mandated the following terms and conditions:*

- Bollgard® cotton may be sold through September 30, 2009. After that date, all sales of Bollgard cotton are prohibited.
- All Bollgard cotton seed must be planted by midnight of July 1, 2010 (the expiration date of the Bollgard cotton registration). After July 1, 2010, planting of Bollgard cotton seed is prohibited. Any Bollgard cotton seed not planted on or before July 1, 2010, must be returned to either the retailer or to Monsanto. No refunds are to be issued on Bollgard cotton seeds bought for planting in 2010 and returned by growers.
- An adequate amount of refuge seed must be purchased for planting an appropriate refuge for Bollgard cotton. Purchase of refuge seed with the Bollgard cotton seed is mandatory, and such seed must be purchased by growers in advance of their receipt of Bollgard cotton seed. Any seed purchased for use as a refuge is non-refundable, unless the proportional amount of Bollgard cotton seed that the refuge seed would have supported is returned at the same time.
- Any order for replacement or additional Bollgard cotton seed for the 2010 planting season, that does not conform to the requirements stated above must be filled with Genuity™ Bollgard II® cotton seed (or other products with current registrations).
- On-farm IRM assessments will be conducted during the planting season.
- In 2010, Bollgard cotton may only be planted in: Alabama, Arkansas, Florida (North of Florida Route 60), Georgia. Kentucky, Louisiana, Maryland, Missouri, Mississippi, North Carolina, South Carolina, Tennessee, Texas (excluding the ten prohibited Texas panhandle counties of: Dallam, Sherman, Hansford, Ochiltree, Lipscomb, Hartley, Moore, Hutchinson, Roberts, and Carson) and Virginia.

*It is a violation of federal law to sell or distribute an unregistered pesticide.

NOTE: Sale or commercial planting of Bollgard®cotton is prohibited in certain states, including: Arizona, California, Colorado, Kansas, New Mexico and Oklahoma.

Sale or planting of Bollgard is prohibited in the Texas counties of: Carson, Dallam, Hansford, Hartley, Hutchison, Lipscomb, Moore, Ochiltree, Roberts, and Sherman.

Sale or commercial planting of both Genuity™ Bollgard II® and Bollgard is prohibited in Hawaii, Puerto Rico, the U.S. Virgin Islands, and in Florida south of Route 60 (near Tampa).

The *B.t. delta endotoxin* protein expressed in this cotton targets certain cotton insect pests. Routine applications of insecticides to control certain insects are usually unnecessary when cotton containing the *B.t. delta endotoxin* protein is planted. However, if insecticide applications are necessary to control certain cotton insect pests, follow all label requirements.

Genuity™ Bollgard II® and Bollgard® Cotton

INSECT RESISTANCE MANAGEMENT (IRM)

Lepidopteran cotton pests have demonstrated the ability to develop resistance to many chemical insecticides. As a pre-emptive measure, Genuity™ Bollgard II® and Bollgard® cotton must be managed in ways that will retard insect resistance development. These practices are designed to ensure that some lepidopteran populations are not exposed to the *B.t.* proteins so they can maintain susceptibility in select populations. In order to achieve this, refuge cotton that does not contain *B.t.* proteins must be planted.

GENUITY™ BOLLGARD II - DUAL EFFECTIVE DOSE

Resistance management is critical to the long-term viability of our technology and the benefits realized by our farmer customers. 2010 is a transition year for Monsanto *B.t.* cotton products as we shift all U.S. cotton acres toward the two-gene insect control product, Genuity™ Bollgard II® cotton. The move to multiple-gene products, including Genuity™ Bollgard II®, offers dual effective modes of action against target insect pests, increasing the longevity of the technology.

INTEGRATED PEST MANAGEMENT (IPM)

Integrated Pest Management (IPM) is an effective and environmentally sensitive approach to pest management that relies on a combination of common-sense practices. IPM programs use current, comprehensive information on the life cycles of pests and their interaction with the environment. This information is used to manage pests in a manner that is least harmful to people, property and the environment.

Prevention

Using the best agronomic management practices in conjunction with the appropriate cotton varieties will yield the greatest benefits.

Use varieties, seeding rates and planting technologies appropriate for each specific geographical area. As much as possible, manage the crop to avoid plant stress.

- Employ appropriate scouting techniques and treatment decisions to preserve beneficial insects that can provide additional insect pest control.
- Manage for appropriate maturity and harvest schedules. destroy stalks immediately after harvest to avoid regrowth and minimize selection for resistance in late-season infestations.
- Use soil management practices that encourage destruction of over-wintering pupae.

Monitor and Identify

Fields should be carefully monitored for all pests, including cotton bollworms, to determine the need for remedial insecticide treatments. For target pests, scouting techniques and supplemental treatment decisions should take into account the fact that larvae must hatch and feed before they can be affected by the *B.t.* protein(s) in either Genuity™ Bollgard II® or Bollgard cotton. Fields should be scouted regularly, following periods of heavy or sustained egg lay, especially during bloom, to determine if significant larval survival has occurred. Scouting should include a modified whole-plant inspection, including terminals, squares, blooms, bloom tags and small bolls. Larvae larger than 1/4 inch (3- to 4-days old) are generally recognized as survivors that may not be controlled by Genuity™ Bollgard II® or Bollgard cotton.

Read the IRM/Grower Guide prior to planting for information on planting and Insect Resistance Management. If you do not have a copy of this Guide, you may download it at www.monsanto.com, or call 1-800-768-6387 to request a copy by mail.

Control

Monsanto recommends the use of appropriate remedial insecticide treatments to ensure desired levels of control if any cotton insect pest reaches locally established thresholds in Genuity™ Bollgard II® or Bollgard cotton.

Although Genuity™ Bollgard II® and Bollgard cotton will sustain less damage from some of the most troublesome lepidopteran pests, they will not provide protection against non-lepidopteran species. These insects should be monitored and treated with insecticides when necessary, using recommended thresholds. Whenever possible, select insecticides that are least harmful to beneficial insects.

NOTE: In 2010, sale or commercial planting of Bollgard® cotton is prohibited in the following states: Arizona, California, Colorado, Kansas, New Mexico and Oklahoma.

In 2010, sale or planting of Bollgard® is prohibited in the Texas counties of: Carson, Dallam, Hansford, Hartley, Hutchison, Lipscomb, Moore, Ochiltree, Roberts, and Sherman.

In 2010, sale or commercial planting of both Genuity™ Bollgard II® and Bollgard® is prohibited in Hawaii, Puerto Rico, and the U.S. Virgin Islands, or in Florida south of Route 60 (near Tampa).

Roundup Ready® Cotton, Genuity™ Bollgard II® with Roundup Ready® Cotton and Bollgard with Roundup Ready Cotton

ROUNDUP READY COTTON

Roundup Ready® cotton varieties contain in-plant tolerance to Roundup® agricultural herbicides, enabling farmers to make in-crop applications of Roundup WeatherMAX® or Roundup PowerMAX® according to label requirements.

GENUITY™ BOLLGARD II WITH ROUNDUP READY COTTON AND BOLLGARD WITH ROUNDUP READY COTTON

Genuity™ Bollgard II® with Roundup Ready® cotton and Bollgard with Roundup Ready varieties offer farmers the benefits of both insect protection and glyphosate tolerance combined in one crop. These varieties exhibit the same insect protection qualities as Genuity™ Bollgard II® and Bollgard cotton and enable farmers to make in-crop applications of Roundup WeatherMAX or Roundup PowerMAX according to label requirements.

MARKET OPTIONS

Gin by-products of cotton containing Monsanto's biotech traits, including cottonseed for feed uses, are fully approved for export to Canada, Japan, Mexico and South Korea. Cottonseed containing Monsanto traits may not be exported for the purpose of planting without a license from Monsanto.

It is a violation of national and international law to move material containing biotech traits across boundaries into nations where import is not permitted.

RECOMMENDED MANAGEMENT PRACTICES

Managing Roundup Ready cotton, Bollgard with Roundup Ready cotton and Genuity™ Bollgard II® with Roundup Ready® cotton requires that a farmer follow the recommended management practices associated with cotton containing each individual trait. Farmers of Bollgard with Roundup Ready cotton and Genuity™ Bollgard II® with Roundup Ready® cotton varieties must follow the same guidelines for establishing required refuge options, practicing IRM and managing target and non-target pests as described for Bollgard and Genuity™ Bollgard II® cotton in the IRM/Grower Guide.

APPLICATION OF ROUNDUP WEATHERMAX® AND ROUNDUP POWERMAX®

Roundup Ready cotton is genetically improved to provide tolerance to glyphosate, the active ingredient in Roundup agricultural herbicides. Roundup Ready cotton can receive over-the-top applications of Roundup agricultural herbicides only through the four-leaf stage. With the introduction of Genuity™ Roundup Ready® Flex cotton, there is the potential for both Roundup Ready cotton and Genuity™ Roundup Ready® Flex cotton to be used on a farmer's farm. This creates concern for the crop safety of Roundup Ready cotton. Monsanto recommends that farmers:

- Maintain accurate records of which technologies have been planted and where they have been planted.
- Communicate the field plan with other members of their work force to ensure proper applications for each technology.
- Clearly mark fields to indicate which technology has been planted.

WEED RESISTANCE MANAGEMENT GUIDELINES

Follow all pesticide label requirements and these guidelines to minimize the risk of developing glyphosate-resistant weed populations in a Roundup Ready cotton system:

- Scout fields before and after each burndown and in-crop application.
- Start clean with a burndown herbicide program or tillage.
- Use the right herbicide product at the right rate and right time.
- Add soil residual herbicide(s) and cultural practices as part of a Roundup Ready weed control program.
- In-crop, apply Roundup WeatherMAX at a minimum of 22 oz/A when weeds are less than 6" in height.
- Tank-mix other approved herbicides with Roundup WeatherMAX if necessary for postemergence weed control.
- Clean equipment before moving from field to field to minimize the spread of weed seed (as well as nematodes, insects and other cotton pests).
- Should repeated non-performance occur, report to Monsanto or your local retailer.

WEED CONTROL RECOMMENDATIONS

Weed control in cotton is essential to help maximize both fiber yield and quality potential. Cotton is very sensitive to early-season weed competition, which can result in unacceptable stands and/or reduced yield potential. The Roundup Ready® cotton system provides farmers with the right tools to control weeds before they become competitive.

PROGRAM	INSTRUCTIONS AND USE RATES*	ADDITIONAL INFORMATION
Preplant Burndown	Always start clean by planting into a weed-free field using either tillage or a burndown application. In no-till and reduced-till systems, apply a preplant burndown application of Roundup WeatherMAX®** at 22 to 44 oz/A in a tank-mix with dicamba or 2,4-D. See the dicamba and 2,4-D product label for rates and time intervals required between application and cotton planting. State restrictions may apply.	Early-season weed competition can result in unacceptable stands and/or reduced yield potential. This tank-mix is recommended for control and management of glyphosate-resistant marestail (*Conyza sp.*) or other tough-to-control weeds. Burndown application should be made far enough in advance of planting to control existing weeds.
Residual Herbicides	Apply residual herbicide(s) as part of a Roundup Ready cotton weed control program. Use the recommended label rate and timing of the residual herbicide applied. Refer to individual product labels for list of residual herbicides that may be used.	The residual herbicide(s) may be applied as either a preemergence (including preplant incorporated), postemergence, and/or layby application as allowed on the label of the specific product being used.
Over-The-Top through Fourth Leaf	Apply Roundup WeatherMAX over the top from crop emergence through the fourth true-leaf (node) stage (until the fifth true leaf reaches the size of a quarter). Two applications can be made during this period at a maximum rate of 22 oz/A per application. Refer to the "Annual Weeds Rate Table" in the Roundup WeatherMAX label for rate recommendations for specific annual weeds.	In-crop over-the-top applications must be at least 10 days apart and the cotton must have at least two nodes of incremental growth between applications. Care should be taken to record growth stage at first application. In situations where the potential for weed infestations is high (including perennial weeds), make the first application early enough to allow a second application before cotton exceeds the fourth true-leaf stage. Over-the-top applications after the fourth true-leaf stage can result in boll loss, delayed maturity, and/or yield loss.
Selective Equipment	After the fourth true-leaf stage through layby, Roundup WeatherMAX may be applied using precision post-directed or hooded sprayers which direct the spray to the base of the cotton plant. Two post-directed applications can be made during this period at a maximum rate of 22 oz/A per application.	Place nozzles in a low horizontal position to permit spray pattern to overlap in the row while contact of spray solution with cotton leaves should be avoided to the maximum extent possible. Excessive foliar contact can result in boll loss, delayed maturity, and/or yield loss. There must be two nodes of growth and at least 10 days between applications.
Preharvest Over-The-Top Applications	Before harvest and after cotton reaches 20% boll-crack, if needed, apply up to 44 oz/A of Roundup WeatherMAX. This treatment is effective in controlling late-season perennial weeds and can improve harvest efficiency.	Applications must be made at least 7 days prior to harvest. Roundup agricultural herbicides are not effective for preharvest cotton regrowth in Roundup Ready cotton. Do not apply Roundup agricultural herbicides preharvest to crops grown for seed under contract at an authorized cotton seed company.

Roundup Ready cotton has excellent vegetative tolerance to Roundup WeatherMAX allowing early-season over-the-top applications. Incomplete reproductive tolerance requires that applications after the 4-leaf (node) stage be properly post-directed.

ATTENTION: Use of Roundup agricultural herbicides in accordance with label directions is expected to result in normal growth of Roundup Ready cotton, however, various environmental conditions, agronomic practices, and other factors make it impossible to eliminate all risks associated with the product, even when applications are made in conformance with the label specifications. In some cases, these factors can result in boll loss, delayed maturity, and/or yield loss.

*Follow all pesticide label requirements.

**If using another Roundup agricultural herbicide, you must refer to the label booklet or Roundup Ready cotton supplemental label for that brand to determine appropriate use rates. If using Roundup PowerMAX®, application rates are the same as for Roundup WeatherMAX.

RECOMMENDATIONS FOR MANAGING GLYPHOSATE-RESISTANT WEEDS

WEEDS	INSTRUCTIONS AND USE RATES*
Glyphosate-Resistant Marestail (Horseweed)	Start clean with a burndown herbicide program or tillage. -Tank-mix Roundup agricultural herbicides with dicamba or 2,4-D (consult label for plant back timing). If you have dense stands of marestail, use a preplant residual herbicide at the recommended rate and timing, such as diuron (Direx®) or flumioxazin (Valor®). Use Roundup WeatherMAX in-crop, as needed, at a minimum of 22 oz/A to control other weeds. In-crop, if applying post-directed to glyphosate-resistant marestail, Roundup WeatherMAX can be tank-mixed with other herbicides, such as diuron or MSMA. Marestail should be less than 6" in height at the time of in-crop application.
Glyphosate-Resistant *Amaranthus* Species **- *Palmer Amaranth*** **- Waterhemp**	Start clean with a burndown herbicide program or tillage. Apply a preemergence residual herbicide such as pendimethalin (Prowl®) plus fluometuron or fomesafen (Reflex®) or flumioxazin (Valor) for control of *Amaranthus* species. In-crop, tank-mix Roundup WeatherMAX at 22 oz/A with metolachlor or other labeled chloracetamide herbicide before *Amaranthus* species emerges. Use Roundup WeatherMAX in-crop, as needed, at a minimum of 22 oz/A to control other weeds. A post-directed application of Roundup WeatherMAX tank-mixed with MSMA and a residual such as diuron (Direx) or flumioxazin (Valor) should be made to control *Amaranthus* species 3" or smaller in height and prevent additional flushes.
Glyphosate-Resistant *Ambrosia* Species **- Giant Ragweed** **- Common Ragweed**	Start clean with a burndown herbicide program or tillage. Apply a preemergence residual herbicide such as pendimethalin (Prowl) plus fluometuron or fomesafen (Reflex)for control of *Ambrosia* species. In-crop, tank-mix Roundup WeatherMAX at 22 oz/A with metolachlor before *Ambrosia* species emerges. Use Roundup WeatherMAX in-crop, as needed, at a minimum of 22 oz/A to control other weeds. A post-directed application of Roundup WeatherMAX tank-mixed with MSMA and a residual such as diuron (Direx) or flumioxazin (Valor) should be made to control *Ambrosia* species 3" or smaller in height and prevent additional flushes.
Glyphosate-Resistant Johnsongrass	Start clean with a burndown herbicide or tillage. Preplant incorporate a residual herbicide such as pendimethalin or trifluralin for control or suppression of seedling johnsongrass. Apply Roundup WeatherMAX in a tank-mix with herbicides such as SelectMAX®, Assure® II or Poast Plus for the control of emerged weeds including seedling and rhizome johnsongrass. Follow all label directions of tank-mix partners, especially those related to weed size.

In certain areas, Italian ryegrass is known to be resistant to glyphosate. For control recommendations, refer to **www.weedresistancemanagement.com** or call 1-800-768-6387. When approved, supplemental labeling for specific herbicide products can also be viewed on **www.cdms.net** or **www.greenbook.net.**

*Follow all pesticide label requirements.

Genuity™ Roundup Ready® Flex Cotton and Genuity™ Bollgard II® with Roundup Ready® Flex Cotton

GENUITY™ ROUNDUP READY® FLEX COTTON

Genuity™ Roundup Ready® Flex cotton varieties possess improved reproductive tolerance to Roundup® agricultural herbicides. This technology gives farmers the opportunity to make over-the-top broadcast applications of labeled Roundup agricultural herbicides from crop emergence up to seven (7) days prior to harvest.

GENUITY™ BOLLGARD II® WITH ROUNDUP READY® FLEX COTTON

Genuity™ Bollgard II® with Roundup Ready® Flex varieties offer farmers the benefits of both insect protection and glyphosate tolerance combined in one crop. These varieties exhibit the same insect protection qualities as Genuity™ Bollgard II® and are tolerant to over-the-top applications of Roundup WeatherMAX® and Roundup PowerMAX®.

MARKET OPTIONS

Genuity™ Roundup Ready® Flex cotton and Genuity™ Bollgard II® with Roundup Ready Flex cotton have regulatory clearance in the United States, but do not have import approval in all export markets. Processed fractions from these products, including linters, oil, meal, cottonseed and gin trash, must not be exported without all necessary approvals in the importing country. It is a violation of national and international law to move material containing biotech traits across boundaries into nations where import is not permitted.

RECOMMENDED MANAGEMENT PRACTICES

Managing Genuity™ Roundup Ready® Flex cotton and Genuity™ Bollgard II® with Roundup Ready® Flex cotton requires a farmer to follow the recommended management practices associated with cotton containing each individual trait. Farmers of Genuity™ Bollgard II® with Roundup Ready® Flex cotton must follow the same guidelines for establishing required refuge options, practicing IRM and managing target and non-target pests as described for Genuity™ Bollgard II® cotton in the IRM/Grower Guide.

WEED RESISTANCE MANAGEMENT GUIDELINES

Follow all label requirements and the guidelines below to minimize the risk of developing weed resistance in a Genuity™ Roundup Ready® Flex cotton system:

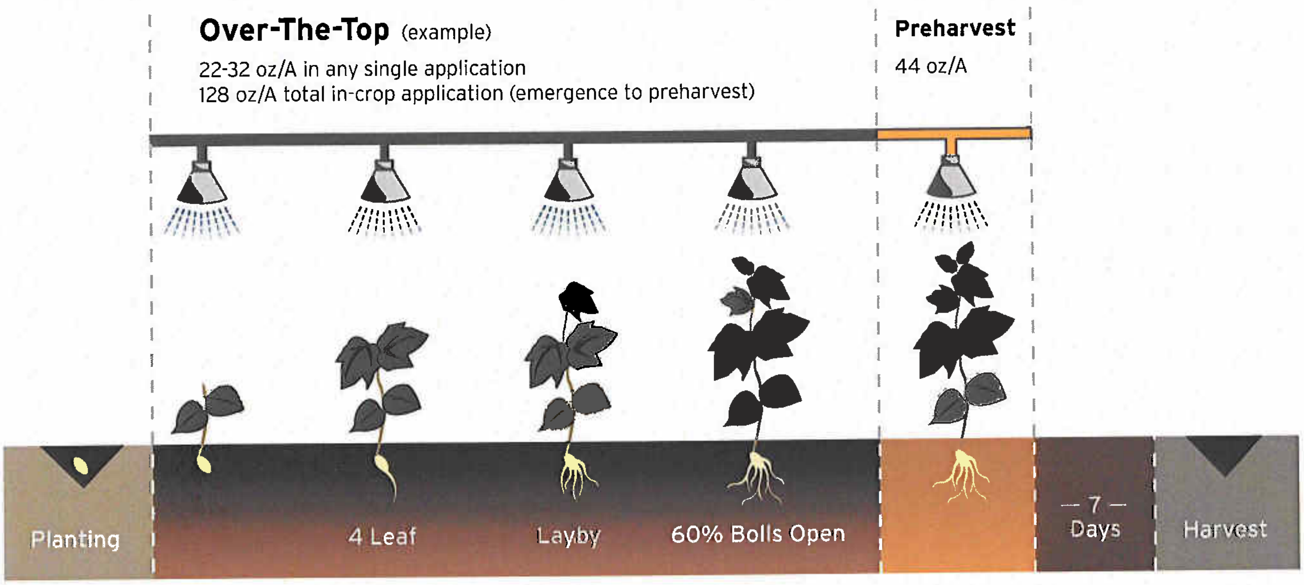
- Scout fields before and after each burndown and in-crop application.
- Start clean with a burndown herbicide program or tillage.
- Use the right herbicide product at the right rate and right time.
- Add soil residual herbicide(s) and cultural practices as part of a Genuity™ Roundup Ready® Flex cotton weed control program.
- In-crop, apply Roundup WeatherMAX at a minimum of 22 oz/A when weeds are 3" to 6" in height.
- Tank-mix other approved herbicides with Roundup WeatherMAX if necessary for postemergence weed control.
- Should repeated non-performance occur, report to Monsanto or your local retailer.
- Clean equipment before moving from field to field to minimize the spread of weed seed (as well as nematodes, insects and other cotton pests).

APPLICATION OF ROUNDUP WEATHERMAX® AND ROUNDUP POWERMAX®

- May be applied over-the-top and/or in-crop, from crop emergence up to 7 days prior to harvest.
- A maximum rate of 32 oz/A per application may be applied using ground application equipment while the maximum is 22 oz/A per application by air.
- There are no growth or timing restrictions for sequential applications.
- Four (4) quarts/A is the total in-crop volume allowed from emergence to 60% open bolls.
- A maximum total volume of 44 oz/A may be applied between layby and 60% open bolls.
- Post-directed equipment may be used to achieve more thorough spray coverage of weeds or if herbicides not labeled for over-the-top application will be tank-mixed with Roundup WeatherMAX or Roundup PowerMAX.

PREHARVEST APPLICATIONS

- Up to 44 oz/A may be applied after cotton reaches 60% open bolls and before harvest, if needed.
- Applications must be made at least 7 days prior to harvest.



CROP SAFETY OF OVER-THE-TOP GLYPHOSATE APPLICATIONS

Monsanto has determined that a combination of components in glyphosate formulations have the potential to cause leaf injury when applied during later stages of crop growth. Roundup WeatherMAX and Roundup PowerMAX are the only Roundup agricultural herbicides labeled and approved for new labeled uses over the top of Genuity™ Roundup Ready® Flex cotton.

Leaf injury may occur if the products are not used according to the product label, used at higher than recommended rates or if overlap of spray occurs in the field. **Farmers must confirm that any glyphosate formulation to be used on Genuity™ Roundup Ready® Flex cotton has been labeled for use on Genuity™ Roundup Ready® Flex cotton and should confirm that it has been tested to demonstrate crop safety.**

WEED CONTROL RECOMMENDATIONS

Weed control in cotton is essential to maximize both fiber yield and quality potential. Cotton is very sensitive to early-season weed competition, which can result in unacceptable stands and/or reduced yield potential. The Genuity™ Roundup Ready® Flex cotton system, with improved reproductive tolerance to Roundup® agricultural herbicides, provides farmers with the right tools to control weeds.

PROGRAM	INSTRUCTIONS AND USE RATES*	ADDITIONAL INFORMATION
Preplant Burndown	Always start clean by planting into a weed-free field using either tillage or a burndown application. In no-till and reduced-till systems, apply a preplant burndown application of Roundup WeatherMAX®** at 22 to 44 oz/A in a tank-mix with dicamba or 2,4-D. See the dicamba and 2,4-D product label for rates and time intervals required between application and cotton planting. State restrictions may apply.	Early-season weed competition can result in unacceptable stands and/or reduced yield potential. This tank-mix is recommended for control and management of glyphosate-resistant marestail (*Conyza sp.*) or other tough-to-control weeds. Burndown application should be made far enough in advance of planting to control existing weeds.
Residual Herbicides	Apply approved residual herbicide(s) as part of a Genuity™ Roundup Ready® Flex cotton weed control program. Use the recommended label rate and timing of the residual herbicide applied. Refer to individual product labels for list of residual herbicides that may be used.	The residual herbicide(s) may be applied as either a preemergence (including preplant incorporated), postemergence, and/or layby application as allowed on the label of the specific product being used.
In-Crop Weed Control	Target the first application of Roundup WeatherMAX on 1-2 leaf cotton when weeds are small. Apply a minimum of 22 oz/A of Roundup WeatherMAX in-crop. The need for sequential applications of Roundup WeatherMAX will depend upon the occurrence of subsequent weed flushes. Refer to the "Annual Weeds Rate Table" in the Roundup WeatherMAX label booklet for rate recommendations for specific annual weeds.	Early-season weed competition can reduce yield potential in cotton. Select timing of application based on the most difficult to control weed species in your field. Post-direct or hooded sprayers can be used to achieve more thorough spray coverage on weeds.
Preharvest Over-The-Top Applications	Before harvest and after cotton reaches 60% open bolls, if needed, apply up to 44 oz/A of Roundup WeatherMAX. This treatment is effective in controlling late-season perennial weeds.	Applications must be made at least 7 days prior to harvest. Roundup agricultural herbicides are not effective for preharvest cotton regrowth in Genuity™ Roundup Ready® Flex cotton.

*Follow all pesticide label requirements.

**The maximum volume of Roundup WeatherMAX and Roundup PowerMAX® that may be used in a single season is 5.3 quarts per acre.

RECOMMENDATIONS FOR MANAGING GLYPHOSATE-RESISTANT WEEDS

WEEDS	INSTRUCTIONS AND USE RATES*
Glyphosate-Resistant Marestail (Horseweed)	Start clean with a burndown herbicide program or tillage. -Tank-mix Roundup agricultural herbicides with dicamba or 2,4-D (consult label for plant back timing). If you have dense stands of marestail, use a preplant residual herbicide at the recommended rate and timing, such as diuron (Direx®) or flumioxazin (Valor®). Use Roundup WeatherMAX in-crop, as needed, at a minimum of 22 oz/A to control other weeds. In-crop, if applying post-directed to glyphosate-resistant marestail, Roundup WeatherMAX can be tank-mixed with other herbicides, such as diuron or MSMA. Marestail should not exceed 6" in height at the time of in-crop application.
Glyphosate-Resistant *Amaranthus* Species **- *Palmer Amaranth*** **- Waterhemp**	Start clean with a burndown herbicide program or tillage. Apply a preemergence residual herbicide such as pendimethalin (Prowl®) plus fluometuron or fomesafen (Reflex®) or flumioxazin (Valor) for control of *Amaranthus* species. In-crop, tank-mix Roundup WeatherMAX at 22 oz/A with metolachlor or other labeled chloracetamide herbicide before *Amaranthus* species emerges. Use Roundup WeatherMAX in-crop, as needed, at a minimum of 22 oz/A to control other weeds. A post-directed application of Roundup WeatherMAX tank-mixed with MSMA and a residual such as diuron (Direx) or flumioxazin (Valor) should be made to control *Amaranthus* species 3" or smaller in height and prevent additional flushes.
Glyphosate-Resistant *Ambrosia* Species **- Giant Ragweed** **- Common Ragweed**	Start clean with a burndown herbicide program or tillage. Apply a preemergence residual herbicide such as pendimethalin (Prowl) plus fluometuron or fomesafen (Reflex) for control of *Ambrosia* species. In-crop, tank-mix Roundup WeatherMAX at 22 oz/A with metolachlor before *Ambrosia* species emerges. Use Roundup WeatherMAX in-crop, as needed, at a minimum of 22 oz/A to control other weeds. A post-directed application of Roundup WeatherMAX tank-mixed with MSMA and a residual such as diuron (Direx) or flumioxazin (Valor) should be made to control *Ambrosia* species 3" or smaller in height and prevent additional flushes.
Glyphosate-Resistant Johnsongrass	Start clean with a burndown herbicide or tillage. Preplant incorporate a residual herbicide such as pendimethalin or trifluralin for control or suppression of seedling johnsongrass. Apply Roundup WeatherMAX in a tank-mix with herbicides such as SelectMAX®, Assure® II or Poast Plus for the control of emerged weeds including seedling and rhizome johnsongrass. Follow all label directions of tank-mix partners, especially those related to weed size.

In certain areas, Italian ryegrass is known to be resistant to glyphosate. For control recommendations, refer to **www.weedresistancemanagement.com** or call 1-800-768-6387. When approved, supplemental labeling for specific herbicide products can also be viewed on **www.cdms.net** or **www.greenbook.net.**

*Follow all pesticide label requirements.

Genuity™ Roundup Ready 2 Yield® and Roundup Ready® soybean varieties contain in-plant tolerance to Roundup® agricultural herbicides. This means you can spray Roundup agricultural herbicides in-crop from emergence through flowering.

Spray labeled Roundup agricultural herbicides over the top from emergence (cracking) through flowering (R2 stage soybeans) for unsurpassed weed control, proven crop safety and maximum yield potential. R2 stage soybeans end when a pod 5 millimeters (3/16") long at one of the four uppermost nodes appears on the main stem along with a fully developed leaf (R3 stage).

WEED CONTROL RECOMMENDATIONS

Starting clean with a weed-free field, and making timely post-emergence in-crop applications, is critical to obtaining excellent weed control and maximum yield potential. The Roundup Ready soybean system provides the flexibility to use the herbicide tools necessary to control weeds at planting and in-crop. Failure to control weeds with the right rate, at the right time and with the right product, can lead to increased weed competition and the potential for decreased yield.

PROGRAM	INSTRUCTIONS AND USE RATES*	ADDITIONAL INFORMATION
Preplant Burndown	To start clean in no-till systems, apply a burndown application of Roundup WeatherMAX®** at 22 to 44 oz/A before planting. See the label for appropriate rates by weed species. For control and management of glyphosate-resistant marestail (*Conyza sp.*) or other difficult-to-control weeds present at burndown, apply 22 oz/A of Roundup WeatherMAX in a tank-mix with 1 to 2 pt/A 2,4-D. Make applications 7 to 30 days before planting and before marestail reaches 6" in height.	Always start with a weed-free field. In no-till and reduced-till systems, apply a Roundup WeatherMAX* burndown application to control existing weeds before planting. Adding 2,4-D in the burndown can significantly reduce broadleaf weed pressure at post-emergence timing. Read the 2,4-D product label for time intervals required between application and soybean planting.
Residual Herbicide Plus Roundup WeatherMAX	Use the recommended label rate of a soil-applied residual herbicide applied preemergence to soybeans as defined in the individual product's labeling. The residual product may be tank-mixed with Roundup WeatherMAX at burndown. Refer to individual product labels for list of residual herbicides that may be used. Follow with 22 oz/A Roundup WeatherMAX in-crop when weeds are 2" to 8" tall. Refer to the "Annual Weeds Rate Table" in the Roundup WeatherMAX label for rate recommendations for specific annual weeds. Crop rotation following Genuity™ Roundup Ready 2 Yield® and Roundup Ready soybeans is strongly encouraged. Use of a residual herbicide is encouraged especially if the cropping system is a continuous Roundup Ready system.	A residual program is encouraged when agronomic conditions favor the practice. Reducing Roundup WeatherMAX rate when tank-mixing with a residual or use of premixes utilizing a reduced rate of glyphosate (such as Extreme®) is not recommended. If the in-crop application is delayed and weeds are larger, apply a higher rate of Roundup WeatherMAX.
Roundup WeatherMAX	Apply a minimum of 22 oz/A of Roundup WeatherMAX** in-crop when weeds are 2" to 8" tall. Refer to the "Annual Weeds Rate Table" in the Roundup WeatherMAX label for rate recommendations for specific annual weeds. Choose the rate to control the most difficult-to-control weed in your field. A sequential application of this product may be required to control new flushes of weeds in the Roundup Ready soybean crop. If a sequential application is necessary, apply 16 to 22 oz/A of Roundup WeatherMAX** when weeds are 3" to 6" tall.	In-crop application of Roundup WeatherMAX provides control of labeled weeds. For best results, apply 3 to 4 weeks after planting or when weeds are less than 8" tall. If initial application is delayed and weeds are larger, apply a higher labeled rate of Roundup WeatherMAX.

*Follow all pesticide label requirements.

**If using another Roundup agricultural herbicide, you must refer to the label booklet or Genuity™ Roundup Ready 2 Yield® soybean or Roundup Ready soybean supplemental label for that brand to determine appropriate use rates. If using Roundup PowerMAX, application rates are the same as for Roundup WeatherMAX.

PROGRAM	INSTRUCTIONS AND USE RATES*	ADDITIONAL INFORMATION
Glyphosate-Tolerant Volunteer Corn	Tank-mix Roundup WeatherMAX® with 6 to 12 oz/A of Select Max™ and apply to 4" to 36" glyphosate-tolerant volunteer corn.	Choose your Roundup WeatherMAX rate based on the weed species and size listed in the "Annual Weeds Rate Table" of the Roundup WeatherMAX Label.
Maximum Use Rates for Roundup WeatherMAX	**In-Crop:** • 44 oz/A per single application • 44 oz/A during flowering • 64 oz/A emergence through flowering (R2 stage soybeans) **Preharvest:** • 22 oz/A application	**Total Season:** The combined total of preplant, in-crop and preharvest applications of Roundup WeatherMAX can not exceed 5.3 qt/A. The combined total of in-crop and preharvest applications can not exceed 64 oz/A.

*Follow all pesticide label requirements.

Herbicide products sold by Monsanto for use over the top of soybeans with Genuity™ Roundup Ready 2 Yield® Technology for the 2010 crop season are as follows:

- Roundup WeatherMAX
- Roundup PowerMAX

WEED CONTROL RECOMMENDATIONS

KEY WEEDS	INSTRUCTIONS AND USE RATES*	ADDITIONAL INFORMATION
Weeds that Tend to Have Multiple Emergence Events	Where dense stands of weed species such as common lambsquarters, tall and common waterhemp, *Palmer Amaranth*, redroot pigweed, common ragweed, and giant ragweed are expected, the following agronomic practices are recommended: • Start clean with tillage or burndown in no-till and reduced till systems. Include 2,4-D in the burndown. • Plant soybeans in narrow rows (<20"). • Use a pre-plant residual herbicide. • Use the right rate of Roundup WeatherMAX at the right time (proper weed size).	Weeds such as lambsquarters, waterhemp, pigweed, and giant ragweed tend to emerge throughout the season. Sequential Roundup WeatherMAX applications or the addition of a soil residual herbicide may be required for control of subsequent weed flushes.
Difficult-to-Control Weeds	Black nightshade, velvetleaf, waterhemp, morningglory, lambsquarters, Florida pusley, giant ragweed, Pennsylvania smartweed, groundcherry, hemp sesbania and spurred anoda are difficult-to-control weeds. Please refer to the Roundup agricultural herbicide label for specific rates and weed sizes for control of these weeds.	These weed species require special attention be paid to Roundup WeatherMAX rate and application timing (proper weed size) to obtain excellent weed control. A sequential application may be required if a new weed flush occurs, especially in soybeans planted in wide rows (>20").
Perennial Weeds	An in-crop application of 22 to 44 oz/A of Roundup WeatherMAX** will provide suppression and/or control of nutsedge and perennial weeds like Canada thistle, field bindweed, hemp dogbane, horsenettle, johnsongrass, milkweed, quackgrass, etc.	For additional information on perennial weeds, see the "Perennial Weeds Rate Table" in the label booklet for Roundup WeatherMAX. For best control, allow perennials to achieve at least 6" or more of growth before spraying.

*Follow all pesticide label requirements.

**If using another Roundup agricultural herbicide, you must refer to the label booklet or Roundup Ready Soybean or Genuity™ Roundup Ready 2 Yield® Soybean supplemental label for that brand to determine appropriate use rates. If using Roundup PowerMAX, application rates are the same as for Roundup WeatherMAX.

WEED RESISTANCE MANAGEMENT GUIDELINES

Follow all pesticide label requirements and the guidelines below to minimize the risk of developing glyphosate-resistant weed populations in a Roundup Ready Soybean System:

- Crop rotation is strongly encouraged.
- Scout fields before and after each burndown and in-crop application.

- Start clean with a burndown herbicide or tillage.
  - Tank-mix with 2,4-D to control glyphosate-resistant marestail or other tough-to-control broadleaf weeds.
- Use the recommended label rate of a soil-applied residual herbicide such as INTRRO®, Valor®, Valor XLT® or Gangster®.
- In-crop, apply Roundup WeatherMAX at a minimum of 22 oz/A before weeds exceed 8" in height.
- If an additional flush of weeds occurs, a sequential application of Roundup WeatherMAX at 22 oz/A may be needed before weeds exceed 6" in height.
- Refer to individual product labels for a list of recommended tank-mix partners.
- Clean equipment before moving from field to field to minimize the spread of weed seed.
- Report repeated non-performance to Monsanto or your local retailer.

RECOMMENDATIONS FOR MANAGING GLYPHOSATE-RESISTANT WEEDS

WEEDS	INSTRUCTIONS AND USE RATES*
Glyphosate-Resistant Marestail (Horseweed)	**Preplant:** Apply a tank-mixture of 22 oz/A Roundup WeatherMAX® with 1 pt/A 2,4-D before marestail exceeds 6" in height. See the 2,4-D product label for time intervals required between application and planting. **In-crop:** It is strongly encouraged that marestail should be controlled prior to planting using recommended preplant burndown treatments. In-crop, apply a tank-mixture of 22 oz/A Roundup WeatherMAX with 0.3 oz/A FirstRate®. This treatment should be used as a salvage treatment only for a marestail infestation that was not controlled preplant. Application should be made between full emergence of the first trifoliate leaf and 50% flowering stage of soybeans. At the time of treatment, marestail should not exceed 6" in height.
Glyphosate-Resistant *Amaranthus* Species **- *Palmer Amaranth*** **- Waterhemp**	**Preplant:** Apply a tank-mix of 22 oz/A Roundup WeatherMAX with a preemergence residual herbicide such as alachlor (INTRRO®), flumioxazin (Valor®) or another residual herbicide for preemergence control of *Amaranthus* species. 2,4-D may be added to the tank-mix to help control emerged *Amaranthus* species and other broadleaf weeds preplant only. Follow label instructions regarding application timing relative to soybean planting. **In-crop:** It is strongly encouraged that a preemergence residual product be used to control *Amaranthus* species prior to emergence. If there is emerged *Amaranthus* in-crop, apply a tank-mixture of 22 oz/A Roundup WeatherMAX with a postemergence product with activity on *Amaranthus* such as lactofen (Cobra®), fomesafen (Flexstar®) or cloransulam (FirstRate). Applications should be made on emerged *Amaranthus* that does not exceed 3" in height. Read and follow all product label instructions. It is likely that visual soybean injury will occur with these tank-mixtures.
Glyphosate-Resistant *Ambrosia* Species **- Giant Ragweed** **- Common Ragweed**	**Preplant:** Apply a tank-mix of 22 oz/A Roundup WeatherMAX with a preemergence residual herbicide such as cloransulam (FirstRate) or cloransulam + flumioxazin (Ganster®) or another residual herbicide for preemergence control of *Ambrosia* species. 2,4-D may be added to the tank-mix to help control emerged *Ambrosia* species and other broadleaf weeds preplant only. Follow label instructions regarding application timing relative to soybean planting. **In-crop:** It is strongly encouraged that a preemergence residual product be used to control *Ambrosia* species prior to emergence. If there is emerged *Ambrosia* in-crop, apply a tank-mixture of 22 oz/A Roundup WeatherMAX with a postemergence product with activity on *Ambrosia* such as lactofen (Cobra) or fomesafen (Flexstar). Applications should be made on emerged *Ambrosia* that does not exceed 3" in height. Read and follow all product label instructions. It is likely that visual soybean injury will occur with these tank-mixtures.
Glyphosate-Resistant Johnsongrass	Start clean with a burndown herbicide or tillage. Preplant incorporate a residual herbicide such as pendimethalin or trifluralin for control or suppression of seedling johnsongrass. Apply Roundup WeatherMAX in a tank-mix with herbicides such as SelectMAX®, Assure® II or Poast Plus for the control of emerged weeds including seedling and rhizome johnsongrass. Follow all label directions of tank-mix partners, especially those related to weed size.

In certain areas, Italian ryegrass is known to be resistant to glyphosate. For control recommendations, refer to **www.weedresistancemanagement.com** or call 1-800-768-6387. When approved, supplemental labeling for specific herbicide products can also be viewed on **www.cdms.net** or **www.greenbook.net.**

*Follow all pesticide label requirements.


CANOLA


ALFALFA


SUGARBEET

ATTENTION: Pursuant to a Court Order issued on May 3, 2007, Genuity™ Roundup Ready® alfalfa seed **CAN NOT be commercially sold or planted** until further administrative regulatory actions are completed. For more information, and the latest updates on Genuity™ Roundup Ready® alfalfa, go to www.roundupreadyalfalfa.com.

Genuity™ Roundup Ready® alfalfa varieties have in-plant tolerance to Roundup® agricultural herbicides, enabling farmers to apply labeled Roundup agricultural herbicides up to 5 days before cutting for unsurpassed weed control, excellent crop safety and preservation of forage quality potential.

Hay and Forage Management Practices

Genuity™ Roundup Ready® alfalfa must be managed for high quality hay/forage production, including timely cutting to promote high forage quality (i.e. before 10% bloom) and to prevent seed development. In geographies where conventional alfalfa seed production is intermingled with forage production and the agronomic conditions (climate and water/irrigation availability) are such that forage alfalfa is allowed to stand and flower late in the season, Genuity™ Roundup Ready® alfalfa must be harvested at or before 10% bloom to minimize potential pollen flow from hay to common or conventional alfalfa seed production. Farmers who are unwilling to or who can not make this commitment to stewardship should not continue to grow Genuity™ Roundup Ready® alfalfa.

Genuity™ Roundup Ready® alfalfa varieties have excellent tolerance to over-the-top applications of labeled Roundup agricultural herbicides. An in-crop weed control program using Roundup WeatherMAX® or Roundup PowerMAX® will provide excellent weed control in most situations. A residual herbicide labeled for use in alfalfa may also be applied postemergence in alfalfa. Contact a Monsanto Representative, local crop advisor or extension specialist to determine the best option for your situation.

Stand Takeout and Volunteer Management

Crop rotations can be divided into two main groups, alfalfa rotated to: 1) grass crops (e.g. corn and cereal crops); and 2) broadleaf crops. More herbicide alternatives exist for management of volunteer alfalfa in grass crops. The recommended steps for controlling volunteer Genuity™ Roundup Ready® alfalfa are:

- Diligent Stand Takeout
- Start Clean
- Plan for Success
- Timely Execution

DILIGENT STAND TAKEOUT

Use appropriate, commercially available herbicide treatments alone for reduced tillage systems or in combination with tillage to terminate the Genuity™ Roundup Ready® alfalfa stand. Refer to your regional technical bulletin for specific stand takeout recommendations. **NOTE:** Roundup® agricultural herbicides are **not** effective for terminating Genuity™ Roundup Ready® alfalfa stands.

START CLEAN

If necessary, utilize tillage and/or additional herbicide application(s) after stand takeout, and before planting of the subsequent rotational crop to manage any newly emerged or surviving alfalfa.

PLAN FOR SUCCESS

Rotate the crops with known and available mechanical or herbicidal methods for managing volunteer alfalfa, keeping in mind that Roundup agricultural herbicides will not terminate Genuity™ Roundup Ready® alfalfa stands.

- Rotations to certain broadleaf crops are not advisable if the farmer is not willing to implement recommended stand termination practices.
- In the event that no known mechanical or herbicidal methods are available to manage volunteer alfalfa in the desired rotational crop, it is suggested that a crop with established volunteer alfalfa management practices be introduced into the rotation.

TIMELY EXECUTION

Implement in-crop mechanical or herbicide treatments for managing alfalfa volunteers in a timely manner; that is, before the volunteers become too large to control or begin to compete with the rotational crop.

Planting Requirements

Genuity™ Roundup Ready® alfalfa is not permitted to be planted in any wildlife feed plots.

Stewardship

All Genuity™ Roundup Ready® alfalfa farmers shall sign the Monsanto Technology/Stewardship Agreement (MTSA) limited-use license application which provides the terms and conditions for the authorized use of the product. Due to special circumstances, alfalfa farmers in the Imperial Valley of California will also sign an Imperial Valley Use Agreement (IVUA) with specific stewardship commitments. The MTSA or IVUA must be completed before purchase or use of seed.

Both the MTSA or IVUA explicitly prohibit all forms of commercial seed harvest on the stand. Every alfalfa farmer producing seed of Genuity™ Roundup Ready® alfalfa must possess an additional, separate and distinct seed farmer contract to produce Genuity™ Roundup Ready® alfalfa seed. Genuity™ Roundup Ready® alfalfa seed may not be planted outside of the United States, or for the production of seed or sprouts.

Any product produced from a Genuity™ Roundup Ready® alfalfa crop or seed, including hay and hay products, must be labeled and may only be used, exported to, processed or sold in countries where regulatory approvals have been granted. It is a violation of national and international laws to move material containing biotech traits across boundaries into nations where import is not permitted.

Pursuant to a Court Order issued on May 3, 2007, Genuity™ Roundup Ready® alfalfa farmers must adhere to the requirements set out in the December 18, 2007 USDA Administrative Order **(http://www.aphis.usda.gov/brs/pdf/RRA_A8_final.pdf)** until the USDA completes its regulatory process.

These requirements include, but are not limited to:

- Pollinators shall not be added to Genuity™ Roundup Ready® alfalfa fields grown only for hay production.
- Farm equipment used in Genuity™ Roundup Ready® alfalfa production shall be properly cleaned after use.
- Genuity™ Roundup Ready® alfalfa shall be handled and clearly identified to minimize commingling after harvest.

For additional information visit the USDA website: **http://www.aphis.usda.gov/biotechnology/alfalfa_history.shtml**

For more information and the latest updates on Genuity™ Roundup Ready® alfalfa, go to **http://www.roundupreadyalfalfa.com**

To meet sales reporting requirements, the seed supplier is required to identify and list all Genuity™ Roundup Ready® alfalfa field locations. Therefore, all farmers MUST PROVIDE their seed supplier with the GPS coordinates of all their Genuity™ Roundup Ready® alfalfa fields.

WEED RESISTANCE MANAGEMENT GUIDELINES

Follow all pesticide label requirements and the guidelines below to minimize the risk of developing glyphosate-resistant weed populations in a Genuity™ Roundup Ready® alfalfa system:

- Scout fields before and after each herbicide application.
- Use the right herbicide product at the right rate and at the right time.
- To control flushes of weeds in established alfalfa, make applications of Roundup WeatherMAX® or Roundup PowerMAX® herbicide at 22 to 44 oz/A before weeds exceed 6" in height, up to 5 days before cutting.
- Use other approved herbicide products tank-mixed or in sequence with Roundup agricultural herbicide if appropriate for the weed spectrum present as part of a Genuity™ Roundup Ready® alfalfa weed control program.
- Report repeated non-performance to Monsanto or your local retailer.

WEED CONTROL RECOMMENDATIONS

In established stands, to preserve the quality potential of forage and hay, applications should be made after weeds have emerged but before alfalfa re-growth interferes with application spray coverage of the target weeds.

PROGRAM	INSTRUCTIONS AND USE RATES*	ADDITIONAL INFORMATION
Established Stands	After the first harvest of a newly established stand, up to 44 oz/A of Roundup WeatherMAX®** herbicide per cutting may be applied up to 5 days before each subsequent cutting. The combined total per year for all in-crop applications in established stands must not exceed 132 oz/A (4.1 qt/A) of Roundup WeatherMAX.	Applications between cuttings may be applied as a single application or in multiple applications (e.g. 2 applications of 22 oz/A). Sequential applications should be at least 7 days apart.
Weeds Controlled	For specific application rates and instructions for control of various annual and perennial weeds, refer to the Roundup WeatherMAX** herbicide label booklet. Some weeds with multiple germination times or suppressed (stunted) weeds may require a second application of Roundup WeatherMAX** herbicide for complete control. For some perennial weeds, repeated applications may be required to eliminate crop competition throughout the growing season.	In addition to those weeds listed in the Roundup WeatherMAX* label booklets, this product will suppress or control the parasitic weed, dodder (*Cuscuta spp.*) in Genuity™ Roundup Ready® alfalfa. Repeat applications may be necessary for complete control. For tough-to-control weeds or weeds not controlled by Roundup® agricultural herbicides use labeled rates of other approved herbicides, alone or in tank-mixtures, with Roundup agricultural herbicides.
Maximum Use Rates	**In-Crop:** • 44 oz/A per single application. • Established Stand Total: 44 oz/A per cutting up to 5 days before harvest.	**Total Per Year:** The combined total per year for all in-crop applications in established stands must not exceed 132 oz/A (4.1 qt/A) of Roundup WeatherMAX.

*Follow all pesticide label requirements.

**If using another Roundup agricultural herbicide, you must refer to the label booklet or separately published Genuity™ Roundup Ready® alfalfa supplemental label for that brand to determine appropriate use rates. If using Roundup PowerMAX, application rates are the same as for Roundup WeatherMAX.

Genuity™ Roundup Ready® spring canola hybrids contain in-plant tolerance to Roundup agricultural herbicides, enabling farmers to apply Roundup® agricultural herbicides over the top of Genuity™ Roundup Ready® spring canola anytime from emergence through the 6-leaf stage of development.

The introduction of the Roundup Ready® trait into leading spring canola hybrids and varieties gives farmers the opportunity for unsurpassed weed control, proven crop safety and maximum profit potential. With Genuity™ Roundup Ready® spring canola, farmers have the weed management tool necessary to improve spring canola profitability, while providing a viable rotational crop to help break pest and disease cycles in cereal-growing areas.

WEED RESISTANCE MANAGEMENT GUIDELINES

Follow all pesticide label requirements and the guidelines below to minimize the risk of developing glyphosate-resistant weed populations in a Genuity™ Roundup Ready® spring canola system:

- Scout fields before and after each burndown and in-crop application.
- Start clean with a burndown herbicide or tillage.
- In-crop, apply Roundup WeatherMAX® herbicide before weeds exceed 3" in height.
- A sequential application of Roundup WeatherMAX herbicide may be needed.
- Clean equipment before moving from field to field to minimize the spread of weed seed.
- Report repeated non-performance to Monsanto or your local retailer.

WEED CONTROL RECOMMENDATIONS (SPRING-SEEDED)

PROGRAM	INSTRUCTIONS AND USE RATES*	ADDITIONAL INFORMATION
Two-Pass Program– For Annual and Perennial Weed Control	For broad-spectrum control of annual and perennial weeds, use an initial application of 11 oz/A of Roundup WeatherMAX**, in 5 to 10 gal/A water volume. No surfactant is required. Make a second application of 11 oz/A of Roundup WeatherMAX** no less than 10 days after initial application up to the 6-leaf stage (prebolting). Do not exceed 11 oz/A per application.	Spray when canola is at the 0- to 6-leaf stage of growth. To maximize yield potential, spray Genuity™ Roundup Ready® spring canola at the 1- to 3-leaf stage to eliminate competing weeds. Short-term yellowing may occur with later applications, with little effect on crop growth, maturity, or yield. Wait a minimum of 10 days between applications. Two applications of Roundup WeatherMAX will: • Control late flushes of annual weeds such as foxtail, pigweed, and wild mustard. • Provide season-long suppression of Canada thistle, quackgrass, and perennial sow thistle. • Provide better yields by eliminating competition from both annuals and hard-to-control perennials.
Single Application– For Annual Weed Control	For broad-spectrum control of annual and easy-to-control perennial weeds, make a single application of 16 oz/A of Roundup WeatherMAX.**	For best results, spray Genuity™ Roundup Ready® spring canola at the 2- to 3-leaf stage. Can be applied up to 6-leaf stage; yellowing may occur with later application with little effect on crop growth, maturity, or yield. No additional over-the-top applications can be made.
Maximum Use Rate For Roundup WeatherMAX	Two over-the-top applications: Do not exceed 11 oz/A per application. Single over-the-top applications: Do not exceed 16 oz/A. No additional application can be made.	

*Follow all pesticide label requirements.

**If using another Roundup agricultural herbicide, you must refer to the label booklet or separately published Genuity™ Roundup Ready® canola supplemental label for that brand to determine appropriate use rates. If using Roundup PowerMAX, application rates are the same as for Roundup WeatherMAX.

Genuity™ Roundup Ready® winter canola varieties have been developed for seeding in the fall and harvesting the following spring/summer.

Genuity™ Roundup Ready® winter canola varieties contain in-plant tolerance to Roundup® agricultural herbicides, enabling farmers to apply Roundup agricultural herbicides over the top of Genuity™ Roundup Ready® winter canola from crop emergence to the pre-bolting stage. The introduction of the Roundup Ready trait into winter canola varieties gives farmers the opportunity of unsurpassed weed control, crop safety and maximum yield potential. Genuity™ Roundup Ready® winter canola offers farmers an important option as a rotational crop in traditional monoculture winter wheat production areas. Introducing crop rotation is an important factor in reducing pest cycles, including weed and disease problems.

WEED RESISTANCE MANAGEMENT GUIDELINES

Follow the same guidelines as stated for spring canola.

WEED CONTROL RECOMMENDATIONS (WINTER-SEEDED)

PROGRAM	INSTRUCTIONS AND USE RATES*	ADDITIONAL INFORMATION
Sequential Applications	The two-pass program gives the greatest flexibility in controlling late emerging weeds. For broad-spectrum weed control, apply 11 to 22 oz/A of Roundup WeatherMAX** herbicide to 2-leaf or larger Genuity™ Roundup Ready® winter canola in the fall. Use 5 to 10 gallons/A water volume. Do not add surfactants. Apply a second application of Roundup WeatherMAX** at 11 to 22 oz/A at a minimum interval of 60 days after the first application and before bolting in the spring. Do not exceed 22 oz/A per application.	Spray when Genuity™ Roundup Ready® winter canola is at the 2-3 leaf stage of growth. Early applications can eliminate competing weeds and improve yield potential. Two applications of Roundup WeatherMAX will provide control of early emerging annual weeds and winter emerging weeds such as downy brome, cheat and jointed goatgrass.
Single Application	For broad-spectrum control of annual and easy-to-control perennial weeds, make a single application of 16 to 22 oz/A of Roundup WeatherMAX**, preferably in the fall.	For best results, spray Genuity™ Roundup Ready® winter canola at the 2-3 leaf stage and when weeds are small and actively growing. Applications must be made prior to bolting. Use the higher rate in the range when weed densities are high, when weeds have over wintered or when weeds become large and well established.
Maximum Use Rate for Roundup WeatherMAX	Any single over-the-top application of Roundup WeatherMAX** should not exceed 22 oz/A. No more than two over-the-top applications may be made from crop emergence to canopy closure prior to bolting in the spring.	Applications of greater than 16 fluid ounces/A prior to the 6-leaf stage may result in temporary yellowing and/or growth reduction.

*Follow all pesticide label requirements.

**If using another Roundup brand herbicide, you must refer to the label booklet or Genuity™ Roundup Ready® winter canola supplemental label for that brand to determine appropriate use rates. If using Roundup PowerMAX, application rates are the same as for Roundup WeatherMAX.

GRAZING

It is recommended that Genuity™ Roundup Ready® winter canola not be grazed. While Genuity™ Roundup Ready® winter canola may provide farmers additional opportunity as a forage for grazing livestock, at the present time insufficient information exists to allow safe and proper grazing recommendations. Preliminary data suggest that excessive grazing can significantly reduce yield, and that careful nitrate management is critical in managing Genuity™ Roundup Ready® winter canola as a forage to limit the risk of livestock nitrate poisoning. State universities are assessing the potential and the instructions for grazing Genuity™ Roundup Ready® winter canola and they will provide grazing management guidelines when their research is completed.

Genuity™ Roundup Ready® sugarbeet varieties have in-plant tolerance to Roundup® agricultural herbicides, enabling farmers to apply labeled Roundup agricultural herbicides from planting through 30 days prior to harvest for unsurpassed weed control, excellent crop safety and preservation of yield potential.

MANAGEMENT PRACTICES

Sugarbeets are extremely sensitive to weed competition for light, nutrients and soil moisture. Research on sugarbeet weed control suggests that sugarbeets need to be kept weed-free for the first eight weeks of growth to protect yield potential. Therefore, weeds must be controlled when they are small and before they compete with Genuity™ Roundup Ready® sugarbeets (exceed crop height), that is from less than 2" up to 4" in height, to preserve sugarbeet yield potential. *More than one in-crop herbicide application will be required* to control weed infestations to protect yield potential as Roundup agricultural herbicides have no soil residual activity. Bolting sugarbeets must be rogued or topped in Genuity™ Roundup Ready® sugarbeet fields.

Genuity™ Roundup Ready® sugarbeet varieties have excellent tolerance to over-the-top applications of labeled Roundup agricultural herbicides. A postemergence weed control program using Roundup WeatherMAX® or Roundup PowerMAX® will provide excellent weed control in most situations. A residual herbicide labeled for use in sugarbeets may also be applied preemergence, preplant or postemergence in Genuity™ Roundup Ready® sugarbeets. Contact a Monsanto Representative, local crop advisor or extension specialist to determine the best option for your situation.

WEED RESISTANCE MANAGEMENT FOR GENUITY™ ROUNDUP READY® SUGARBEETS

Follow all pesticide label requirements and the guidelines below to minimize the risk of developing glyphosate-resistant weed populations in a Genuity™ Roundup Ready® sugarbeet system:

- Start clean with tillage and follow-up with a burndown herbicide, such as Roundup WeatherMAX, if needed prior to planting.
- Early-season weed control is critical to protect sugarbeet yield potential. Apply the first in-crop application of Roundup WeatherMAX at a minimum of 22 oz/A while weeds are less than 2" in height.
- Follow with additional postemergence in-crop application of Roundup WeatherMAX at a minimum of 22 oz/A for additional weed flushes before weeds exceed 4" in height.
- Add spray grade ammonium sulfate at a rate of 17 lbs/100 gallons of spray solution with Roundup® agricultural herbicides to maximize product performance.
- Use mechanical weed control/cultivation and/or residual herbicides where appropriate in your Genuity™ Roundup Ready® sugarbeets.
- Use additional herbicide modes of action/residual herbicides and/or mechanical weed control in other Roundup Ready crops you rotate with Genuity™ Roundup Ready® sugarbeets.
- Report repeated non-performance of Roundup agricultural herbicides to Monsanto or your local retailer.

AGRONOMIC PRINCIPLES IN SUGARBEETS

Sugarbeets are very sensitive to early-season weed competition. It is important to select the appropriate herbicide product, application rate and timing to minimize weed competition to protect yields. The Genuity™ Roundup Ready® sugarbeet system provides a mechanism to control weeds at planting and once Genuity™ Roundup Ready® sugarbeets emerge. Failure to control weeds with the right rate, at the right time and with the right product, can lead to increased weed competition, weed escapes and the potential for decreased yields. Tank-mixtures of Roundup agricultural herbicides with fungicides, insecticides, micronutrients or foliar fertilizers are not recommended as they may result in crop injury and reduced pest control or antagonism.

PLANTING REQUIREMENTS

Genuity™ Roundup Ready® sugarbeets are not permitted to be planted in any wildlife feed plots.

STEWARDSHIP

All Genuity™ Roundup Ready® sugarbeet farmers shall sign the Monsanto Technology/Stewardship Agreement (MTSA) limited-use license application which provides the terms and conditions for the authorized use of the product. The MTSA must be signed and approved prior to purchase or use of seed.

WEED CONTROL RECOMMENDATIONS

PROGRAM	INSTRUCTIONS AND USE RATES*	ADDITIONAL INFORMATION
Preplant Burndown	After preplant tillage or bedding operations have been completed, a preplant burndown application of Roundup WeatherMAX®** at 22 to 44 oz/A may be applied to control weeds that have germinated after tillage and prior to planting. See the label for appropriate rates by weed species and weed size.	Always utilize tillage to start with a weed-free field.
Over-The-Top Applications up to eight-leaf Genuity™ Roundup Ready® Sugarbeets	Up to two applications of Roundup agricultural herbicides may be made prior to the 8-leaf stage of Genuity™ Roundup Ready® sugarbeets. The first application of 22 to 32 oz/A of Roundup WeatherMAX** should be made when weeds are less than 2" in height to protect yield potential. Make an additional application of 22 to 32 oz/A of Roundup WeatherMAX before weeds exceed 4" in height. Maximum in-crop Roundup WeatherMAX prior to 8-leaf stage must not exceed 56 oz/A.	Sugarbeets are sensitive to weed competition and can lose yield rapidly if weeds are not controlled early. More than one in-crop Roundup WeatherMAX application will be required to control weed infestations to protect yield potential as Roundup agricultural herbicides have no soil residual activity. Add ammonium sulfate at a rate of 17 lbs/100 gallons of spray solution with Roundup agricultural herbicides to maximize product performance. Tank-mixtures of Roundup agricultural herbicides with fungicides, insecticides, micronutrients or foliar fertilizers are not recommended. Sequential applications should be at least 10 days apart.
Over-The-Top Applications to greater than eight-leaf Genuity™ Roundup Ready® Sugarbeets	Up to two additional applications of 22 oz/A of Roundup WeatherMAX can be made after the eight-leaf stage up to 30 days prior to harvest. Maximum in-crop Roundup WeatherMAX from 8-leaf stage up until 30 days prior to harvest must not exceed 44 oz/A.	Add ammonium sulfate at a rate of 17 lbs/100 gallons of spray solution with Roundup agricultural herbicides to maximize product performance. Tank-mixtures of Roundup agricultural herbicides with fungicides, insecticides, micronutrients or foliar fertilizers are not recommended. Sequential applications should be at least 10 days apart.
Maximum Use Rates	**In-Crop:** • Two applications of Roundup WeatherMAX prior to the 8-leaf stage of Genuity™ Roundup Ready® sugarbeets - 32 oz/A per single application up to the 8-leaf stage. - Combined maximum of 56 oz/A in-crop prior to the 8-leaf stage • Two applications of Roundup WeatherMAX after the 8-leaf stage up to 30 days prior to harvest - 22 oz/A per single application after the 8-leaf stage. - Combined maximum of 44 oz/A in-crop after the 8-leaf stage until 30 days prior to harvest	**Total Per Year:** The combined total per year for all Roundup WeatherMAX applications including pre-plant must not exceed 5.3 qt/A. Total in-crop application must not exceed 3 qt/A. Add ammonium sulfate at a rate of 17 lbs/100 gallons of spray solution with Roundup agricultural herbicides to maximize product performance. Tank-mixtures of Roundup agricultural herbicides with fungicides, insecticides, micronutrients or foliar fertilizers are not recommended.

*Follow all pesticide label requirements.

**If using another Roundup agricultural herbicide, you must refer to the label booklet or separately published Genuity™ Roundup Ready® sugarbeets supplemental label for that brand to determine appropriate use rates. If using Roundup PowerMAX, application rates are the same as for Roundup WeatherMAX.

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- Saves the equivalent of 585 mature trees
- Reduces solid waste by 35,308 pounds
- Reduces waste water by 213,390 gallons
- Reduces greenhouse gas emissions by 199,989.75 pounds

Insect Resistance Management
Planting Refuges, Preserving Technology

Before opening a bag of seed, be sure to read, understand and accept the stewardship requirements, **including applicable refuge requirements for insect resistance management,** for the biotechnology traits expressed in the seed as set forth in the Monsanto Technology Agreement that you sign. By opening and using a bag of seed, you are reaffirming your obligation to comply with the most recent stewardship requirements.

Roundup Ready® Alfalfa seed is currently not for sale or distribution. The movement and use of Roundup Ready® Alfalfa forage is subject to a USDA administrative Order available at http://www.aphis.usda.gov/brs/pdf/RRA_A8_final.pdf.

This stewardship statement applies to all products listed herein except Genuity™ VT Double PRO™, Genuity™ VT Triple PRO™ and Genuity™ SmartStax™. See restrictions related to Genuity™ Double PRO™, Genuity™ VT Triple PRO™ and Genuity™ SmartStax™ below:

Monsanto Company is a member of Excellence Through Stewardship® (ETS). Monsanto products are commercialized in accordance with ETS Product Launch Stewardship Guidance, and in compliance with Monsanto's Policy for Commercialization of Biotechnology-Derived Plant Products in Commodity Crops. This product has been approved for import into key export markets with functioning regulatory systems. Any crop or material produced from this product can only be exported to, or used, processed or sold in countries where all necessary regulatory approvals have been granted. It is a violation of national and international law to move material containing biotech traits across boundaries into nations where import is not permitted. Growers should talk to their grain handler or product purchaser to confirm their buying position for this product. Excellence Through Stewardship® is a registered trademark of Biotechnology Industry Organization.

IMPORTANT: Grain Marketing and Seed Availability: Genuity™ VT Double PRO™ has received the necessary approvals in the United States, however, as of October 22, 2009, approvals have not been received in certain major corn export markets. **Genuity™ VT Double PRO™** will not be launched and seed will not be available until after import approvals are received in appropriate major corn export markets. ***B.t.* products, including Genuity™ VT Double PRO™** may not yet be registered in all states. Check with your Monsanto representative for the registration status in your state.

IMPORTANT: Grain Marketing and Seed Availability: Genuity™ VT Triple PRO™ has received the necessary approvals in the United States however, as of October 22, 2009, approval has not been received in all major corn export markets. Monsanto anticipates that all such approvals will be in place for the 2010 growing season. If all approvals are not in place, **Genuity™ VT Triple PRO™** seed will only be available as part of a commercial demonstration program that includes grain marketing stewardship requirements. It is a violation of national and international law to move material containing biotech traits across boundaries into nations where import is not permitted. Consult with your seed representative for current regulatory and stewardship information status.

IMPORTANT: Grain Marketing and Seed Availability: Genuity™ SmartStax™ has received the necessary approvals in the United States, however, as of October 22, 2009, approvals have not been received in certain major corn export markets. **Genuity™ SmartStax™** will not be launched and seed will not be available until after import approvals are received in appropriate major corn export markets. ***B.t.* products, including Genuity™ SmartStax™** may not yet be registered in all states. Check with your Monsanto representative for the registration status in your state.

Cottonseed containing Monsanto traits may not be exported for the purpose of planting without a license from Monsanto.

Individual results may vary, and performance may vary from location to location and from year to year. This result may not be an indicator of results you may obtain as local growing, soil and weather conditions may vary. Growers should evaluate data from multiple locations and years whenever possible.

Growers may utilize the natural refuge option for varieties containing the Bollgard II® trait in the following states: AL, AR, FL, GA, KS, KY, LA, MD, MS, MO, NC, OK, SC, TN, VA, and most of Texas (excluding the Texas counties of Brewster, Crane, Crockett, Culberson, El Paso, Hudspeth, Jeff Davis, Loving, Pecos, Presidio, Reeves, Terrell, Val Verde, Ward and Winkler). The natural refuge option does not apply to **Bollgard II** cotton grown in areas where pink bollworm is a pest, including CA, AZ, NM, and the above listed Texas counties. It also remains the case that **Bollgard®** and **Bollgard II** cotton cannot be planted south of Highway 60 in Florida, and that **Bollgard** cotton cannot be planted in certain other counties in the Texas panhandle. Refer to the Technology Use Guide and IRM/Grower Guide for additional information regarding Bollgard II, Bollgard, natural refuge and EPA-mandated geographical restrictions on the planting of *B.t.* cotton.

ALWAYS READ AND FOLLOW PESTICIDE LABEL DIRECTIONS. Roundup Ready® crops contain genes that confer tolerance to glyphosate, the active ingredient in Roundup® brand agricultural herbicides. Roundup® brand agricultural herbicides will kill crops that are not tolerant to glyphosate. Degree® and Harness® are not registered in all states. Degree® and Harness® may be subject to use restrictions in some states. Bullet®, Degree Xtra®, Harness®, INTRRO®, Lariat®, and Micro-Tech™ are restricted use pesticides and are not registered in all states. The distribution, sale, or use of an unregistered pesticide is a violation of federal and/or state law and is strictly prohibited. Check with your local Monsanto dealer or representative for the product registration status in your state.

Tank mixtures: The applicable labeling for each product must be in the possession of the user at the time of application. Follow applicable use instructions, including application rates, precautions and restrictions of each product used in the tank mixture. Monsanto has not tested all tank mix product formulations for compatibility or performance other than specifically listed by brand name. Always predetermine the compatibility of tank mixtures by mixing small proportional quantities in advance.

Appendix

B

National and Tier III Production Data and State Maps with County-Level Detail for the Eleven Tier III States with Seed Production Greater Than 100,000 lbs

Counties Within Eleven States with Seed Production greater than 100,000 lbs in 2007 (County List)

State	County	Seed Production Reported, 2007	Alfalfa For Forage Production	Seed - Acres Hvstd.	Seed - Operations	Seed - In Pounds		Alf. Hay - Acres	Alf. Hay - Operations	Alf. Hay - Tons	Hay % Operations Excluded	Hay % Operations Included
ARIZONA	COCONINO	No	Yes, With Limits and GPS Reporting					0	4	141		
ARIZONA	GILA							0	1	0		
ARIZONA	GREENLEE			0	0	0		1,126	19	6,767		
ARIZONA	LAPAZ							60,290	52	451,583		
ARIZONA	MOHAVE							10,374	15	58,068		
ARIZONA	PIMA							1,888	23	19,303		
ARIZONA	SANTA CRUZ							0	2	0		
			Subtotals	0	0	0	0	73,678	116	535,862	12%	
ARIZONA	APACHE	Yes	No new RRA forage production	0	2	0		0	146	4,372		
ARIZONA	COCHISE			0	1	0		19,621	65	142,696		
ARIZONA	GRAHAM			304	6	112,960		1,973	61	0		
ARIZONA	MARICOPA			776	17	182,099		75,394	175	612,404		
ARIZONA	NAVAJO			0	2	0		2,694	48	7,561		
ARIZONA	PINAL			0	6	859,873		54,495	175	420,575		
ARIZONA	YAVAPAI			0	3	30,000		0	28	2,981		
ARIZONA	YUMA			1,723	16	708,212		25,789	129	228,082		
Subtotal			Subtotals	2,803	53	1,893,144	0	179,966	827	1,418,671		88%
			State Total	2,803	53	1,893,144	0	253,644	943	1,954,533		
CALIFORNIA	ALAMEDA	No	Yes, With Limits and GPS Reporting					0	4	2,770		
CALIFORNIA	ALPINE							0	1	0		
CALIFORNIA	AMADOR							1,613	4	9,692		
CALIFORNIA	BUTTE			0	0	0		1,349	20	7,782		
CALIFORNIA	CALAVERAS							0	1	0		
CALIFORNIA	COLUSA							14,900	49	104,403		
CALIFORNIA	CONTRA COSTA							3,696	15	22,423		
CALIFORNIA	GLENN							13,851	109	90,271		
CALIFORNIA	INYO							3,273	12	16,177		
CALIFORNIA	LAKE							58	8	347		
CALIFORNIA	LOS ANGELES			0	0	0		7,693	30	59,240		
CALIFORNIA	MARIN							0	0	0		
CALIFORNIA	MARIPOSA							0	0	0		

Counties Within Eleven States with Seed Production greater than 100,000 lbs in 2007 (County List)

State	County	Seed Production Reported, 2007	Alfalfa For Forage Production	Seed - Acres Hvstd.	Seed - Operations	Seed - In Pounds		Alf. Hay - Acres	Alf. Hay - Operations	Alf. Hay - Tons	Hay % Operations Excluded	Hay % Operations Included
CALIFORNIA	MENDOCINO							1,218	7	5,325		
CALIFORNIA	MERCED			0	0	0		82,731	304	622,298		
CALIFORNIA	MONO							7,525	17	40,666		
CALIFORNIA	MONTEREY							428	12	2,633		
CALIFORNIA	NAPA							125	6	436		
CALIFORNIA	NEVADA							0	3	0		
CALIFORNIA	ORANGE							0	1	0		
CALIFORNIA	PLACER							170	4	0		
CALIFORNIA	PLUMAS							5,118	10	16,888		
CALIFORNIA	SAN BENITO							489	4	3,161		
CALIFORNIA	SAN BERNARDINO			0	0	0		9,345	43	66,349		
CALIFORNIA	SAN DIEGO							183	10	660		
CALIFORNIA	SAN JOAQUIN			0	0	0		56,969	225	394,624		
CALIFORNIA	SAN LUIS OBISPO							0	20	25,519		
CALIFORNIA	SAN MATEO							0	1	0		
CALIFORNIA	SANTA BARBARA							841	21	6,123		
CALIFORNIA	SANTA CLARA							1,213	8	7,268		
CALIFORNIA	SHASTA							4,894	54	21,418		
CALIFORNIA	SIERRA							1,064	11	3,594		
CALIFORNIA	SISKIYOU			0	0	0		59,216	194	267,718		
CALIFORNIA	SOLANO							28,129	69	197,659		
CALIFORNIA	SONOMA			0	0	0		925	11	4,119		
CALIFORNIA	STANISLAUS			0	0	0		28,836	259	220,581		
CALIFORNIA	SUTTER			0	0	0		6,388	39	40,765		
CALIFORNIA	TEHAMA							5,289	44	31,465		
CALIFORNIA	TRINITY							0	6	0		
CALIFORNIA	TULARE			0	0	0		76,413	306	624,055		
CALIFORNIA	TUOLUMNE							0	0	0		
CALIFORNIA	VENTURA							1,001	7	6,682		
CALIFORNIA	YUBA							850	9	4,267		
			Subtotals	0	0	0	0	425,793	1,958	2,927,378	55%	
CALIFORNIA	FRESNO	Yes	No new RRA forage production	3,287	20	2,603,178		69,290	250	528,024		

Counties Within Eleven States with Seed Production greater than 100,000 lbs in 2007 (County List)

State	County	Seed Production Reported, 2007	Alfalfa For Forage Production	Seed - Acres Hvstd.	Seed - Operations	Seed - In Pounds		Alf. Hay - Acres	Alf. Hay - Operations	Alf. Hay - Tons	Hay % Operations Excluded	Hay % Operations Included
CALIFORNIA	HUMBOLDT			0	1	0		997	16	4,487		
CALIFORNIA	IMPERIAL			25,848	64	11,411,921		127,406	199	976,999		
CALIFORNIA	KERN			367	7	253,000		85,756	274	704,029		
CALIFORNIA	KINGS			5,779	5	4,295,319		63,840	243	485,411		
CALIFORNIA	LASSEN			377	4	190,000		19,752	119	85,017		
CALIFORNIA	MADERA			0	2	0		29,759	78	220,963		
CALIFORNIA	MODOC			65	5	41,000		45,890	159	217,036		
CALIFORNIA	RIVERSIDE			0	1	0		47,418	104	422,220		
CALIFORNIA	SACRAMENTO			0	2	0		9,960	65	75,678		
CALIFORNIA	YOLO			0	3	86,240		57,001	122	405,914		
			Subtotals	35,723	114	18,880,658	0	557,069	1,629	4,125,778		45%
			State Total	35,723	114	18,880,658	0	982,862	3,587	7,053,156		
IDAHO	ADAMS	No	Yes, With Limits and GPS Reporting					6,953	84	11,390		
IDAHO	BANNOCK							20,926	258	55,839		
IDAHO	BEAR LAKE							22,934	219	42,805		
IDAHO	BENEWAH							1,093	16	1,938		
IDAHO	BINGHAM			0	0	0		56,101	477	267,008		
IDAHO	BLAINE							22,083	101	78,802		
IDAHO	BOISE							1,471	25	0		
IDAHO	BONNER							4,298	90	7,340		
IDAHO	BONNEVILLE							41,382	348	160,554		
IDAHO	BOUNDARY			0	0	0		9,988	134	25,562		
IDAHO	BUTTE							31,843	110	123,505		
IDAHO	CAMAS							44,382	52	44,559		
IDAHO	CARIBOU							21,060	131	54,535		
IDAHO	CLARK							0	22	0		
IDAHO	CLEARWATER							1,544	16	2,634		
IDAHO	CUSTER							23,590	126	66,103		
IDAHO	FREMONT							17,469	184	55,889		
IDAHO	IDAHO							14,264	183	23,380		
IDAHO	JEFFERSON			0	0	0		80,999	432	389,645		

Counties Within Eleven States with Seed Production greater than 100,000 lbs in 2007 (County List)

State	County	Seed Production Reported, 2007	Alfalfa For Forage Production	Seed - Acres Hvstd.	Seed - Operations	Seed - In Pounds		Alf. Hay - Acres	Alf. Hay - Operations	Alf. Hay - Tons	Hay % Operations Excluded	Hay % Operations Included
IDAHO	KOOTENAI							5,362	100	11,974		
IDAHO	LATAH							4,156	90	8,391		
IDAHO	LEMHI							21,478	116	52,354		
IDAHO	LEWIS							4,469	57	9,744		
IDAHO	LINCOLN							23,248	145	104,300		
IDAHO	MADISON							15,114	183	58,374		
IDAHO	NEZ PERCE							0	91	10,414		
IDAHO	POWER							9,961	89	32,946		
IDAHO	SHOSHONE							0	3	0		
IDAHO	TETON							12,617	110	24,422		
IDAHO	VALLEY							1,304	22	3,585		
			Subtotals	0	0	0	0	520,089	4,014	1,727,992	46%	
IDAHO	ADA	Yes	No new RRA forage production	0	8	609,015		20,972	461	88,529		
IDAHO	CANYON			7,018	31	5,940,842		40,654	867	230,714		
IDAHO	CASSIA			0	1	0		53,422	267	284,796		
IDAHO	ELMORE			0	1	0		38,569	162	167,200		
IDAHO	FRANKLIN			0	2	0		33,233	320	110,584		
IDAHO	GEM			233	7	129,588		10,747	241	43,580		
IDAHO	GOODING			0	1	0		33,174	289	169,518		
IDAHO	JEROME			707	5	577,532		42,265	286	233,523		
IDAHO	MINIDOKA			0	1	0		29,381	269	168,412		
IDAHO	ONEIDA			0	6	430,150		28,802	178	97,341		
IDAHO	OWYHEE			1,179	11	877,054		48,409	307	281,034		
IDAHO	PAYETTE			496	9	267,467		15,850	290	75,673		
IDAHO	TWIN FALLS			258	5	151,500		68,924	596	395,914		
IDAHO	WASHINGTON			130	4	68,418		29,866	270	87,337		
			Subtotals	10,021	92	9,051,566	0	494,268	4,803	2,434,155		54%
			State Total	10,021	92	9,051,566		1,014,357	8,817	4,162,147		
MONTANA	CASCADE	No	Yes, With Limits and GPS Reporting					65,292	401	116,943		
MONTANA	DANIELS							19,602	95	26,311		
MONTANA	DEER LODGE							4,150	21	13,459		

Counties Within Eleven States with Seed Production greater than 100,000 lbs in 2007 (County List)

State	County	Seed Production Reported, 2007	Alfalfa For Forage Production	Seed - Acres Hvstd.	Seed - Operations	Seed - In Pounds		Alf. Hay - Acres	Alf. Hay - Operations	Alf. Hay - Tons	Hay % Operations Excluded	Hay % Operations Included
MONTANA	FERGUS							158,137	520	264,997		
MONTANA	GARFIELD			0	0	0		30,927	121	35,604		
MONTANA	GLACIER							28,397	151	45,795		
MONTANA	GOLDEN VALLEY							21,207	64	31,268		
MONTANA	GRANITE							8,720	50	26,982		
MONTANA	HILL							13,796	99	24,359		
MONTANA	JUDITH BASIN							79,911	181	142,981		
MONTANA	LAKE							33,618	379	89,981		
MONTANA	LEWIS AND CLARK							31,028	282	88,048		
MONTANA	LIBERTY							6,982	43	11,875		
MONTANA	MADISON							47,830	215	160,160		
MONTANA	MEAGHER							18,583	54	48,779		
MONTANA	MINERAL							1,332	25	2,323		
MONTANA	MISSOULA							9,158	157	23,051		
MONTANA	MUSSELSHELL			0	0	0		26,499	104	44,026		
MONTANA	PARK			0	0	0		38,637	205	117,514		
MONTANA	PONDERA							27,044	188	52,042		
MONTANA	POWELL							17,602	79	52,203		
MONTANA	RAVALLI							15,037	333	52,990		
MONTANA	ROOSEVELT							52,241	205	92,044		
MONTANA	SHERIDAN							19,749	125	34,294		
MONTANA	SILVER BOW							3,585	19	7,060		
MONTANA	SWEET GRASS							38,484	136	72,294		
MONTANA	TETON							42,172	240	108,722		
MONTANA	TOOLE							8,782	59	11,299		
MONTANA	VALLEY			0	0	0		51,908	257	112,848		
MONTANA	WHEATLAND							22,600	70	33,514		
MONTANA	WIBAUX			0	0	0		19,272	77	32,690		
			Subtotals	0	0	0	0	962,282	4,955	1,976,456	51%	
MONTANA	BEAVERHEAD	Yes	No new RRA forage production	0	1	0		42,828	145	141,961		
MONTANA	BIG HORN			619	7	341,502		70,177	293	181,466		
MONTANA	BLAINE			0	3	230,000		53,439	254	135,988		

Counties Within Eleven States with Seed Production greater than 100,000 lbs in 2007 (County List)

State	County	Seed Production Reported, 2007	Alfalfa For Forage Production	Seed - Acres Hvstd.	Seed - Operations	Seed - In Pounds		Alf. Hay - Acres	Alf. Hay - Operations	Alf. Hay - Tons	Hay % Operations Excluded	Hay % Operations Included
MONTANA	BROADWATER			0	1	0		20,608	115	80,074		
MONTANA	CARBON			0	12	1,253,336		34,963	309	87,750		
MONTANA	CARTER			560	3	76,000		68,447	185	103,119		
MONTANA	CHOUTEAU			0	1	0		25,519	149	42,578		
MONTANA	CUSTER			0	5	53,921		41,624	198	91,104		
MONTANA	DAWSON			0	1	0		29,735	206	54,018		
MONTANA	FALLON			105	3	22,341		73,050	165	83,380		
MONTANA	FLATHEAD			0	2	0		18,783	315	50,486		
MONTANA	GALLATIN			0	1	0		54,242	372	150,592		
MONTANA	JEFFERSON			0	2	0		13,747	83	41,164		
MONTANA	LINCOLN			0	1	0		3,341	70	5,873		
MONTANA	MCCONE			0	1	0		20,625	111	33,913		
MONTANA	PETROLEUM			0	1	0		26,304	53	49,588		
MONTANA	PHILLIPS			0	2	0		40,426	211	82,203		
MONTANA	POWDER RIVER			2,187	17	410,112		68,080	190	121,469		
MONTANA	PRAIRIE			0	2	0		14,352	88	28,379		
MONTANA	RICHLAND			0	1	0		44,729	227	92,452		
MONTANA	ROSEBUD			749	8	200,108		35,367	166	88,426		
MONTANA	SANDERS			0	1	0		13,685	129	28,181		
MONTANA	STILLWATER			0	1	0		43,459	222	59,995		
MONTANA	TREASURE			0	1	0		7,278	38	26,923		
MONTANA	YELLOWSTONE			0	2	0		41,666	462	98,907		
			Subtotals	4,220	80	2,587,320	0	906,474	4,756	1,959,989		49%
			State Total	4,220	80	2,587,320	0	1,868,756	9,711	3,936,445		
NEVADA	CARSON CITY	No	Yes, With Limits and GPS Reporting					0	2	0		
NEVADA	CLARK							1,742	28	0		
NEVADA	DOUGLAS							0	55	41,706		
NEVADA	ELKO							12,076	80	42,599		
NEVADA	ESMERALDA							12,114	13	58,110		
NEVADA	EUREKA							22,340	49	106,164		
NEVADA	LANDER							23,245	44	92,820		

Counties Within Eleven States with Seed Production greater than 100,000 lbs in 2007 (County List)

State	County	Seed Production Reported, 2007	Alfalfa For Forage Production	Seed - Acres Hvstd.	Seed - Operations	Seed - In Pounds		Alf. Hay - Acres	Alf. Hay - Operations	Alf. Hay - Tons	Hay % Operations Excluded	Hay % Operations Included
NEVADA	LYON							43,451	139	218,529		
NEVADA	MINERAL			0				0	4	0		
NEVADA	NYE							9,787	41	42,319		
NEVADA	STOREY							0	1	0		
NEVADA	WASHOE							4,134	101	14,842		
			Subtotals	0	0	0	0	128,889	557	617,089	49%	
NEVADA	CHURCHILL			162	5	129,000		25,955	294	122,839		
NEVADA	HUMBOLDT			4,206	6	3,024,793		51,041	101	215,768		
NEVADA	LINCOLN	Yes	No new RRA forage production	0	2	0		11,039	47	53,193		
NEVADA	PERSHING			1,960	4	1,067,308		30,625	74	145,593		
NEVADA	WHITE PINE			0	2	0		12,056	55	42,735		
			Subtotals	6,328	19	4,221,101	0	130,716	571	580,128		51%
			State Total	6328	19	4221101		259605	1128	1197217		
OKLAHOMA	ADAIR	No	Yes, With Limits and GPS Reporting					190	7	561		
OKLAHOMA	ATOKA							524	10	1,078		
OKLAHOMA	BEAVER							3,786	34	20,502		
OKLAHOMA	BECKHAM			-	-	-		5,527	76	16,930		
OKLAHOMA	BLAINE							6,525	89	20,137		
OKLAHOMA	BRYAN							4,071	31	11,658		
OKLAHOMA	CADDO							7,456	116	20,444		
OKLAHOMA	CANADIAN			-	-	-		14,541	165	46,215		
OKLAHOMA	CARTER							1,339	19	3,707		
OKLAHOMA	CHEROKEE							302	6	670		
OKLAHOMA	CHOCTAW							1,634	13	2,996		
OKLAHOMA	CIMARRON							5,390	16	26,933		
OKLAHOMA	CLEVELAND							3,482	46	10,993		
OKLAHOMA	COAL							260	9	656		
OKLAHOMA	COMANCHE							5,384	58	11,161		
OKLAHOMA	CRAIG							1,066	21	2,312		
OKLAHOMA	CUSTER							9,835	121	48,291		
OKLAHOMA	DELAWARE							352	18	1,001		

Appendix B

Counties Within Eleven States with Seed Production greater than 100,000 lbs in 2007 (County List)

State	County	Seed Production Reported, 2007	Alfalfa For Forage Production	Seed - Acres Hvstd.	Seed - Operations	Seed - In Pounds		Alf. Hay - Acres	Alf. Hay - Operations	Alf. Hay - Tons	Hay % Operations Excluded	Hay % Operations Included
OKLAHOMA	DEWEY							3,325	39	13,615		
OKLAHOMA	ELLIS							4,878	31	25,770		
OKLAHOMA	GARFIELD							7,838	108	24,312		
OKLAHOMA	GARVIN			-	-	-		17,535	133	68,099		
OKLAHOMA	GREER			-	-	-		4,437	39	14,481		
OKLAHOMA	HARMON							2,416	27	8,171		
OKLAHOMA	HASKELL							2,442	13	10,935		
OKLAHOMA	HUGHES							1,166	25	3,106		
OKLAHOMA	JACKSON			-	-	-		4,420	59	14,916		
OKLAHOMA	JEFFERSON							303	4	938		
OKLAHOMA	JOHNSTON							-	2	-		
OKLAHOMA	KINGFISHER			-	-	-		12,149	102	39,621		
OKLAHOMA	LATIMER							290	3	-		
OKLAHOMA	LEFLORE							1,973	22	3,165		
OKLAHOMA	LINCOLN			-	-	-		1,509	43	4,672		
OKLAHOMA	LOGAN			-	-	-		3,878	69	10,497		
OKLAHOMA	MAJOR			-	-	-		8,079	90	25,063		
OKLAHOMA	MARSHALL							-	4	160		
OKLAHOMA	MAYES							1,157	33	3,599		
OKLAHOMA	MCCLAIN							10,022	100	34,842		
OKLAHOMA	MCCURTAIN							2,094	40	5,364		
OKLAHOMA	MCINTOSH							519	16	1,293		
OKLAHOMA	MURRAY							2,254	18	7,483		
OKLAHOMA	NOBLE							5,315	92	13,656		
OKLAHOMA	NOWATA							996	25	3,499		
OKLAHOMA	OKFUSKEE							317	6	1,141		
OKLAHOMA	OKLAHOMA			-	-	-		5,565	75	17,875		
OKLAHOMA	OSAGE							2,902	55	8,210		
OKLAHOMA	OTTAWA							680	17	1,300		
OKLAHOMA	PAWNEE							1,667	38	6,427		
OKLAHOMA	PAYNE			-	-	-		2,560	47	9,524		
OKLAHOMA	PITTSBURG							681	12	1,642		

Counties Within Eleven States with Seed Production greater than 100,000 lbs in 2007 (County List)

State	County	Seed Production Reported, 2007	Alfalfa For Forage Production	Seed - Acres Hvstd.	Seed - Operations	Seed - In Pounds		Alf. Hay - Acres	Alf. Hay - Operations	Alf. Hay - Tons	Hay % Operations Excluded	Hay % Operations Included
OKLAHOMA	PONTOTOC							409	14	1,080		
OKLAHOMA	POTTAWATOMIE			-	-	-		2,510	61	5,679		
OKLAHOMA	PUSHMATAHA							497	6	1,186		
OKLAHOMA	ROGER MILLS							6,267	48	29,205		
OKLAHOMA	ROGERS							606	24	2,585		
OKLAHOMA	SEMINOLE							850	13	2,458		
OKLAHOMA	SEQUOYAH							968	18	2,183		
OKLAHOMA	TULSA							1,016	24	2,829		
OKLAHOMA	WASHINGTON							203	8	546		
OKLAHOMA	WOODS			-	-	-		13,060	106	40,906		
OKLAHOMA	WOODWARD							2,879	64	11,551		
			Subtotals	0	0	0		214,296	2,628	729,829	70%	
OKLAHOMA	ALFALFA			96	3	1,696		21,702	178	68,863		
OKLAHOMA	COTTON			-	2	-		813	14	1,665		
OKLAHOMA	CREEK			-	1	-		1,853	24	3,908		
OKLAHOMA	GRADY			275	5	4,350		22,971	220	70,671		
OKLAHOMA	GRANT			-	1	-		13,621	138	36,665		
OKLAHOMA	HARPER			-	2	-		3,421	38	11,823		
OKLAHOMA	KAY			-	2	-		6,991	119	19,145		
OKLAHOMA	KIOWA	Yes	No new RRA forage production	-	3	-		6,226	84	18,238		
OKLAHOMA	LOVE			-	1	-		328	11	901		
OKLAHOMA	MUSKOGEE			-	2	-		1,735	27	4,242		
OKLAHOMA	OKMULGEE			-	2	-		298	9	1,038		
OKLAHOMA	STEPHENS			-	1	-		2,222	26	6,829		
OKLAHOMA	TEXAS			-	1	-		6,611	32	31,588		
OKLAHOMA	TILLMAN			-	1	-		18,134	94	75,361		
OKLAHOMA	WAGONER			-	1	-		878	17	1,703		
OKLAHOMA	WASHITA			-	1	-		12,700	122	48,894		30%
			Subtotals	371	29	6,046		120,504	1,153	401,534		
			State Total	371	29	6046		334800	3781	1131363		
OREGON	BAKER	No	Yes, With Limits and GPS Reporting					22,057	215	80,919		

Counties Within Eleven States with Seed Production greater than 100,000 lbs in 2007 (County List)

State	County	Seed Production Reported, 2007	Alfalfa For Forage Production	Seed - Acres Hvstd.	Seed - Operations	Seed - In Pounds		Alf. Hay - Acres	Alf. Hay - Operations	Alf. Hay - Tons	Hay % Operations Excluded	Hay % Operations Included
OREGON	BENTON							390	9	2,620		
OREGON	CLACKAMAS							1,371	42	4,679		
OREGON	CLATSOP							185	5	513		
OREGON	COLUMBIA							345	12	0		
OREGON	COOS							268	8	616		
OREGON	CROOK							17,975	149	76,640		
OREGON	DESCHUTES							8,165	126	27,089		
OREGON	DOUGLAS							1,928	34	11,140		
OREGON	GRANT							8,796	80	17,985		
OREGON	HARNEY							45,514	178	150,512		
OREGON	JEFFERSON							15,175	146	65,594		
OREGON	JOSEPHINE							463	25	1,904		
OREGON	KLAMATH							61,859	335	271,713		
OREGON	LAKE							64,174	171	268,148		
OREGON	LANE			0	0	0		737	22	3,009		
OREGON	LINCOLN							130	3	0		
OREGON	LINN							829	23	3,122		
OREGON	MARION			0	0	0		1,740	69	6,219		
OREGON	MORROW							18,269	57	92,461		
OREGON	MULTNOMAH							238	12	640		
OREGON	POLK							342	19	1,402		
OREGON	SHERMAN							421	14	1,303		
OREGON	TILLAMOOK							326	3	0		
OREGON	UNION							26,633	314	80,843		
OREGON	WALLOWA							19,777	147	69,497		
OREGON	WHEELER							4,006	42	10,743		
OREGON	YAMHILL							1,781	51	5,747		
			Subtotals	0	0	0	0	323,894	2,311	1,255,058	65%	
OREGON	GILLIAM	Yes	No new RRA forage production	0	1	0		2,312	14	10,643		
OREGON	HOOD RIVER			0	1	0		236	14	452		
OREGON	JACKSON			0	1	0		4,127	104	14,850		
OREGON	MALHEUR			3,565	25	2,317,740		58,166	707	294,335		

Counties Within Eleven States with Seed Production greater than 100,000 lbs in 2007 (County List)

State	County	Seed Production Reported, 2007	Alfalfa For Forage Production	Seed - Acres Hvstd.	Seed - Operations	Seed - In Pounds		Alf. Hay - Acres	Alf. Hay - Operations	Alf. Hay - Tons	Hay % Operations Excluded	Hay % Operations Included
OREGON	UMATILLA			0	2	0		34,341	312	175,636		
OREGON	WASCO			0	1	0		4,451	70	18,402		
OREGON	WASHINGTON			0	1	0		1,285	37	5,550		
			Subtotals	3,565	32	2,317,740	0	104,918	1,258	519,868		35%
			Total	3,565	32	2,317,740		428,812	3,569	1,774,926		
SOUTH DAKOTA	AURORA	No	Yes, With Limits and GPS Reporting	0	0	0		17,065	159	52,198		
SOUTH DAKOTA	BEADLE			0	0	0		38,312	315	126,217		
SOUTH DAKOTA	BON HOMME							28,997	352	100,562		
SOUTH DAKOTA	BRULE			0	0	0		23,814	178	66,440		
SOUTH DAKOTA	BUFFALO							10,296	38	21,181		
SOUTH DAKOTA	BUTTE			0	0	0		46,953	299	119,239		
SOUTH DAKOTA	CHARLES MIX							42,202	358	122,162		
SOUTH DAKOTA	CLARK							23,158	208	70,286		
SOUTH DAKOTA	CLAY							17,946	140	66,019		
SOUTH DAKOTA	CODINGTON			0	0	0		22,632	244	72,022		
SOUTH DAKOTA	CUSTER							8,523	86	10,981		
SOUTH DAKOTA	DAVISON			0	0	0		19,504	209	60,524		
SOUTH DAKOTA	DAY			0	0	0		16,978	239	47,623		
SOUTH DAKOTA	DEUEL							15,882	224	57,396		
SOUTH DAKOTA	DOUGLAS							16,158	198	59,366		
SOUTH DAKOTA	EDMUNDS			0	0	0		27,401	164	66,818		
SOUTH DAKOTA	FALL RIVER			0	0	0		8,596	72	9,968		
SOUTH DAKOTA	FAULK							33,758	149	82,460		
SOUTH DAKOTA	GRANT							18,919	222	58,049		
SOUTH DAKOTA	HAAKON			0	0	0		44,691	146	35,926		
SOUTH DAKOTA	HAMLIN			0	0	0		10,296	153	36,251		
SOUTH DAKOTA	HAND							46,311	218	120,449		
SOUTH DAKOTA	HANSON							9,084	110	28,164		
SOUTH DAKOTA	HARDING							56,869	131	56,085		
SOUTH DAKOTA	HYDE							24,976	96	52,674		
SOUTH DAKOTA	JERAULD							20,034	110	61,931		

Counties Within Eleven States with Seed Production greater than 100,000 lbs in 2007 (County List)

State	County	Seed Production Reported, 2007	Alfalfa For Forage Production	Seed - Acres Hvstd.	Seed - Operations	Seed - In Pounds		Alf. Hay - Acres	Alf. Hay - Operations	Alf. Hay - Tons	Hay % Operations Excluded	Hay % Operations Included
SOUTH DAKOTA	JONES			0	0	0		25,627	82	38,332		
SOUTH DAKOTA	LAKE							10,956	200	36,862		
SOUTH DAKOTA	LAWRENCE							17,738	108	43,706		
SOUTH DAKOTA	LINCOLN							6,988	205	26,174		
SOUTH DAKOTA	MCCOOK							11,207	207	39,346		
SOUTH DAKOTA	MCPHERSON							46,056	180	117,492		
SOUTH DAKOTA	MINER							14,753	162	40,614		
SOUTH DAKOTA	MINNEHAHA			0	0	0		21,271	413	85,718		
SOUTH DAKOTA	MOODY							10,304	163	42,074		
SOUTH DAKOTA	PERKINS			0	0	0		101,477	260	138,351		
SOUTH DAKOTA	POTTER							12,155	68	26,927		
SOUTH DAKOTA	ROBERTS			0	0	0		21,618	268	68,944		
SOUTH DAKOTA	SANBORN			0	0	0		24,493	158	78,542		
SOUTH DAKOTA	SPINK			0	0	0		28,985	241	103,565		
SOUTH DAKOTA	STANLEY							10,430	55	12,373		
SOUTH DAKOTA	TODD			0	0	0		55,694	124	102,834		
SOUTH DAKOTA	UNION							7,753	143	33,192		
SOUTH DAKOTA	WALWORTH							20,749	105	46,700		
SOUTH DAKOTA	YANKTON							29,048	309	111,003		
SOUTH DAKOTA	ZIEBACH							34,754	101	33,260		
			Subtotals	0	0	0	0	1,161,411	8,370	2,887,000	66%	
SOUTH DAKOTA	BENNETT	Yes	No new RRA forage production	759	5	100,000		30,980	131	45,279		
SOUTH DAKOTA	BROOKINGS			0	2	0		19,123	299	65,750		
SOUTH DAKOTA	BROWN			0	1	0		32,865	315	100,125		
SOUTH DAKOTA	CAMPBELL			0	2	0		24,821	130	66,849		
SOUTH DAKOTA	CORSON			0	1	0		89,144	206	124,029		
SOUTH DAKOTA	DEWEY			2,113	9	50,000		65,514	186	92,402		
SOUTH DAKOTA	GREGORY			0	1	0		64,016	330	153,946		
SOUTH DAKOTA	HUGHES			0	1	0		9,816	97	17,901		
SOUTH DAKOTA	HUTCHINSON			0	1	0		23,966	300	90,463		
SOUTH DAKOTA	JACKSON			0	1	0		51,461	161	51,950		
SOUTH DAKOTA	KINGSBURY			0	1	0		22,344	218	71,982		

Counties Within Eleven States with Seed Production greater than 100,000 lbs in 2007 (County List)

State	County	Seed Production Reported, 2007	Alfalfa For Forage Production	Seed - Acres Hvstd.	Seed - Operations	Seed - In Pounds		Alf. Hay - Acres	Alf. Hay - Operations	Alf. Hay - Tons	Hay % Operations Excluded	Hay % Operations Included
SOUTH DAKOTA	LYMAN			0	1	0		21,977	111	39,503		
SOUTH DAKOTA	MARSHALL			324	4	23,782		23,530	187	64,281		
SOUTH DAKOTA	MEADE			0	5	30,500		150,760	489	181,724		
SOUTH DAKOTA	MELLETTE			0	2	0		43,478	146	59,893		
SOUTH DAKOTA	PENNINGTON			0	2	0		55,621	290	54,028		
SOUTH DAKOTA	SHANNON			0	1	0		9,094	39	10,968		
SOUTH DAKOTA	SULLY			0	2	0		6,121	39	14,082		
SOUTH DAKOTA	TRIPP			175	3	0		76,438	343	172,293		
SOUTH DAKOTA	TURNER			0	2	0		14,119	266	49,890		
			Subtotals	3,371	47	204,282	0	835,188	4,283	1,527,338		34%
			Total	3,371	47	204,282	0	1,996,599	12,653	4,414,338		
UTAH	BEAVER	No	Yes, With Limits and GPS Reporting					19,908	120	102,373		
UTAH	CARBON			0	0	0		5,786	142	16,774		
UTAH	DAGGETT							3,761	20	9,850		
UTAH	DAVIS			0	0	0		3,715	155	18,078		
UTAH	EMERY			0	0	0		17,488	351	49,048		
UTAH	GARFIELD							9,738	156	26,741		
UTAH	GRAND							2,945	45	13,868		
UTAH	IRON							45,230	238	226,627		
UTAH	KANE							1,443	50	4,885		
UTAH	MORGAN			0	0	0		9,406	165	24,368		
UTAH	PIUTE			0	0	0		8,870	73	24,732		
UTAH	RICH							9,270	78	22,164		
UTAH	SALT LAKE			0	0	0		3,324	153	12,577		
UTAH	SAN JUAN							5,300	64	9,792		
UTAH	SEVIER							25,878	394	109,322		
UTAH	SUMMIT			0	0	0		7,361	214	17,962		
UTAH	TOOELE							5,951	144	21,645		
UTAH	WASATCH			0	0	0		7,189	227	23,045		
UTAH	WASHINGTON			0	0	0		5,031	153	23,003		
UTAH	WAYNE							11,732	157	45,074		

Counties Within Eleven States with Seed Production greater than 100,000 lbs in 2007 (County List)

State	County	Seed Production Reported, 2007	Alfalfa For Forage Production	Seed - Acres Hvstd.	Seed - Operations	Seed - In Pounds		Alf. Hay - Acres	Alf. Hay - Operations	Alf. Hay - Tons	Hay % Operations Excluded	Hay % Operations Included
			Subtotals	0	0	0	0	209,326	3,099	801,928	40%	
UTAH	BOX ELDER			0	21	1,091,907		49,161	533	190,085		
UTAH	CACHE			580	6	311,706		50,741	636	193,480		
UTAH	DUCHESNE			60	3	30,000		33,357	423	110,596		
UTAH	JUAB			0	1	0		15,445	158	64,677		
UTAH	MILLARD	Yes	No new RRA forage production	1,118	16	426,700		72,244	421	343,717		
UTAH	SANPETE			0	1	0		35,994	475	139,572		
UTAH	UINTAH			0	2	0		36,019	497	125,099		
UTAH	UTAH			0	2	0		30,197	996	139,095		
UTAH	WEBER			0	2	0		16,086	542	63,969		
			Subtotals	1,758	54	1,860,313	0	339,244	4,681	1,370,290		60%
			Total	1,758	54	1,860,313		548,570	7,780	2,172,218		
WASHINGTON	ASOTIN	No	Yes, With Limits and GPS Reporting					673	10	0		
WASHINGTON	CHELAN							1,561	44	0		
WASHINGTON	CLALLAM							1,633	40	4,025		
WASHINGTON	CLARK							431	12	1,356		
WASHINGTON	COLUMBIA							1,284	29	3,462		
WASHINGTON	COWLITZ							0	1	0		
WASHINGTON	DOUGLAS			0	0	0		1,624	44	6,336		
WASHINGTON	GARFIELD							394	12	0		
WASHINGTON	GRAYS HARBOR							108	6	121		
WASHINGTON	ISLAND							1,612	20	3,186		
WASHINGTON	JEFFERSON							77	5	105		
WASHINGTON	KING							0	0	0		
WASHINGTON	KITSAP							0	2	0		
WASHINGTON	LEWIS							638	18	2,079		
WASHINGTON	PACIFIC							0	2	0		
WASHINGTON	PEND OREILLE							1,603	36	0		
WASHINGTON	PIERCE							105	7	399		
WASHINGTON	SAN JUAN							0	2	0		
WASHINGTON	SKAGIT							254	8	843		

Counties Within Eleven States with Seed Production greater than 100,000 lbs in 2007 (County List)

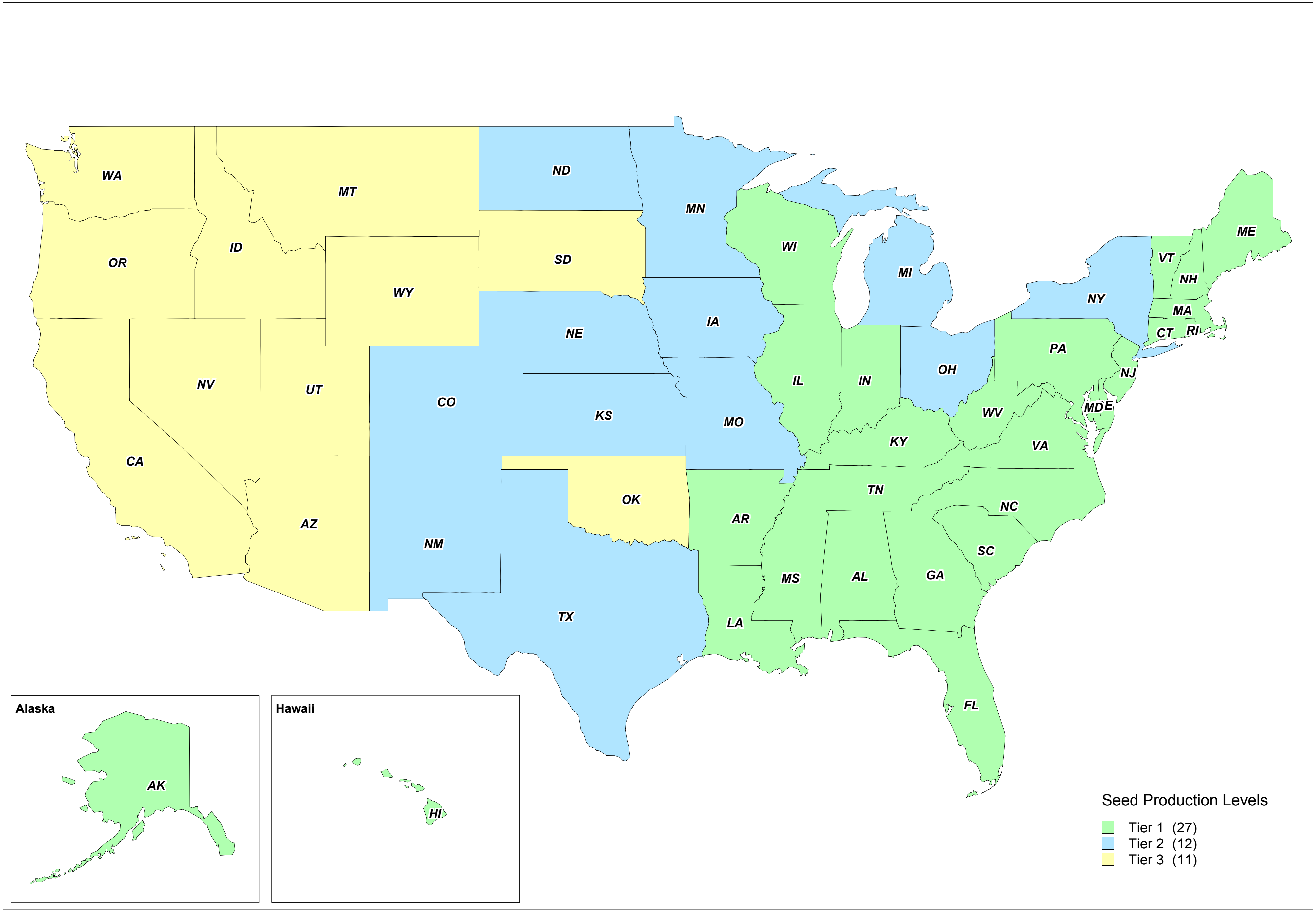
State	County	Seed Production Reported, 2007	Alfalfa For Forage Production	Seed - Acres Hvstd.	Seed - Operations	Seed - In Pounds		Alf. Hay - Acres	Alf. Hay - Operations	Alf. Hay - Tons	Hay % Operations Excluded	Hay % Operations Included
WASHINGTON	SKAMANIA							0	2	0		
WASHINGTON	SNOHOMISH			0	0	0		632	14	2,432		
WASHINGTON	THURSTON							307	16	641		
WASHINGTON	WAHKIAKUM							0	1	0		
WASHINGTON	WHATCOM							791	16	2,208		
			Subtotals	0	0	0	0	13,727	347	27,193	8%	
WASHINGTON	ADAMS	Yes	No new RRA forage production	0	1	0		20,982	104	125,759		
WASHINGTON	BENTON			0	3	43,225		12,412	162	67,352		
WASHINGTON	FERRY			0	1	0		3,866	56	9,124		
WASHINGTON	FRANKLIN			311	5	238,526		77,441	272	573,937		
WASHINGTON	GRANT			4,249	25	2,308,614		117,488	549	752,332		
WASHINGTON	KITTITAS			0	1	0		8,721	165	35,824		
WASHINGTON	KLICKITAT			0	1	0		26,515	160	35,517		
WASHINGTON	LINCOLN			0	1	0		14,545	127	41,293		
WASHINGTON	OKANOGAN			129	7	25,731		23,253	399	73,994		
WASHINGTON	SPOKANE			0	3	19,200		36,386	656	77,020		
WASHINGTON	STEVENS			0	6	46,112		32,477	436	58,452		
WASHINGTON	WALLA WALLA			10,759	14	7,510,760		14,772	123	93,678		
WASHINGTON	WHITMAN			0	2	0		8,456	130	27,003		
WASHINGTON	YAKIMA			713	12	409,045		37,363	608	184,071		
			Subtotals	16,161	82	10,601,213	0	434,677	3,947	2,155,356		92%
			Totals	16,161	82	10,601,213	0	448,404	4,294	2,182,549		
WYOMING	ALBANY	No	Yes, With Limits and GPS Reporting					6,972	33	16,137		
WYOMING	CAMPBELL							45,631	177	61,739		
WYOMING	CARBON							14,065	61	21,953		
WYOMING	CONVERSE							28,914	135	62,321		
WYOMING	GOSHEN							58,944	369	179,960		
WYOMING	HOT SPRINGS							9,766	94	23,140		
WYOMING	JOHNSON							21,923	103	53,077		
WYOMING	LARAMIE							22,606	106	83,138		
WYOMING	LINCOLN							39,848	271	89,104		

Counties Within Eleven States with Seed Production greater than 100,000 lbs in 2007 (County List)

State	County	Seed Production Reported, 2007	Alfalfa For Forage Production	Seed - Acres Hvstd.	Seed - Operations	Seed - In Pounds		Alf. Hay - Acres	Alf. Hay - Operations	Alf. Hay - Tons	Hay % Operations Excluded	Hay % Operations Included
WYOMING	NATRONA							25,269	152	76,777		
WYOMING	NIOBRARA							12,974	60	30,041		
WYOMING	PLATTE							30,497	176	88,012		
WYOMING	SUBLETTE							5,485	29	10,312		
WYOMING	TETON							4,610	32	14,440		
WYOMING	UINTA							6,251	53	13,751		
WYOMING	WESTON							21,847	67	22,306		
			Subtotals	0	0	0	0	355,602	1,918	846,208	48%	
WYOMING	BIG HORN			0	18	2,816,147		35,845	332	126,064		
WYOMING	CROOK			0	3	0		77,829	232	104,988		
WYOMING	FREMONT			0	6	173,138		85,550	608	275,524		
WYOMING	PARK	Yes	No new RRA forage production	4,560	29	2,534,285		37,844	407	133,764		
WYOMING	SHERIDAN			0	1	0		45,376	268	113,207		
WYOMING	SWEETWATER			0	1	0		20,607	126	42,944		
WYOMING	WASHAKIE			0	4	244,826		15,631	116	53,739		
			Subtotals	4,560	62	5,768,396	0	318,682	2,089	850,230		52%
			Totals	4,560	62	5,768,396	0	674,284	4,007	1,696,438		
						Per State Average Exclusion/Inclusion:					46%	54%

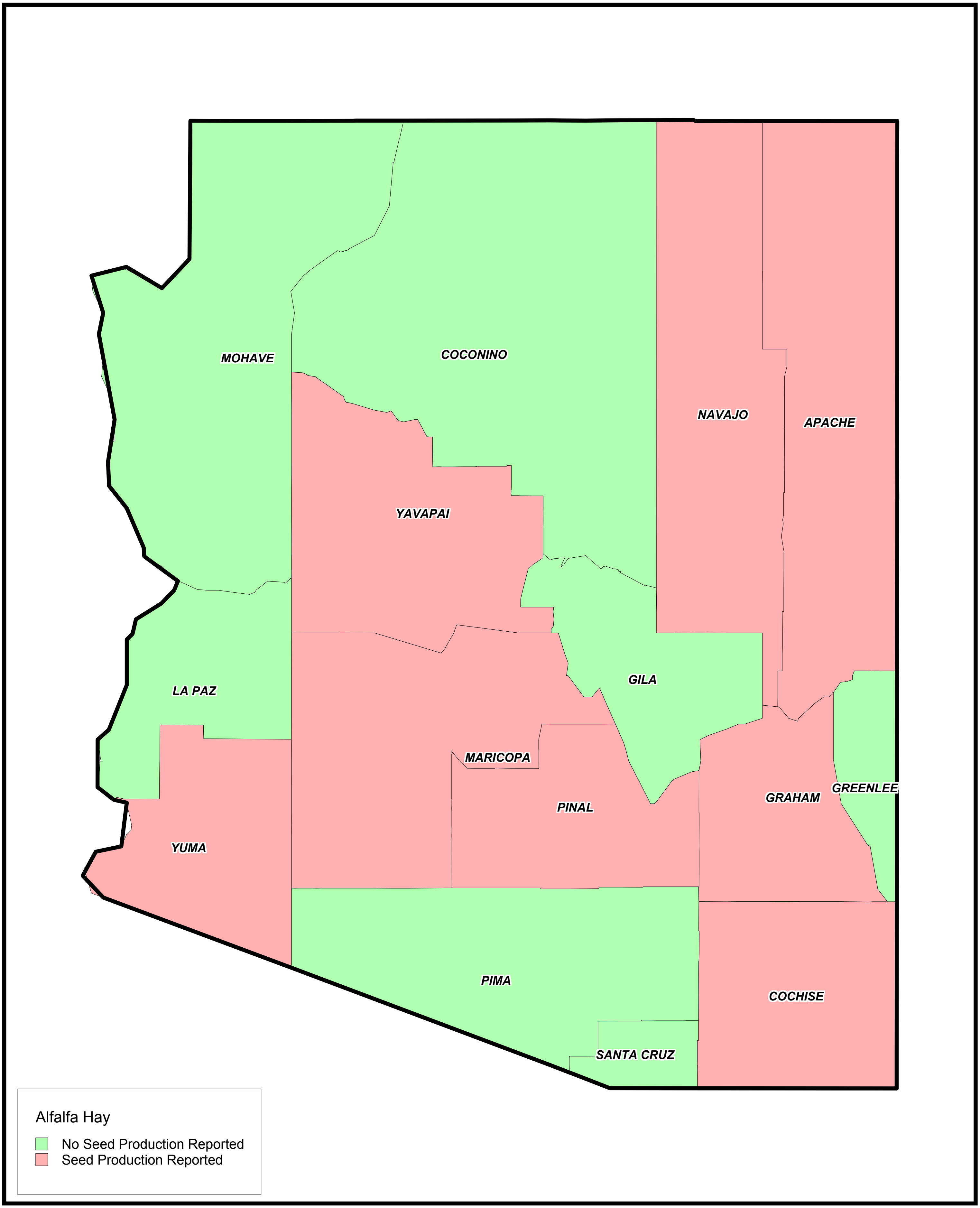
Seed Production Levels from 2007 Ag Census Data

Appendix B

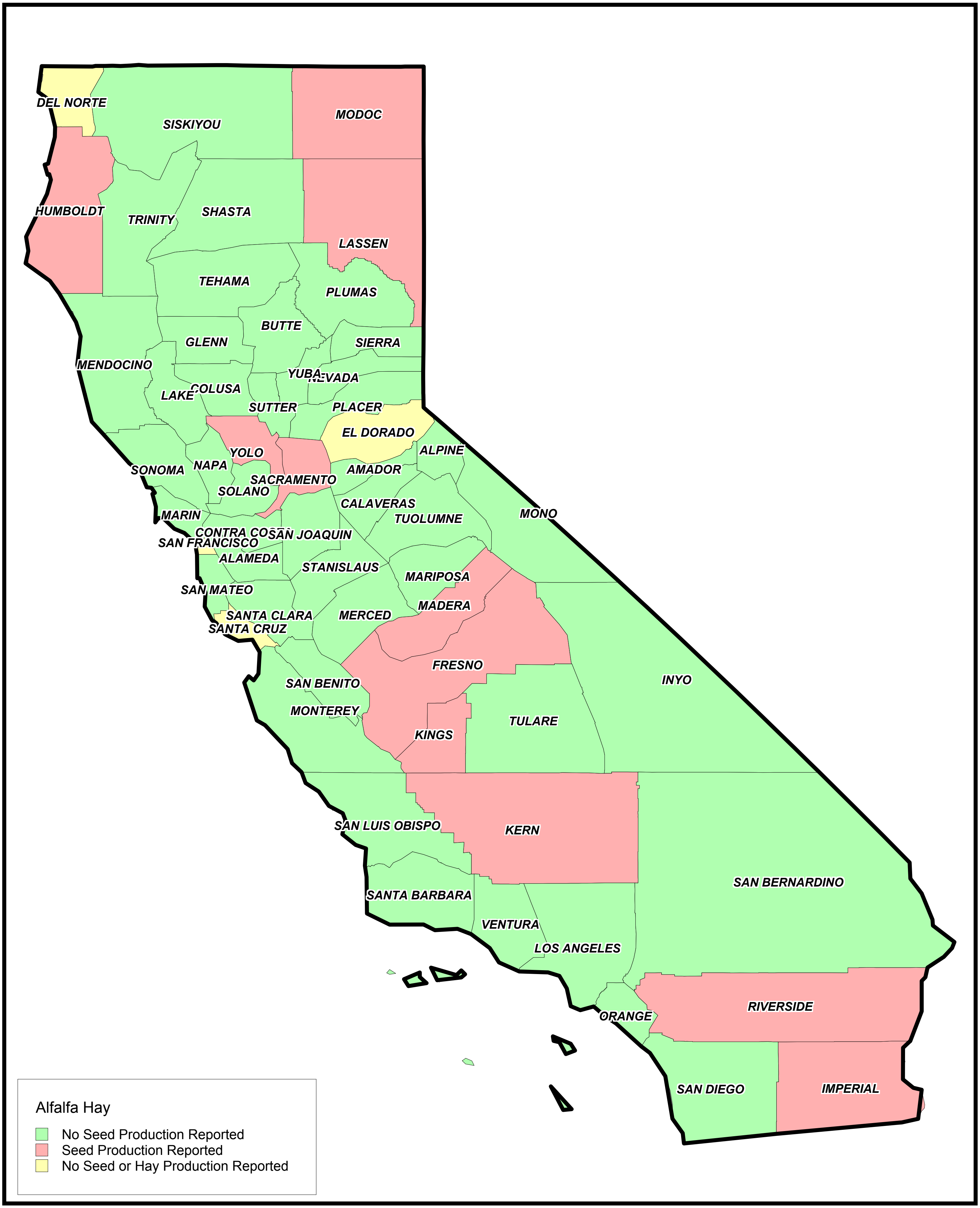


Arizona - Alfalfa Hay Counties With and Without Seed Production

Appendix B

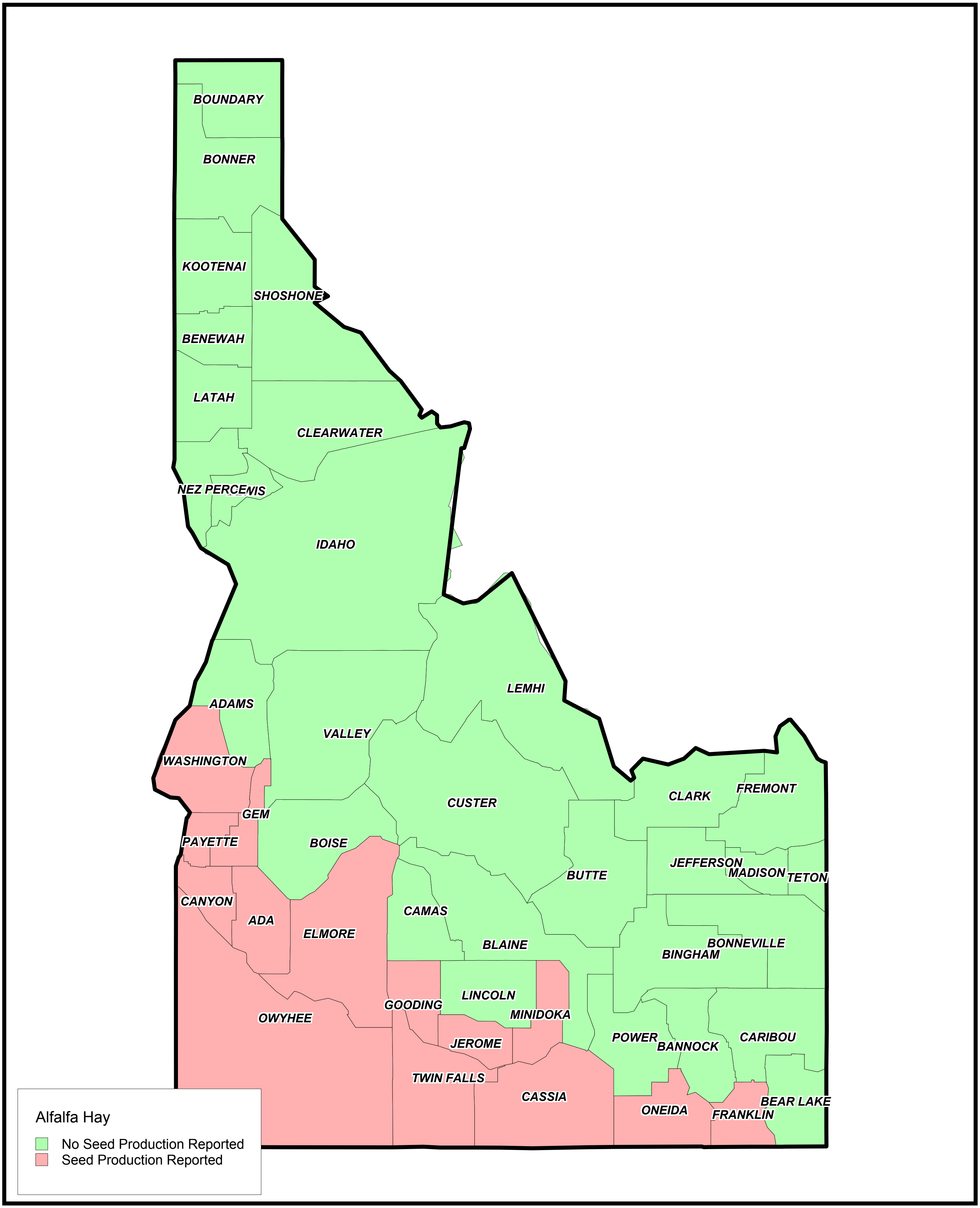


California - Alfalfa Hay Counties With and Without Seed Production



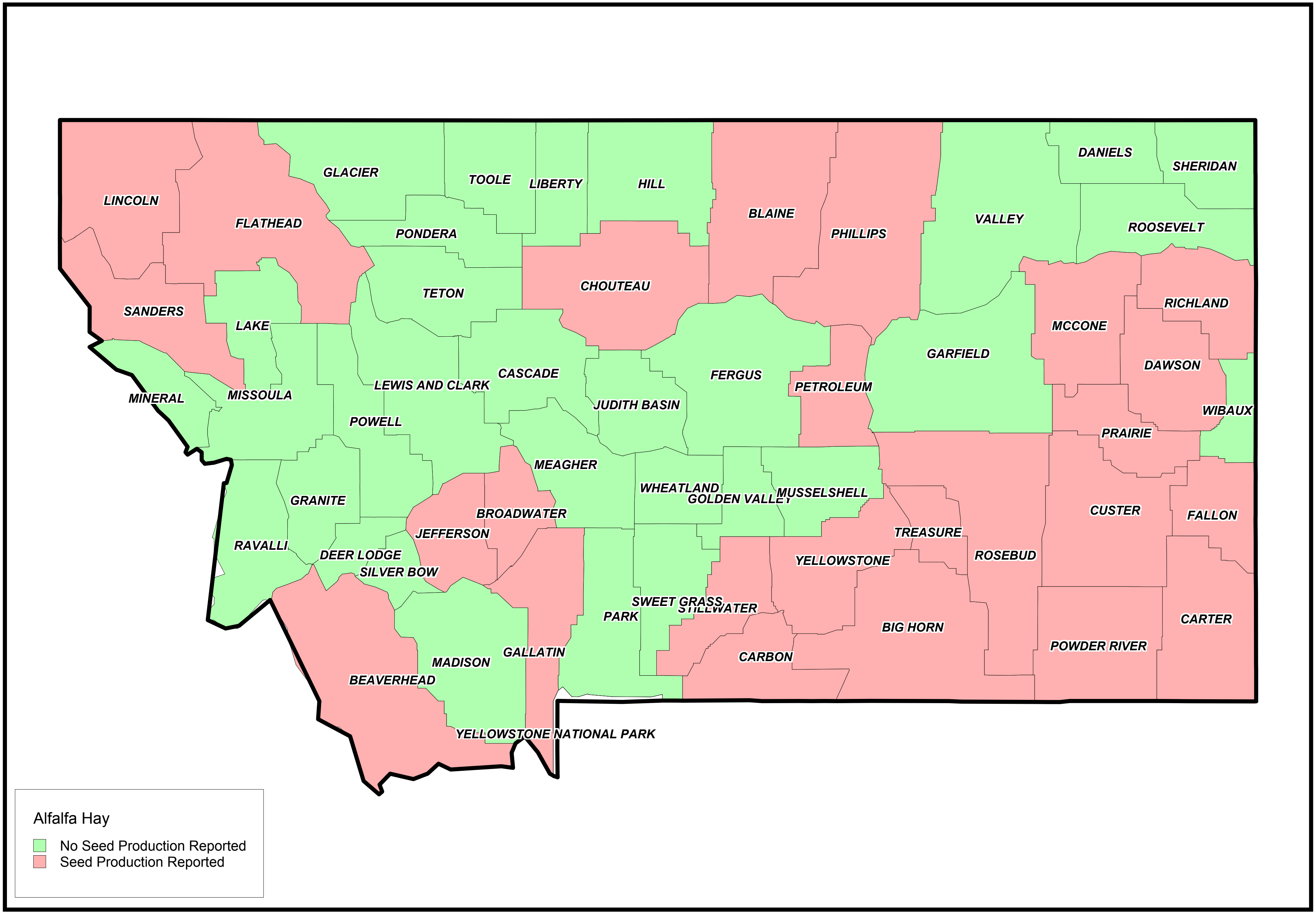
Idaho - Alfalfa Hay Counties
With and Without Seed Production

Appendix B

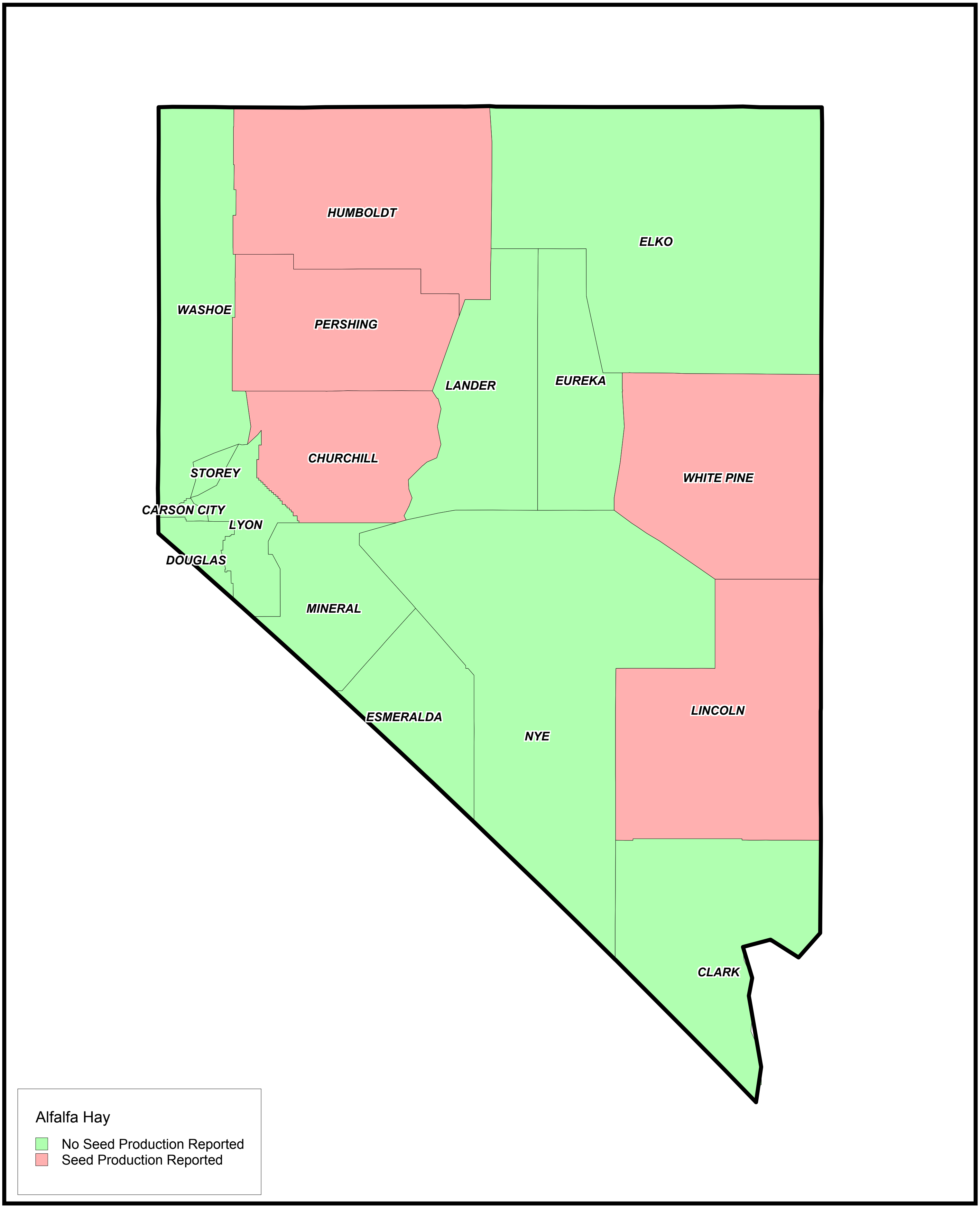


Montana - Alfalfa Hay Counties
With and Without Seed Production

Appendix B

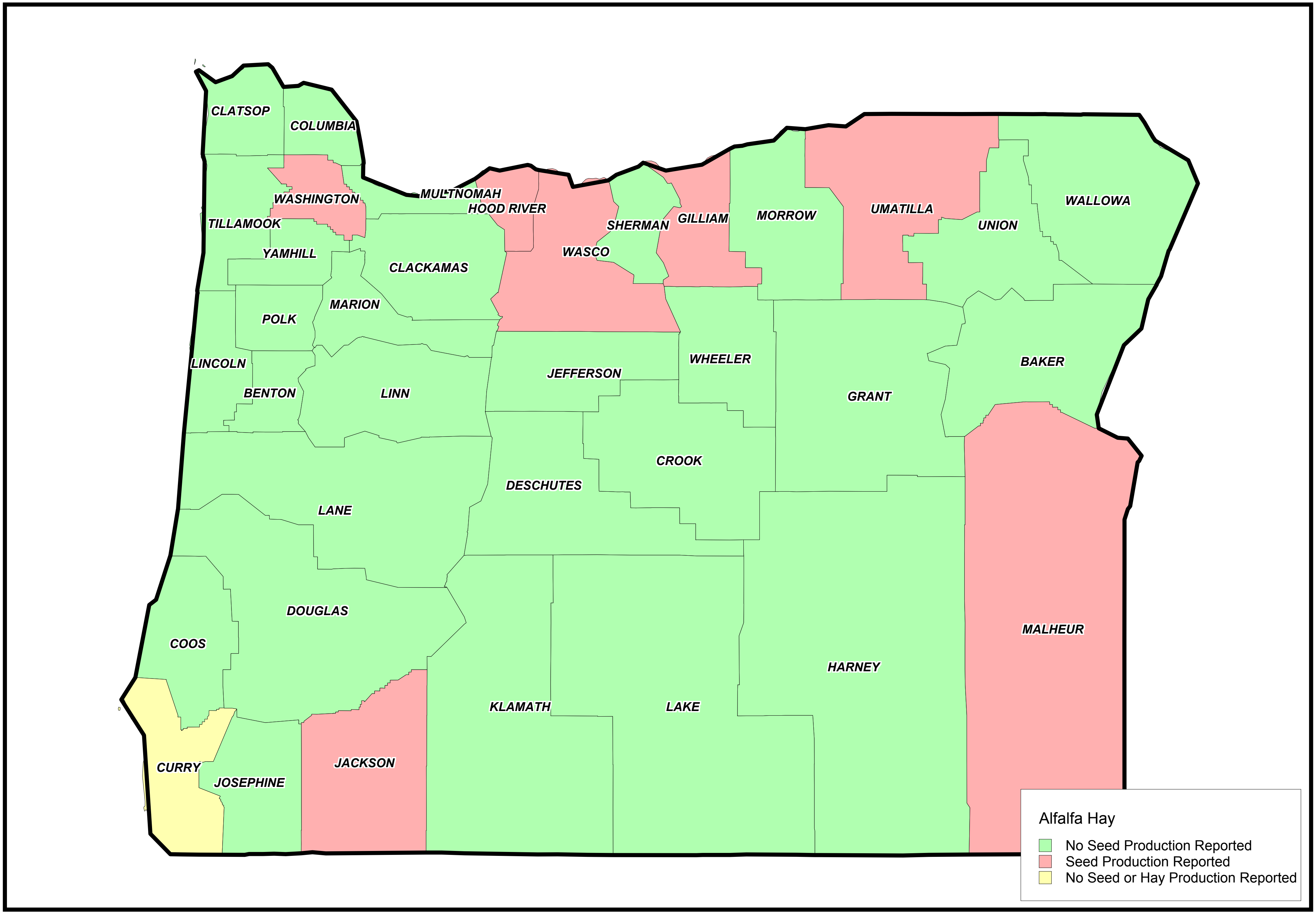


Nevada - Alfalfa Hay Counties With and Without Seed Production



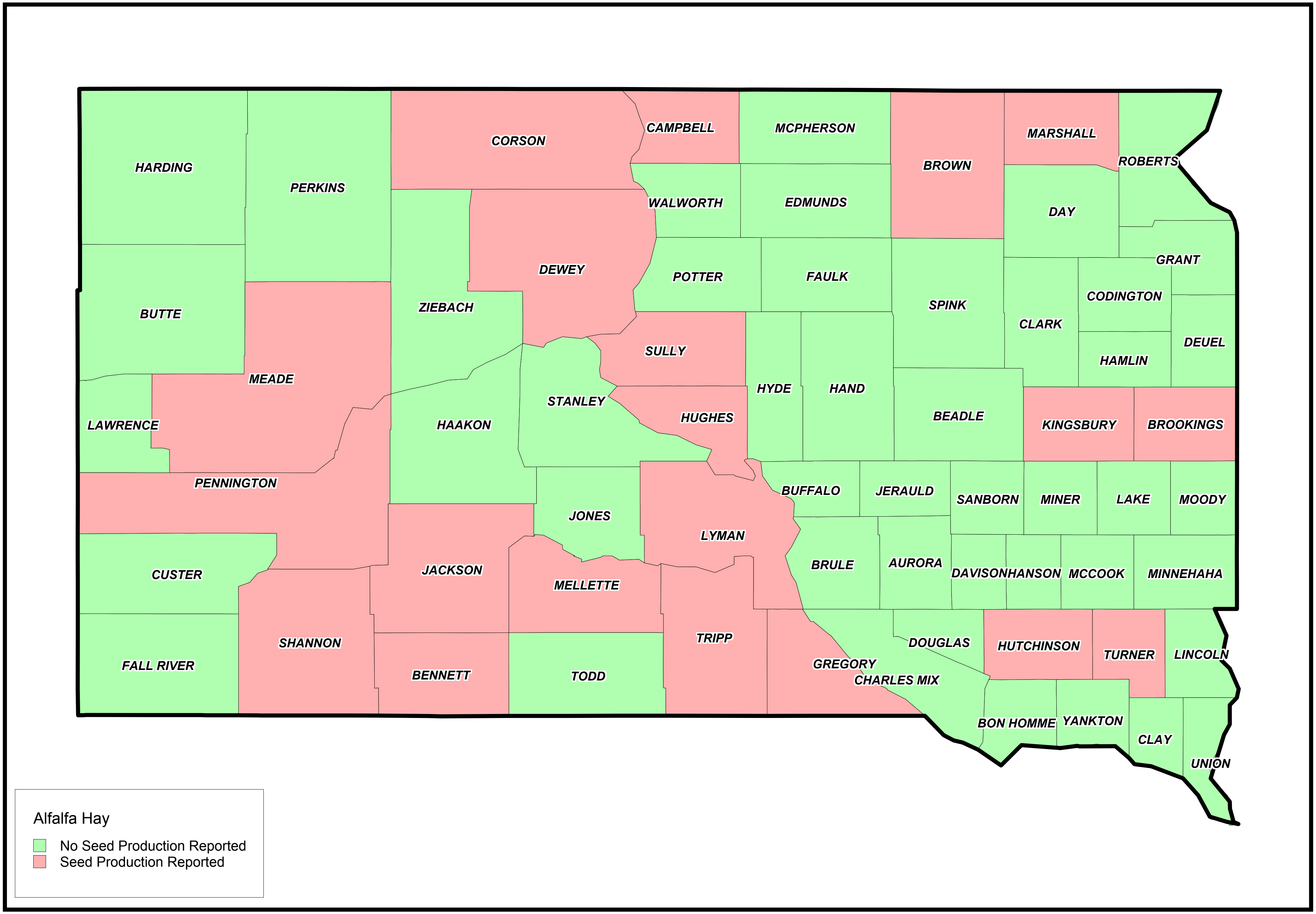
Oregon - Alfalfa Hay Counties
With and Without Seed Production

Appendix B



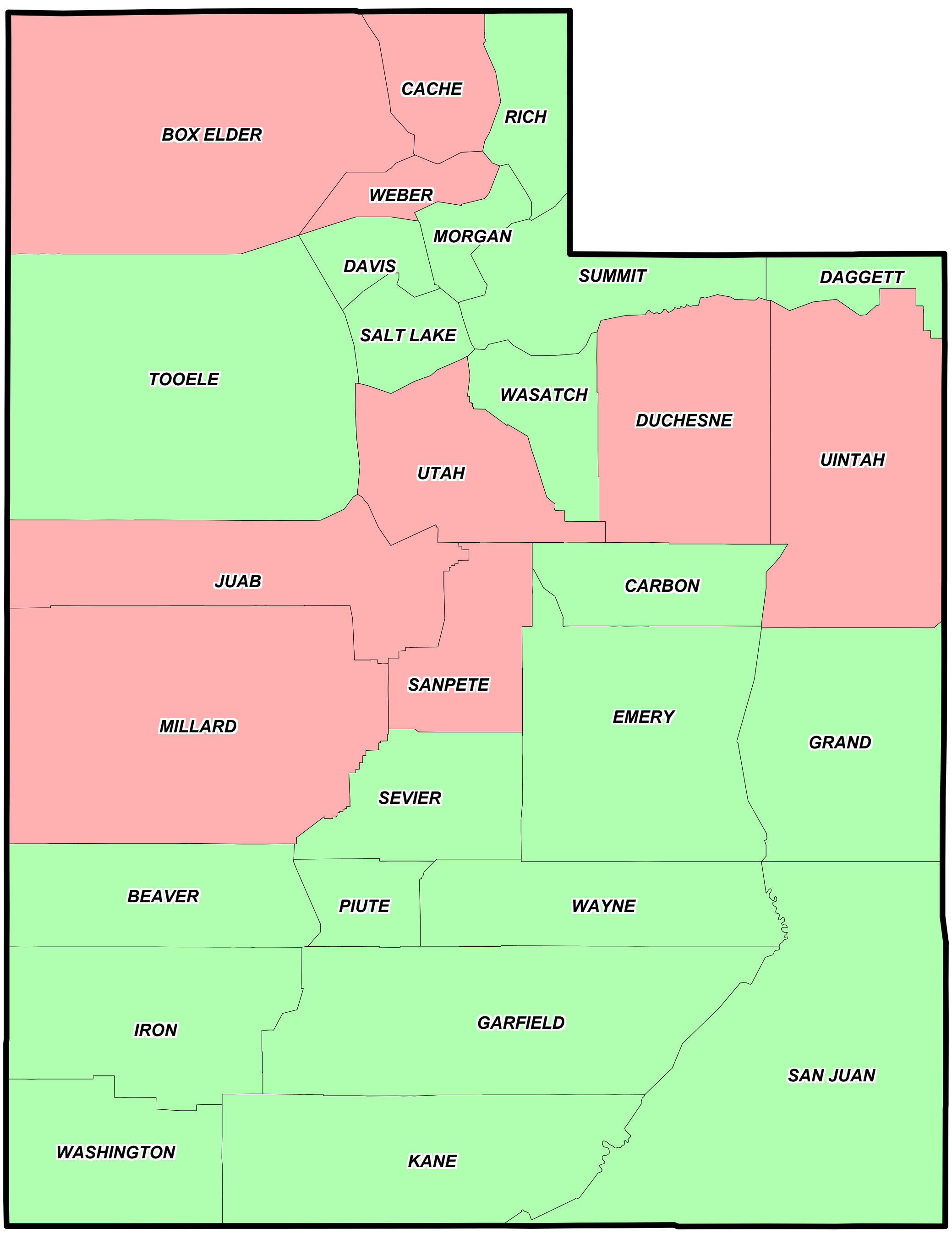
South Dakota - Alfalfa Hay Counties With and Without Seed Production

Appendix B



Utah - Alfalfa Hay Counties
With and Without Seed Production

Appendix B

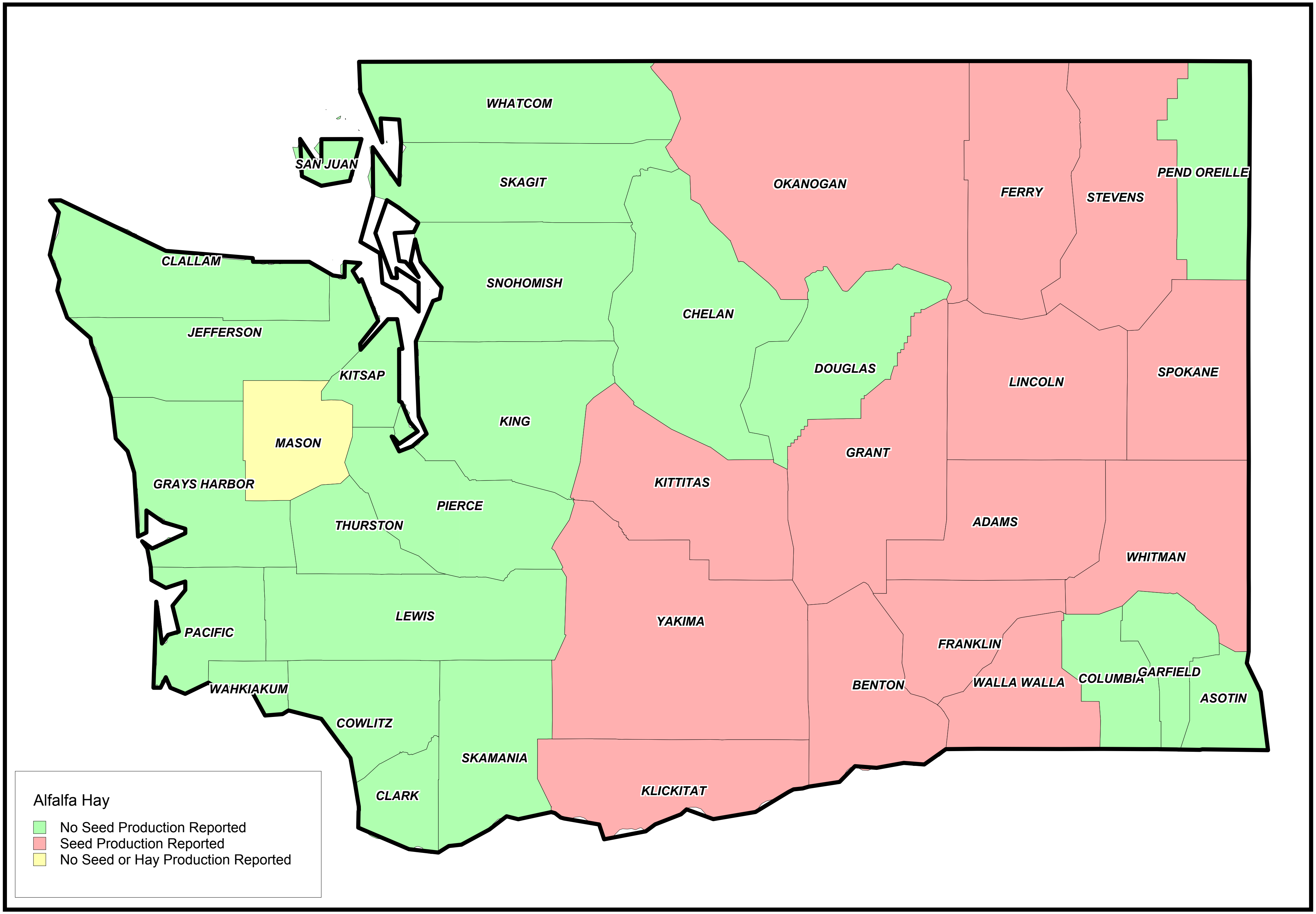


Alfalfa Hay

- No Seed Production Reported
- Seed Production Reported

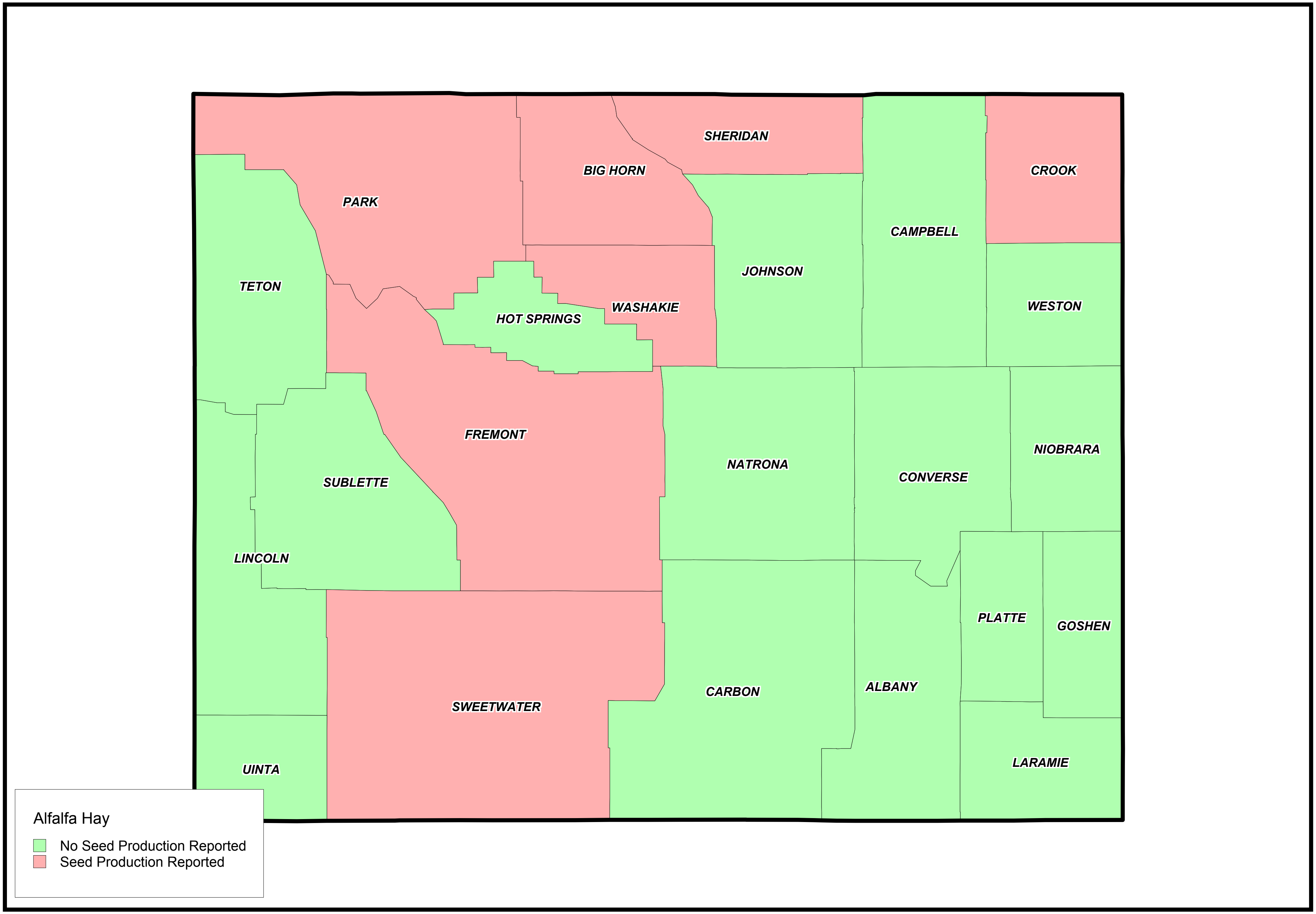
Washington - Alfalfa Hay Counties With and Without Seed Production

Appendix B

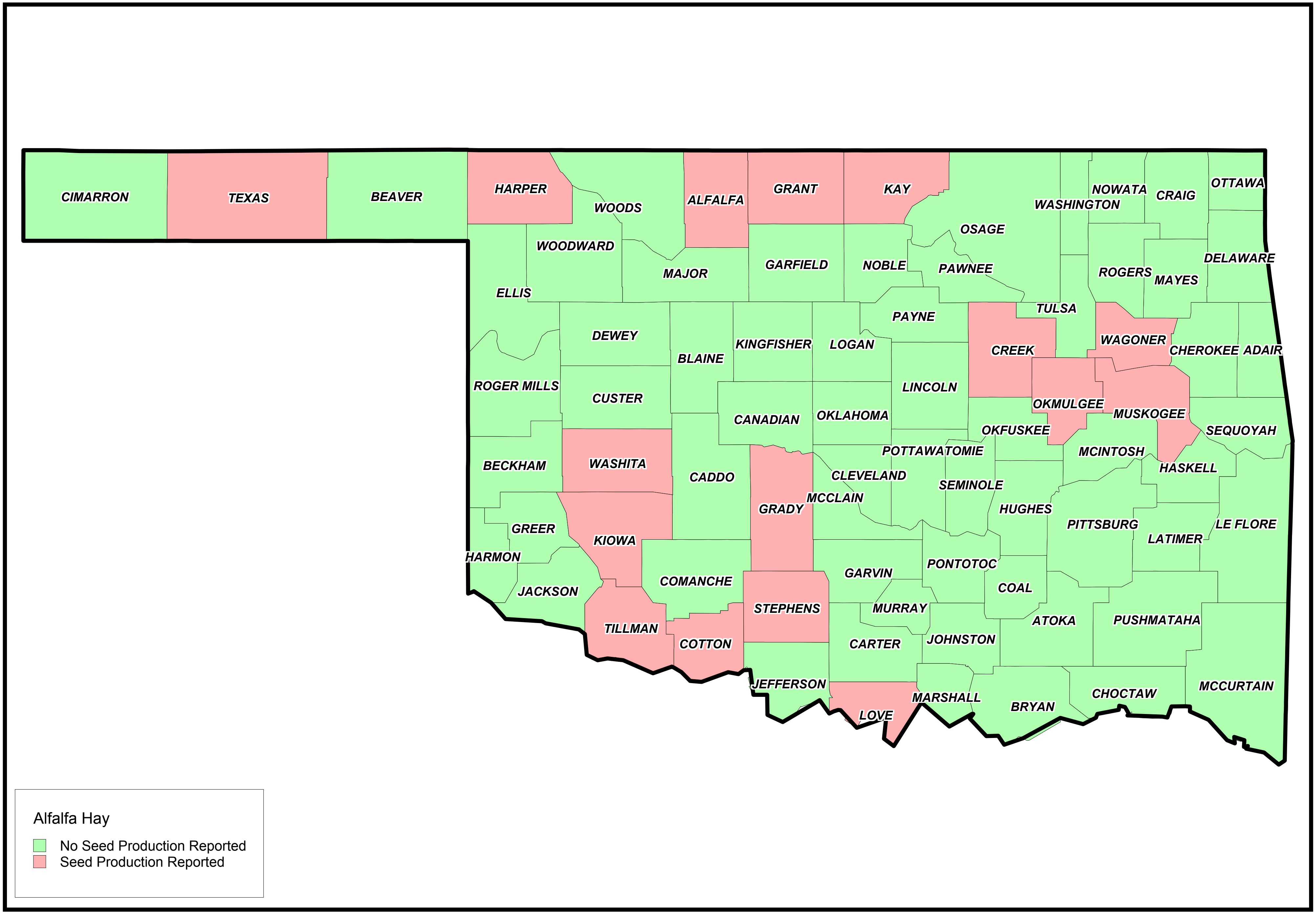


Wyoming - Alfalfa Hay Counties
With and Without Seed Production

Appendix B



Oklahoma - Alfalfa Hay Counties With and Without Seed Production



Appendix
C

National Alfalfa & Forage Alliance Best Management Practices for Roundup Ready® Alfalfa Seed Production

Best Management Practices for Roundup Ready® Alfalfa Seed Production

Introduction

The genetic supplier members (hereinafter called the "Companies") of National Alfalfa & Forage Alliance (NAFA) have agreed to jointly adopt, as a minimum, the following Best Management Practices for Roundup Ready Alfalfa (RRA) Seed Production in the United States. Compliance is required under a separate and binding agreement of the Companies to each other in this commitment. Forage Genetics International (FGI) is the exclusive licensed seed producer of RRA and will require all RRA seed production sub-licensees (herein after called the "RRA Seed Contractor(s)") to become a party to this binding agreement. It is not the intent of this document to establish best management practices for the production of alfalfa seed for GE sensitive markets. Changes to this document will require a recommendation from the Companies and approval by the NAFA Board of Directors.

Roundup Ready Trait Stewardship in Seed Production

- This document establishes RRA commercial seed production policies that exceed industry standards for Certified alfalfa seed production.
- Specifically, RRA seed production practices will meet or exceed Association of Official Seed Certifying Agencies (AOSCA) standards for the seed production of Foundation Class alfalfa seed production.
- All RRA seed growers must complete RRA seed stewardship training and agree to follow the RRA seed production policies as described herein and as required by RRA seed production contracts.

RRA Seed Contractors' Responsibilities

Isolation. The RRA Seed Contractor will insure that the isolation distance between the new planting and any established conventional seed production meets the following pollinator-specific isolation requirements for RRA seed production. Note the pollinator designated applies to normal pollinating bees introduced or locally cultured for alfalfa seed production in the area. If more than one pollinator species is introduced or locally cultured, the longer minimum distance applies.

- Leaf cutter bee – 900 feet
- Alkali bee – 1 mile
- Honey bee – 3 miles

Every year the Companies will collectively sample conventional seed lots, test for adventitious presence of the Roundup Ready trait, and use isolation distance from RRA seed production to monitor the effectiveness of current isolation standards. The Companies, along with three AOSCA representatives of state crop improvement associations or their designees, will analyze the data and make recommendations for changes to required isolation distances, if appropriate.

Reporting. The RRA Seed Contractor shall report GPS coordinates of all established and planned RRA seed production fields to local state seed certification officials as early as possible, but no later than two weeks prior to planting. State officials will confirm minimum isolation and establish a state pinning map for RRA seed production. The RRA Seed Contractor must authorize state officials to report to any seed grower or seed company, on request, the isolation distance between a planned new conventional alfalfa seed field and the nearest RRA seed field. GM-trait sensitive conventional or organic alfalfa seed producers can then use this third party service to assist them in planning their field locations to meet their company's isolation or field crop history goals or the certification agent may use the data to certify a stated isolation distance. The RRA Seed Contractor shall also notify local state seed certification officials, and officials shall confirm when a RRA seed production field is terminated.

GE-free seed production zones. The RRA Seed Contractor will limit RRA seed production contracts to the following states: Arizona, California, Colorado, Idaho, Montana, Nevada, Oregon, Texas, Utah, Washington and Wyoming. The RRA Seed Contractor will also respect any GE-free alfalfa seed production zone designated as such by a consensus of local seed growers. Recognition and designation of such zones will be based on the requirements of each state. It is envisioned that the local state seed certification agency would play an active role in administering programs of this nature.

Cooperation. All seed companies are encouraged to communicate and work together individually to manage joint seed quality issues and concerns.

RRA seed grower training. The RRA Seed Contractor will require RRA stewardship training for all new RRA seed growers. The RRA seed grower will confirm having received a copy of the NAFA Best Management Practices for Roundup Ready Alfalfa Seed Production (see Appendix 2).

RRA seed grower contracts. The RRA Seed Contractor shall stipulate which bee species can be introduced for pollination and incorporate key grower stewardship requirements (as listed below) in RRA seed production contracts.

License. The RRA Seed Contractor will have an FGI license for RRA seed production, including reporting requirements for acreage planted and seed harvested, by variety.

RRA Seed Growers' Responsibilities

Monsanto Technology/Stewardship Agreement (MTA). RRA Seed Grower must sign an MTA and are bound by the terms outlined in the current Monsanto Technology Use Guide (TUG). The MTA is a limited-use license for Monsanto traits, and renews automatically each year. The TUG is updated annually.

Observe patent rights. All RRA stock seed and harvested seed contains patent-protected, Roundup Ready trait, therefore:

- All seed transfer/sale is exclusive between RRA Seed Grower and the RRA Seed Contractor; no seed may be sold by RRA Seed Grower to other parties.
- RRA Seed Grower may not save seed for any purpose as per MTA.

Observe all federal, state and local regulations. It is the RRA Seed Grower's responsibility to know and obey current federal, state and local regulations affecting their agricultural practices. Some examples are as follows:

Federal Laws and Regulations:
- Pesticide use labels and restrictions;
- U.S. Patent Rights;
- Plant Variety Protection; Federal Seed Act.
- Phytosanitary laws governing import or export of seeds and pollinators.

State Laws and Regulations:
- Noxious or prohibited weeds, pathogens or insects;
- Pesticide use labels and restrictions

Local Laws and Regulations:
- Pesticide use notifications (field posting);
- County restrictions or prohibitions on the use of biotechnology, as applicable.

Bees. RRA Seed Grower will manage pollinators to minimize pollen flow to conventional/other variety fields.

- Only contract-specified bee species can be introduced for pollination supporting RRA seed production.
- There shall be no bee domicile movement from RRA to conventional alfalfa seed fields until pollination is finished for the year.
  - Once bees are in RRA seed fields, they may only be moved among RRA fields. It is the RRA Seed Grower's responsibility to inform their pollinator contractors or bee keepers of this requirement.
- RRA Seed Grower will locate domiciles to maximize domicile distance to other varieties, to the extent reasonable and appropriate to each field.
- The main pollinator bee species will be stated on each RRA Seed Grower Contract. Isolation requirements are specific to the main pollinator species.
- If honeybees are not the contract-stipulated pollinator species, the RRA Seed Grower will discourage neighbors from keeping honeybee hives in proximity to RRA seed production. In cases where this cannot be avoided, RRA Seed Grower is required to report the incident to the RRA Seed Contractor.

Isolation. RRA Seed Grower will assist RRA Seed Contractor with field location planning prior to planting, isolation zone monitoring after planting and facilitate crop improvement inspections as requested.

- The pollinator species-specific isolation policy is as follows (minimum distance to preexisting conventional seed at planting of RRA):
  - Leaf cutter bee – 900 feet
  - Alkali bee – 1 mile
  - Honey bee – 3 miles
- Once the RRA seed field is planted, State Certification officials will visit to confirm minimum isolation distances are in place. RRA Seed Grower must cooperate with this verification process.
- If the RRA Seed Grower learns that new alfalfa seed field(s) are planned or planted in close proximity the RRA seed field, RRA Seed Grower will communicate this information to RRA Seed Contractor. Management strategies for maintaining RRA seed quality (varietal/trait purity) can then be implemented by the RRA Seed Contractor.

Trait purity. RRA stock seed is guaranteed by the provider to have ≥90% RR plants; up to 10% non-RR plants, or "nulls", are normal and expected based on the breeding and genetics of the trait.

- Growers must apply sufficient Roundup® herbicide to kill the <10% nulls prior to 9 inches of growth in the establishment year.
- Apply only registered (labeled) Roundup brand herbicides to the field.

Weeds and in-crop volunteers. Manage weeds and volunteers using integrated weed control strategies (e.g., conventional practices supplemented with Roundup agricultural herbicide formulations applied according to the label for alfalfa seed production). Integrated weed control strategies:

- Minimize risk of weed shifts or development of tolerant weeds. Growers are required to use integrated weed control methods.
- Maintain variety true to type: RRA seed fields need non-Roundup practices to control in-crop Roundup Ready alfalfa volunteers sprouting from prior year

seed crop in carry-over fields. This is consistent with conventional alfalfa seed production practices for certified quality seeds.

Stand take-out.

- The RRA seed field must be destroyed at the expiration/termination of the seed contract. Take-out must be completed prior to first flower in the subsequent year so that seed certification inspectors can verify stand termination.
- Stand termination and volunteer management measures must be sufficient to allow seed certification inspectors to validate stand take-out and to render the alfalfa stand worthless for any unlicensed purpose or use (e.g., unlicensed seed, forage, hay or pasture production purpose).
- RRA stand take-out date and method must be reported to the RRA Seed Contractor and stand destruction verified by local crop improvement using the RRA stand take out form, or the equivalent, to report the information (see Appendix).
- Plan to use a subsequent crop that allows management of alfalfa and RRA alfalfa volunteers should they occur.

Sanitation requirements. Manage equipment to minimize seed mixture potential between different varieties and or variety types. Growers shall use dedicated equipment for planting and harvesting RRA seed production, when possible. Zero tolerance for seed admixture is not feasible under commercial production conditions; however, grower must take reasonable steps to assure that equipment is clean prior to and after use in the Roundup Ready seed field. *Examples:*

- Planter inspection, clean-down before and after use;
- Combine inspection, clean-down thoroughly before and after use;
- RRA seed bins may only be used for RRA seed; maintain physical separation of varieties in storage; inspect bins before use;
- Handle all like-trait varieties together; plan for harvest sequence of fields to maintain best separation of varieties by trait type;
- Clean all seed handling equipment to avoid mixing RRA and conventional seed;
- Return unused, unopened stock seed to the contracting seed company for credit; maintain in clean storage areas;
- When a contract harvester is used for RRA seed harvest, Growers must notify the contract harvester, in advance, that the field to be harvested is RRA.

Communication. Immediately communicate questions or concerns to the RRA Seed Contractor or to FGI.

Field records. RRA Seed Grower must record and communicate the following to RRA Seed Contractor:

- Planting date; actual acres planted; seed rate/acre; stock seed received/returned;
- Accurate field address with latitude/longitude (decimal degrees) and local field map;
- Roundup herbicide application date(s), rate(s), formulation used;
- Seed box/bin numbers used for harvest;
- Stand destruct date and methods used using the RRA stand take out form, or the equivalent, to report the information (see Appendix).

RRA Seed Contractors' Production Staff Responsibilities

- Working in close partnership with seed growers;
- Complying with binding agreements with local crop improvement organizations:
    - RRA Seed Contractor will report each field location, planting date and stand take-out date to local crop improvement organizations;
- Coating RRA stock seed purple for easy identification by seed growers;
- Recommending changes to this document, should the need arise.

Roundup Ready® and Roundup® are registered trademarks of Monsanto.

"Best Management Practices for Roundup Ready® Alfalfa Seed Production"

Coexistence Strategy Forum Steering Committee

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Reedsville, WI

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Logan, UT

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APPENDIX 1

VERIFICATION OF STAND TAKE-OUT TO TERMINATE THE PRODUCTION OF ROUNDUP READY® ALFALFA SEED

The AGREEMENT: The Grower planted the RRA Proprietary stock seed described below on the acreage described below. In accordance with the terms of the Proprietary Seed Services Agreement for the Production of Roundup Ready Alfalfa Seed, upon expiration or termination of the agreement, the grower must take such actions as are necessary to prevent any future seed harvest or unlicensed use for hay, forage or grazing. Stand destruction must occur not later than first flower in subsequent year. Grower must notify Contracting Seed Company of each stand take-out date and method used to destroy the stand. The Contracting Seed Company must perform on-site verification that each field has been killed and Contracting Seed Company will notify local crop improvement organization of stand termination.

Use a separate form for each field or field group reported to crop improvement.

	Experimental or Variety Name:					
#	Field names	Number of Acres	Field Location: Town-Range-Section & County	Latitude / Longitude (original GPS Coordinate)	# ACRES + DATE(s) + METHOD(s)	SITE VISIT VERIFICATION DATE(s)*
1						
2						
3						
Total no. acres this contract planted:				**Total no. acres reported to be killed:**		
Seed Company representative verifying information Signature(s) Date(s)				**Seed Company representative notifying Crop Improvement** Signature(s) Date(s)		

GROWER

By:_________________________(signature)

By: _________________________(printed name)

Title:______________________________

Company: _________________________

Address: __________________________

____

CONTRACTING SEED COMPANY

By:___________________________(signature)

By:_________________________(printed name)

Title:______________________________

Company: _________________________

Address: ___________________________

____

APPENDIX 2

These signatures confirm that the RRA Seed Grower has received the NAFA Best Management Practices for Roundup Ready® Alfalfa Seed Production

Contracting Seed Company has communicated NAFA Best Management Practices for Roundup Ready Alfalfa Seed Production to the Grower prior to initial RRA seed field planting and will update Grower annually, thereafter.

RRA Seed Contractor Representative Conducting Initial Grower Training:

PRINT NAME AND ADDRESS	SIGNATURE AND DATE
Seed Company Representative:	______________________________ Date: __________________

RRA Seed Grower Acknowledgement of Training and/or Receipt of NAFA Best Management Practices for Roundup Ready Alfalfa Seed Production:

PRINT NAME AND ADDRESS	SIGNATURE AND DATE
Grower: Telephone number: _________________	______________________________ Date: __________________

Signature page original to be retained by RRA Seed Contractor.

Signature page copy to be retained by RRA Seed Grower.

Appendix
D

Orloff, S., D.H. Putnam, M. Canevari and W.T. Lanini, *Avoiding Weed Shifts and Weed Resistance in Roundup Ready Alfalfa Systems,* University of California Division of Agriculture and Natural Resources Publication 8362 (2009)

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Division of Agriculture and Natural Resources

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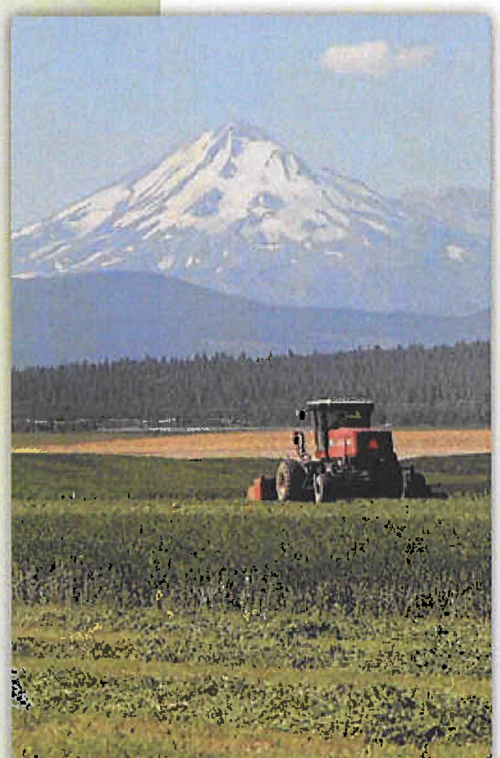
PUBLICATION 8362 / FEBRUARY 2009

Avoiding Weed Shifts and Weed Resistance in Roundup Ready Alfalfa Systems

STEVE B. ORLOFF, University of California Cooperative Extension Farm Advisor, Siskiyou County; **DANIEL H. PUTNAM,** Extension Agronomist, Department of Plant Sciences, University of California, Davis; **MICK CANEVARI,** University of California Cooperative Extension Farm Advisor, San Joaquin County; and **W. THOMAS LANINI,** UC Cooperative Extension Weed Ecologist, Department of Plant Sciences, University of California, Davis

OVERVIEW

Weeds present a continual challenge for profitable alfalfa production. The Roundup Ready (RR) production system, using transgenic alfalfa, has the potential to simplify weed management by improving broad-spectrum control of both annual and difficult-to-control perennial weeds. The use of glyphosate, in combination with transgenic crops, has proven to be a reliable weed control strategy.



However, weed species shifts and the selection for glyphosate-resistant weeds can result from the increased use of this technology if the crop is not managed properly from the outset. Aspects of the alfalfa production system both favor and discourage the occurrence of weed shifts and the evolution of resistant weeds. Alfalfa is a competitive perennial crop that is cut multiple times per year, making it difficult for most weeds to become established. On the other hand, the RR alfalfa system may be vulnerable to weed shifts and resistant weeds for several reasons: tillage typically only occurs between crops, alfalfa is produced over a wide geographical area and in large fields with a great diversity of weeds, and there is potential for long-term repeated use of a single herbicide because it is a perennial crop. In this publication we recommend an integrated weed management system designed to prevent the proliferation of tolerant or resistant weeds. Elements include crop rotation, rotations with herbicides of different modes of action (preferably soil-residual herbicides), tank mixtures, and irrigation and harvest timing. Successful adaptation of these concepts into production systems would assure the long-term effectiveness and sustainability of the Roundup Ready system in alfalfa. A preemptive approach is warranted; these strategies should be employed before weed shifts and weed resistance occur.

IMPORTANCE OF WEED CONTROL IN ALFALFA

Alfalfa, the queen of forages, is the principal forage crop in the United States and frequently the third most important crop in value. It is a vital component of the feed ration for dairy cows and is a principal feed for horses, beef cattle, sheep, and other livestock. Because animal performance depends upon the palatability and nutritional value of alfalfa, livestock managers, especially those in the dairy and horse industry, expect high-quality hay. Although many factors influence quality, the presence of grassy and broadleaf weeds (of low forage quality) plays a significant role in reducing the feeding value of hay throughout the United States. Weeds that accumulate nitrates or are poisonous to livestock are also a major concern in alfalfa, since poisonous weeds sicken or kill animals every year (Puschner 2005). Most livestock producers demand weed-free alfalfa for optimum quality and maximum animal performance.

Weed-free alfalfa can be difficult to achieve, whether using nonchemical methods or conventional herbicides. Typically, no single herbicide controls all weeds present in a field, and some weeds—especially perennials—are not adequately controlled with any of the currently registered conventional herbicides. Cultural practices such as modifying harvest schedules, grazing, time of planting, and use of nurse crops such as oats (*Avena sativa* L.) help suppress weeds; however, these practices are almost never entirely effective and some of them suppress alfalfa seedling growth. In addition to being difficult to achieve, complete weed control in alfalfa is costly. Alfalfa growers continually seek ways to enhance the level of weed control while minimizing costs.

Roundup Ready technology was a major development in alfalfa weed control, providing growers with a useful weed management tool and a means to deal with some of the most difficult-to-control weed species.

THE ROUNDUP READY ALFALFA TECHNOLOGY

Glyphosate (Roundup) is generally considered the most effective broad-spectrum post-emergence herbicide available. The first commercially available glyphosate-resistant crops were soybean, canola, cotton, and corn, which were released in 1996, 1997, 1997, and 1998, respectively. Glyphosate-resistant or Roundup Ready alfalfa (RR alfalfa) was developed through biotechnology in late 1997 and became commercially available in the fall of 2005. This technology imparts genetic resistance to glyphosate by inserting a single gene from a soil bacterium into alfalfa. These biotechnology-derived alfalfa plants have an altered enzyme that allows them to tolerate a glyphosate application while susceptible weeds are killed. Glyphosate resistance is the first commercially available, genetically engineered (GE) trait in alfalfa.

This technology was a major development in alfalfa weed control, providing growers with a useful weed management tool and a means to deal with some of the most difficult-to-control weed species. Researchers have evaluated its effectiveness as a weed control strategy (Canevari et al. 2007; Sheaffer et al. 2007; Steckel et al. 2007, Van Deynze et al. 2004). The advantages and disadvantages of this technology have been reviewed (Van Deynze et al. 2004). Glyphosate was found to be especially effective for weed control in seeding alfalfa (Canevari et al. 2007). Glyphosate typically causes no perceptible crop injury, is much more flexible and less restrictive in application, and provides superior weed control across a range of weed species when compared with other currently used herbicides. One of the greatest advantages of this technology is that it provides a tool for suppressing perennial weeds such as dandelion (*Taraxacum officinale*), yellow nutsedge (*Cyperus esculentus* L.), bermudagrass (*Cynodon dactylon* (L.) Pers.), and quackgrass (*Elytrigia repens* (L.) Nevski) that have not been adequately controlled with conventional practices.

After deregulation of this trait in 2005, over 300,000 acres of RR alfalfa were planted in the United States, about 1.4 percent of U.S. acreage. (For equivalents between U.S. and metric systems of measurement, a conversion table is provided at the end of this publication.) However, in the spring of 2007, further plantings were suspended pending the outcome of a legal challenge and further environmental analysis by the U.S. Department of Agriculture's Animal and Plant Health Inspection Service (USDA-APHIS). There were two key issues in this process: the possibility of contamination of organic and conventional alfalfa through the adventitious presence of the gene, and the possibility of a greater level of weed resistance due to the adoption of the Roundup Ready technology in alfalfa (USDA 2008).

Grower experience in commercial fields following deregulation confirmed many of the benefits that early research had suggested in terms of the efficacy and safety of the RR system (Van Deynze et al. 2004). Growers have generally found that this technology is easy to use and provides superior weed control and improved forage quality in many cases compared with conventional herbicides. However, no new technology is a panacea, and, like other weed control strategies, RR alfalfa has its limitations. An important limitation of this new weed-management system is the potential for weed shifts and weed resistance. This publication discusses techniques that are available to manage the possibility of weed shifts and weed resistance occurring in Roundup Ready alfalfa weed control systems.

WEED SHIFTS AND WEED RESISTANCE

Change in weed populations as a result of repeated use of a single herbicide is not a new phenomenon. Such changes result from shifts in the weeds present from susceptible to tolerant species, or conversion of a population within a species to resistant individuals, as a consequence of selection pressure (Holt and LeBaron 1990; Prather et al. 2000).

Weed Shift

A weed shift refers to a change in the relative abundance or type of weeds as a result of a management practice (fig. 1). The management practice could be herbicide use or any other practice such as tillage, manure application, or harvest schedule that brings about a change in weed species composition.

In the case of chemical weed control, no single herbicide controls all weeds, as weeds differ in their susceptibility to an herbicide. Susceptible weeds are largely eliminated over time with continued use of the same herbicide. This allows inherently tolerant weed species to remain, which often thrive and proliferate with the reduced competition. As a result, there is a gradual shift to tolerant weed species when practices are continuously used that are not effective against those species. A weed shift does not necessarily have to be a shift to a different species. For example, with a foliar herbicide without residual activity like glyphosate, there could also be a shift within a weed species to a late-emerging biotype that emerges after application. In the case of weed shifts, the total population of weeds does not necessarily change as a result of an herbicide or an agronomic practice; these practices simply favor one species (or biotype) over another.

Weed Resistance

In contrast to a weed shift, weed resistance is a change in the population of weeds that were previously susceptible to an herbicide, turning them into a population of the same species that is no longer controlled by that herbicide (fig 2).

Figure 1. Weed shifts due to herbicide application. A weed species shift occurs when both susceptible and tolerant weed species are present in a field. After continued use of a single herbicide, the susceptible weed species is nearly eliminated. The tolerant weed species survives and proliferates, eventually becoming the prevailing species. In this example, a shift to a broadleaf weed is favored by use of a grass herbicide.

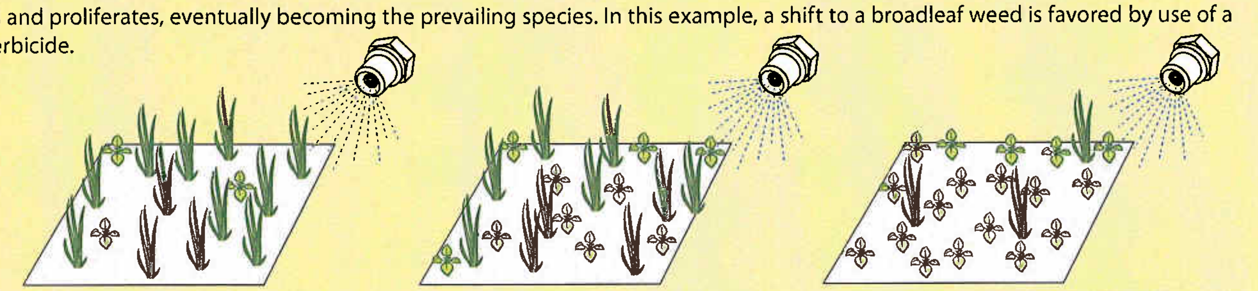
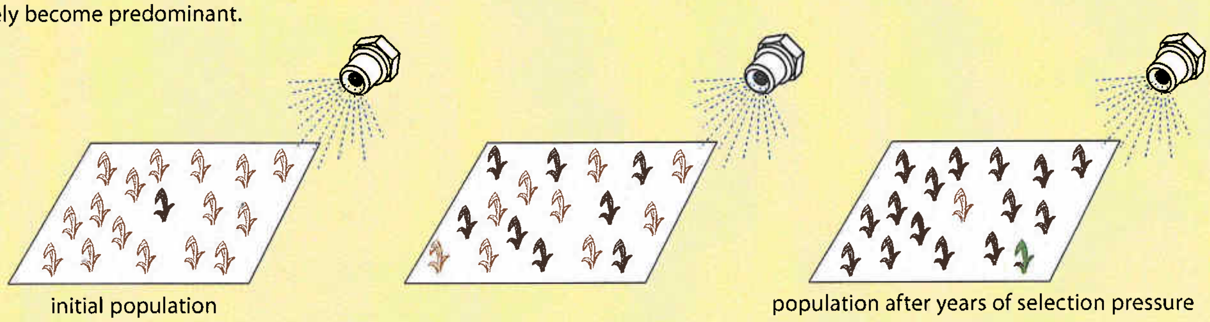


Figure 2. Evolution of herbicide resistance due to selection pressure. An herbicide controls susceptible weeds, preventing them from reproducing and leaving only those individuals carrying the genes for resistance. Typically an extremely small percentage of the weed population initially possesses the genes for resistance. These altered genes are thought to exist in weed populations at very low frequencies. As repeated use of an herbicide controls the susceptible individuals, the resistant weeds continue to multiply and ultimately become predominant.



While weed shifts can occur with any agronomic practice (crop rotation, tillage, frequent harvests, or use of particular herbicides), the evolution of weed resistance is only the result of continued herbicide application. The use of a single class of herbicides continually over time creates selection pressure so that resistant individuals of a species survive and reproduce, while susceptible ones are killed.

Which Is More Important, Weed Shifts or Weed Resistance?

A weed species shift is far more common than weed resistance, and ordinarily takes less time to develop. If an herbicide does not control all the weeds, the tendency is to quickly jump to the conclusion that resistance has occurred. However, a weed shift is a far more likely explanation for weed escapes following an application of glyphosate. See table 1 for a list of weeds sometimes found in alfalfa fields that are tolerant to or difficult to control with glyphosate.

Table 1. Annual weeds encountered in alfalfa fields that are potential candidates for weed shifts in continuous glyphosate systems

Latin name	Common name
*Brassica nigra**	black mustard
Chenopodium album†	lambsquarters
Echinochloa colona†	junglerice
Epilobium	Willowherb, panicle
*brachycarpum**	willowherb, panicle
*Eragrostis**	lovegrass
Erodium spp.†	filaree
Lamium amplexicaule†	henbit
Lolium multiflorum†‡	ryegrass
*Malva parviflora**	malva (cheeseweed)
Polygonum convolvulus†	wild buckwheat
Polygonum spp.†	knotweeds
Portulaca oleracea†	purslane
Sonchus oleraceus†	annual sowthistle
*Trifolium spp.**	clover
*Urtica urens**	burning nettle

Note: This table includes weeds that are listed as susceptible on the label but are difficult to control and weeds which are not controlled by glyphosate.
*Glyphosate-tolerant weeds—not listed as controlled on product label.
†Difficult to control weeds.
‡Glyphosate-resistant biotype has been confirmed.

Are Weed Shifts or Weed Resistance Linked Only to Genetically Engineered Crops?

A common misconception is that weed resistance is intrinsically linked to genetically engineered (GE) crops. However, this is not correct. The occurrence of weed shifts and weed resistance is not unique to genetically engineered crops. Weed shifts and resistance are caused by the practices that may accompany a GE crop (for example, repeated use of a single herbicide), not the GE crop itself. Similarly, some people believe that herbicide resistance is transferred from the GE crop to weed species. However, unless a crop is genetically very closely related to a naturally-occurring weed, weed resistance cannot be transferred from crop to weed. In the case of alfalfa, there are no known wild plants that cross with alfalfa, so direct transfer of herbicide resistance through gene flow to weedy species will not occur. However, the glyphosate-tolerant genes from RR alfalfa can be transferred to feral (wild) alfalfa plants if cross pollination occurs.

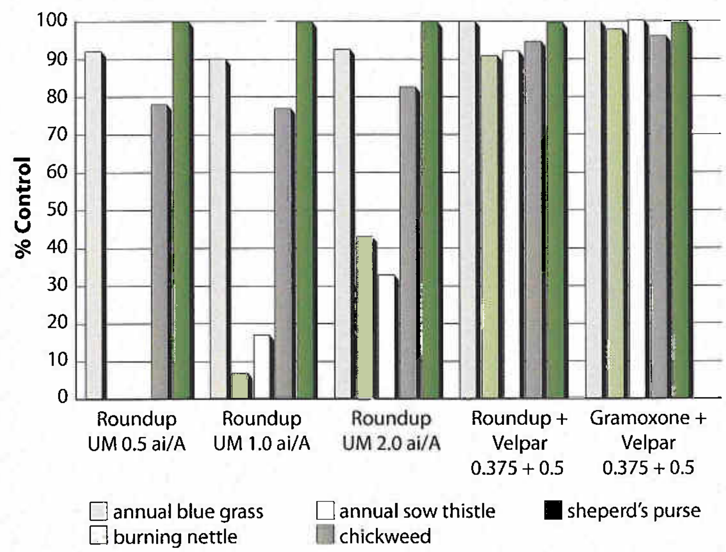
Link to Management Practices

The development of weed shifts or the evolution of weed resistance in cropping systems is primarily a result of management practices, not the crop itself. Continued use of the same management practice, in this case the use of a single herbicide, increases the probability of a weed shift or the evolution of resistant weeds as a result of constant selection pressure. For example, if the herbicide diuron (Karmex) is used alone for several years in established alfalfa, susceptible weeds are controlled. However, there is likely to be an increase in tolerant weeds such as common groundsel (*Senecio vulgaris*), Persian speedwell (*Veronica persica*), and others. Similarly, if imazethapyr (Pursuit) is used repeatedly for several years without rotating with other herbicides, there is likely to be an increase in the population of prickly lettuce (*Lactuca serriola*), annual sowthistle (*Sonchus oleraceus*), and many grassy weeds that are not controlled by this herbicide. Rigid ryegrass (*Lolium rigidum*) and horseweed (*Conyza canadensis*) resistance to glyphosate was the outcome of repeated glyphosate applications in California orchards and noncrop settings, respectively. Weed shifts and weed resistance are not new; evolved resistance was first reported in the 1970s and now occurs with a range of herbicide classes (Holt and LeBaron 1990; Heap 1999; Heap 2008).

RR Crops Present a Challenge

Transgenic herbicide-resistant crops do, nonetheless, have greater potential to foster weed shifts and resistant weeds since a grower is more likely to use a single herbicide repeatedly in herbicide-resistant crops such as RR alfalfa. Additionally, the accumulation of acreage of different RR crops (corn, soybean, and cotton) could increase the potential for weed shifts or weed resistance in cropping systems utilizing RR crops. This is because the probability of repeated use of the

Figure 3. Weed control 69 days after treatment in an established stand of Roundup Ready alfalfa, San Joaquin County, California, 2004.



same herbicide is higher and the potential applied acreage (and therefore the size and genetic diversity of the weed population) is greater. Fortunately, there are simple methods available to prevent weed shifts and weed resistance from occurring.

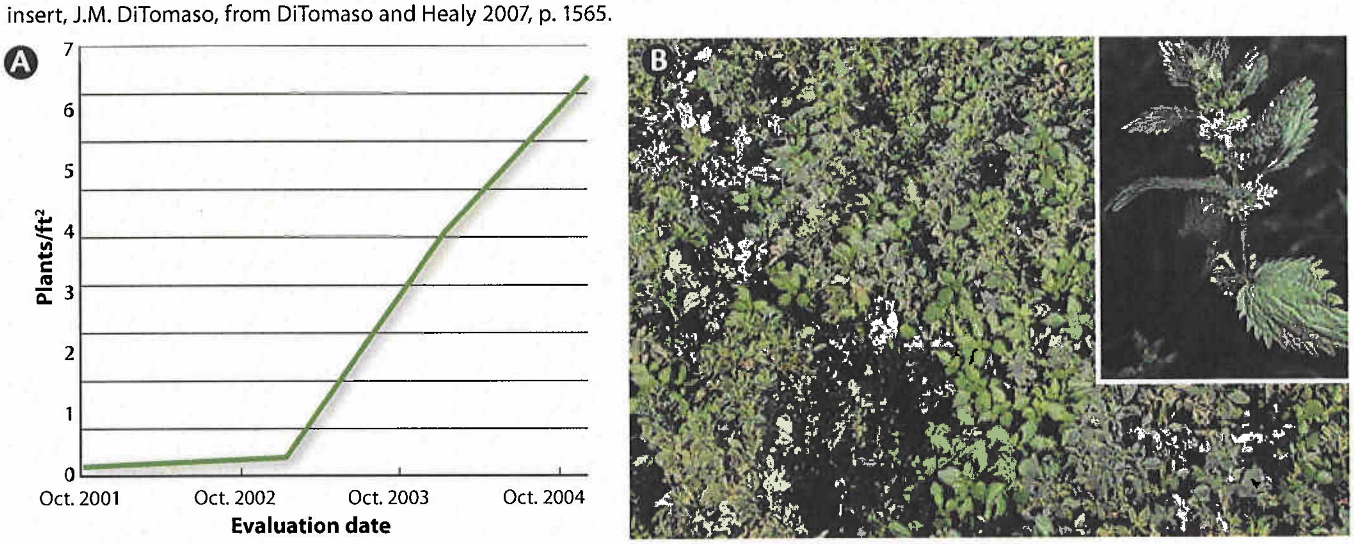
In studies conducted in San Joaquin County, California, weeds shifts were found to occur during the first few years of use when glyphosate-tolerant weeds were present (Van Deynze et al. 2004). Annual bluegrass and shepherd's purse were adequately controlled with glyphosate, whereas chickweed control was about 80 percent and burning nettle and annual sowthistle were not adequately controlled with any of the glyphosate rates (fig. 3). During the 3 years of this field trial, when glyphosate was used repeatedly, there was a gradual weed species shift away from annual bluegrass and shepherd's purse to higher populations of burning nettle and annual sowthistle (figs. 4A and 4B). A tank mix of glyphosate and Velpar, or a rotation to Velpar and Gramoxone, was needed to adequately control all weed species at this location.

To our knowledge there have been no documented cases of weed resistance in alfalfa during the first 3 years of RR alfalfa production (2005 to 2008) in the United States.

WEED SHIFTS AND RESISTANCE WITH RR ALFALFA

The possibility of weed shifts and weed resistance is a concern with RR alfalfa. This is due to its perennial growth habit, its long stand life, and the potential for repeated use of a single herbicide over several years without crop rotation. Although some stands last 3 to 4 years, it is common in many areas of the United States to keep an alfalfa stand in production for 5 to 7 years or longer. If the rotation crop (e.g. a grain crop) is not treated with an herbicide, an even longer period of time without herbicide diversity could occur. In this instance, weed populations could slowly return to preglyphosate composition, but the new species or resistant biotypes would not disappear. In areas where alfalfa is rotated with transgenic RR corn, cotton, or soybean varieties, this

Figure 4. (A): Increase in burning nettle population in Roundup Ready alfalfa with repeated annual applications of glyphosate alone, San Joaquin County, California, 2006. **(B):** Plot overtaken with burning nettle after 3 years of continual glyphosate use. *Photos:* Mick Canevari; insert, J.M. DiTomaso, from DiTomaso and Healy 2007, p. 1565.



again could result in a prolonged time period where a single herbicide is used repeatedly.

There are aspects of the alfalfa production system that both favor and discourage the development of weed shifts and the evolution of resistant weeds.

Attributes of Alfalfa That Favor Weed Shifts and Resistance

First, crop rotation opportunities with a perennial crop like alfalfa are significantly reduced compared with annual cropping systems. Mechanical weed control, such as cultivation, is impractical in a solid-seeded perennial crop like alfalfa, and hand weeding is not economical. Alfalfa is grown over extensive acreage in the United States and fields can be large in size; therefore, the overall weed flora available for selection of resistant traits or for weed shifts is plentiful. Perennials like alfalfa, if sprayed repeatedly with the same herbicide, are likely candidates for weed shifts and weed resistance.

Attributes of Alfalfa That Discourage Weed Shifts and Resistance

On the other hand, many weeds do not flourish in an alfalfa field due to its perennial nature and the competitiveness of the crop after establishment. Alfalfa is an aggressive competitor with most weeds, which fail to establish in alfalfa fields due to the crop's vigorous growth and shading ability. In addition, many weed species do not tolerate the frequent cutting that occurs in alfalfa fields. The lack of soil disturbance once the alfalfa stand is established also reduces opportunities for germination of some weed species. Furthermore, the interval between alfalfa cuttings is short enough that seed production for many weeds is reduced compared with annual crops that allow completion of the weeds' life cycles.

Risk of Resistance Generally Lower with Glyphosate Than with Other Herbicides

Weed shifts or resistant weeds are unavoidable and will occur eventually with any herbicide used repeatedly, and the same is true with the use of glyphosate (Heap 1999). Fortunately, resistance to glyphosate is not as common as resistance to many other herbicides, such as acetolactate synthase (ALS) and acetyl-CoA carboxylase (ACCase) herbicides that have a single binding site and single target enzyme mechanisms of action (Heap 2008). The relatively low rate of resistance in weeds to glyphosate relative to the widespread use of this chemical has not been fully explained, but may be due to the number or frequency of mutations that may be required to confer resistance to glyphosate. Two resistance mechanisms, a weak target site mutation, and a reduced glyphosate translocation mechanism have been documented in weed species that have evolved resistance to this herbicide (Powles and Preston 2006).

Regardless of the mechanism, weed resistance to glyphosate is not as common as resistance to other herbicides. However, cases of weed resistance to glyphosate have been documented and are increasing. There is a range of species across the world with documented resistance to glyphosate (table 2). Fortunately, most of these species are not common in alfalfa fields. Two weed species in particular have evolved resistant populations in California: *Lolium* spp. (ryegrass) and *Conyza* sp. (marestail). The latter is not important in alfalfa, but ryegrass is frequently found in alfalfa fields. Glyphosate-resistant ryegrass is increasing in the Sacramento Valley and northern San Joaquin Valley of California and may become problematic during fall stand establishment of RR alfalfa.

Weed shifts and/or weed resistance have occurred with the other transgenic RR crops released before RR alfalfa (Duke and Powles 2008). Weed resistance is of greater concern than weed shifts and has occurred in RR soybean, cotton, and corn in less than a decade after their initial release (see table 2). Alfalfa growers can learn from experience with these crops and in noncrop areas as a preemptive measure to avoid, or at least minimize, the problems with weed shifts and weed resistance. These problems are sure to occur in alfalfa if proper weed management practices are not followed.

Alfalfa growers can learn from experience with other RR crops and in noncrop areas as a preemptive measure to avoid, or at least minimize, the problems with weed shifts and weed resistance.

WEED MANAGEMENT PRINCIPLES TO REDUCE WEED SHIFTS AND RESISTANCE IN ALFALFA

Glyphosate-resistant crops have provided growers with an easy-to-use, low-cost, and effective weed management tool. However, the effectiveness of weed control systems using RR crops can make growers complacent in their weed control practices. Even though this technology is highly effective, growers must follow sound weed management principles to prevent short- or long-term weed shifts or weed resistance from occurring. This includes weed identification, crop rotation, attention to application rate, proper timing of application, herbicide rotation, and tank mixtures.

Weed Identification

Effective weed management practices begin with proper identification to assess the competiveness of the weeds present and to select the proper herbicide if one is needed. A weed management strategy to prevent weed shifts and weed resistance requires knowledge of the composition of weeds present. Identification of young seedlings is particularly important because seedling weeds are easier to control. Resources for weed identification can be found at the UC IPM Web site (http://www.ipm.ucdavis.edu/PMG/weeds_common.html) and at the UC Weed Research and Information Center Web site (http://wric.ucdavis.edu/information/information.html).

Table 2. Glyphosate-resistant weed populations

Resistant weed	Common name	Location of resistant populations	Situation(s)	Year first reported
UNITED STATES			(In the U.S.)	
Amaranthus palmeri	Palmer amaranth	Arkansas, Georgia, North Carolina, Mississippi, Tennessee	corn, cotton, soybean	2005
Amaranthus rudis	common waterhemp	Illinois, Kansas, Minnesota, Missouri	corn, soybean	2005
Ambrosia artemisiifolia	common ragweed	Arkansas, Kansas, Missouri	soybean	2004
Ambrosia trifida	giant ragweed	Arkansas, Indiana, Kansas, Minnesota, Ohio, Tennessee	cotton, soybean	2004
Conyza bonariensis	hairy fleabane	California	roadsides	2007
Conyza canadensis	horseweed (marestail)	17 states including California	cotton, nurseries, road-sides (in CA), soybean	2000
Lolium multiflorum	Italian ryegrass	Mississippi , Oregon	cotton, orchards, soybean	2004
Lolium rigidum	rigid ryegrass	California	orchards	1998
Sorghum halepense	Johnsongrass	Arkansas	soybean	2007
WORLD			(in the world)	
Conyza bonariensis	hairy fleabane	Brazil, Colombia, South Africa, Spain	corn, orchards, soy-bean, vineyards, wheat	2003
Conyza canadensis	horseweed (marestail)	Brazil, China, Czech Republic, Spain	orchards, soybean, railways	2005
Digitaria insularis	sourgrass	Brazil , Paraguay	soybean	2006
Echinochloa colona	junglerice	Australia (New South Wales)	cropland	2007
Eleusine indica	goosegrass	Colombia , Malaysia	cropland , orchards	1997
Euphorbia heterophylla	wild poinsettia	Brazil	soybean	2006
Lolium multiflorum	Italian ryegrass	Argentina, Brazil, Chile, Spain	cropland orchards, soybean	2001
Lolium rigidum	rigid ryegrass	Australia, France, South Africa, Spain	asparagus, orchards, railways, sorghum, vineyards, wheat	1996
Plantago lanceolata	buckhorn plantain	South Africa	orchards, vineyards	2003
Sorghum halepense	Johnsongrass	Argentina	soybean	2005
Urochloa panicoides	liverseedgrass	Australia (New South Wales)	sorghum, wheat	2008

Source: International Survey of Herbicide Resistant Weeds, adapted from Heap 2008.

Frequent Monitoring for Escapes

It is difficult to detect an emerging weed shift or weed resistance problem if fields are not frequently monitored for weeds that escape current weed management practices. Identification and frequent monitoring can detect problem weeds early and guide management practices, including herbicide selection, rate, and timing.

Herbicide Rate and Timing

It is important to use the appropriate rate and timing for the weeds present. For example, some weeds that are considered somewhat tolerant to glyphosate (cheeseweed, filaree, and purslane) can be controlled effectively in seedling alfalfa with glyphosate, provided the proper rate is used and the application is made when the weeds are very small. Research in Nebraska over a 7-year period (Wilson 2004) demonstrated a rapid increase in lambsquarters when a low rate of glyphosate (0.5 lb ai/acre) was applied, but a higher rate (1.0 lb ai/acre) successfully controlled this weed. Just like with traditional weed management programs, the grower must be sure to use the recommended rate for the weed species present and treat at the appropriate time when the weeds are still small.

Crop Rotation

One of the most effective practices for preventing weed shifts and weed resistance is crop rotation, which allows growers to modify selection pressure imposed on weeds. Continuous (also called back-to-back) alfalfa is not recommended for other agronomic reasons, but especially would be ill advised when it comes to management of resistance and weed shifts. Crops differ in their ability to compete with weeds; some weeds are a problem in some crops, while they are less problematic in others. Rotation therefore would not favor any particular weed spectrum. Crop rotation also allows the use of different weed control practices, such as cultivation and application of herbicides with different sites of action. As a result, no single weed species or biotype should become dominant. The effectiveness of crop rotation to manage weed shifts and resistance is substantially reduced if another RR crop (such as corn or cotton) is planted in rotation with RR alfalfa, since the same herbicide and selection pressure would likely occur.

Using an effective herbicide with a different mode of action from the one to which the weeds are resistant controls both the susceptible and resistant biotypes, thus preventing reproduction and slowing the spread of the resistant biotype.

Agronomic Practices

In addition to crop rotation, several management practices may have an impact on the selection of problem weed populations. If problem weeds germinate at a specific time of year, crop seeding date can be shifted to avoid these weed populations, allowing a vigorous alfalfa crop to develop that is capable of outcompeting weeds. Delaying irrigation after alfalfa cutting can reduce germination of certain summer annual weeds. However, this practice only works on some soil types, and water stress in alfalfa can reduce yields. Harvest management can, in some cases, assist in eliminating or suppressing problem weed populations, but harvests must occur before weed seed production to prevent weed proliferation.

Rotation of Herbicides

Weed shifts occur because herbicides are not equally effective against all weed species and herbicides differ greatly in the weed spectrum they control. A weed species that is not controlled will survive and increase in density following repeated use of one herbicide. Therefore, rotating herbicides is recommended. Rotation of herbicides reduces weed shifts, provided the rotational herbicide is highly effective against the weed species that is not controlled with the primary herbicide. The grower should rotate to an herbicide with a complimentary spectrum of weed control, along with a different mechanism of action and therefore a different herbicide binding site. Weed susceptibility charts are useful to help develop an effective herbicide rotation scheme (Canevari et al. 2006). In addition, publications on herbicide chemical families are available to assist growers in choosing herbicides with different mechanisms of action (Retzinger and Mallory-Smith 1997).

Rotating herbicides is also an effective strategy for resistance management. Within a weed species there are different biotypes, each with its own genetic makeup, enabling some of them to survive a particular herbicide application. The susceptible weeds in a population are killed, while the resistant ones survive, set seed, and increase over time. Using an effective herbicide with a different mode of action from the one to which the weeds are resistant, however, controls both the susceptible and resistant biotypes. This prevents reproduction and slows the spread of the resistant biotype.

Herbicide Tank Mixtures

For the same reasons that rotating herbicides is effective, tank mixing herbicides is also recommended. The key is to select tank mix partners that have different target sites and that compliment each other so that, when combined, they provide complete or nearly complete weed control.

RECOMMENDED WEED MANAGEMENT PROGRAM FOR RR ALFALFA

The cost of RR alfalfa seed, including the technology fee, is generally twice or more than that of conventional alfalfa seed. Naturally, growers will want to recoup their investment as quickly as possible. Therefore, considerable economic incentive exists for the producer to rely solely on repeated glyphosate applications alone as a weed control program. Some producers may even be inclined to shave the rates to the minimum amount that would provide acceptable weed control. While relying solely on glyphosate and shaving rates may provide satisfactory results in the short term, it is a risky practice in the long run as it will accelerate weed species shifts and the evolution of resistant weeds. Sound weed management practices should be employed to maintain the effectiveness of the RR technology.

Roundup Ready alfalfa is still a relatively new technology, so there has been limited field experience with it to date. The following are some suggestions to consider based upon proven resistance management strategies, our understanding of alfalfa production practices, and our initial experience with RR alfalfa. Ultimately, growers and pest control advisors hold the key to avoiding weed shifts and resistance by reducing selection pressure, which is accomplished by developing a weed management program that does not rely solely on the continuous use of glyphosate. Any management practice that reduces the selection pressure (in this case, the selection pressure imposed by continual use of the same herbicide) will help avoid weed species shifts and resistance.

For Seedling Alfalfa, Use Glyphosate Alone or in a Tank Mix Combination

Seedling alfalfa is most vulnerable to weed competition because weeds are often more vigorous and competitive than young alfalfa. Additionally, complete weed control in seedling alfalfa is often difficult to achieve and frequently requires tank mixes of different herbicides to control the broad spectrum of weeds found in an individual field. Yield and stand loss from weed competition, and injury from conventional herbicides, are usually far greater in seedling than in established alfalfa. Numerous field trials throughout the United States have proven the effectiveness of RR alfalfa for stand establishment. Superior weed control with no perceptible alfalfa injury has occurred in most studies. Therefore, it is only logical to use glyphosate for weed control in RR seedling alfalfa for the cost savings, improved weed control, reduced crop injury, superior stand establishment, and the elimination of the small percentage of alfalfa seedlings (commonly called nulls) that do not carry the RR gene. Delayed removal of these nulls may cause weed control problems in the future by creating open spaces for weeds to grow.

Ordinarily, 1.0 pound per acre active ingredient of glyphosate is sufficient for weed control during the seedling period. However, a higher rate may be needed if the field contains some of the more tolerant weeds listed in table 1. A tank mix may be advised if especially-difficult-to-control weeds are present. For example, a tank mix of glyphosate with imazamox (Raptor) or imazethapyr (Pursuit) may be advised if burning nettle is present, or a tank mix with clethodim (Prism) will be necessary if the field or surrounding area is known to have glyphosate-resistant ryegrass.

Rotate or Tank Mix Herbicides at Least Once During the Life of an Alfalfa Stand

Alfalfa stand life varies considerably throughout the western United States depending on the production area, grower practice, and the existence of profitable rotation crop options. A stand life of 3 to 5 years is common in the Central Valley of California and other warm, long growing-season areas of the Southwest. A stand life of 5 to 7 years is common in much of the Northwest, and some alfalfa stands remain in production in excess of 10 years. As suggested by the principles outlined above, it is unwise to rely solely on glyphosate applications for weed control throughout the life of a transgenic alfalfa field. This practice would encourage weed shifts and resistance, and over time weed control would diminish in most cases. Once an herbicide is rendered ineffective as a result of resistant weeds, its usefulness as a weed control tool may be greatly diminished. After a resistant weed population has gained a foothold, it is practically impossible to eliminate it due to the presence of a weed seedbank.

Most alfalfa producers apply an herbicide to alfalfa during the dormant season to control winter annual weeds that infest the first cutting. It is strongly recommended that growers not rely solely on glyphosate for their winter weed control program for the duration of the stand. They should rotate to another herbicide or tank mix at least once in the middle of the life of a stand, and perhaps twice if the stand life is over 5 years (table 3).

Use an Herbicide with a Different Mode of Action

Fortunately, all of the herbicides currently registered in alfalfa—and there are several to choose from—have

Table 3. Comparison of weed management strategies for glyphosate-resistant alfalfa using continuous glyphosate applications versus a recommended approach where glyphosate is rotated with other herbicides during a 4-year alfalfa stand

Year	Objective	Season	Continuous glyphosate strategy	Rotational herbicide strategy
Seedling	control weeds that compete during stand establishment	fall	glyphosate	glyphosate
1	control late-emerging weeds during establishment	winter (late)	glyphosate	glyphosate*
	summer annual weed control may not be needed first year	spring		
		summer		
		fall		
2	control winter annual weeds and/or pre-emergence control of summer weeds	winter	glyphosate	soil residual herbicide or tank mix* of soil residual herbicide with glyphosate†
	summer annual weed control/dodder	spring		
		summer	glyphosate	
		fall		
3	control winter annual weeds and/or pre-emergence control of summer weeds	winter	glyphosate	soil residual herbicide or tank mix* of soil residual with gly-phosate†
	control summer annual grassy weeds/ dodder	spring	glyphosate	
		summer (mid)	glyphosate	
		fall		
4	control winter annual weeds	winter	glyphosate	glyphosate
	control summer annual grassy weeds/ dodder	spring	glyphosate	
		summer (mid)	glyphosate	glyphosate
	(stand take-out)	fall (late)	tillage and/or 2,4-D + dicamba as necessary	tillage and/or 2,4-D + dicamba as necessary
(4 years)	**Total number of glyphosate applications**		**10**	**4–6**

Note: A combination of soil residual herbicides and different modes of action is recommended to prevent weed shifts and herbicide resistance. These are examples only—appropriate strategies should be modified for different regions and weed pressures.

*Tank mixing with another herbicide is advised if significant populations of glyphosate, tolerant weeds such as burning nettle are present.

†Soil residual herbicide (depending on location and weed spectrum, use hexazinone, diuron, or metribuzin) for pre-emergence control of winter annual weeds. An application of a dinitroaniline herbicide (pendimethalin or trifluralin) applied at this time will control summer annual grassy weeds.

a different target site of action than does glyphosate. The soil-residual herbicides applied during the dormant season to established alfalfa [such as hexazinone (Velpar), diuron (Karmex), metribuzin (Sencor), and pendimethalin (Prowl)] would be appropriate herbicides for a rotation or tank-mix partner. The rotation herbicide or tank-mix partner of choice depends on the weeds present in the field and their relative susceptibility to the herbicides. Paraquat (Gramoxone) is another candidate for rotation, but paraquat, like glyphosate, lacks residual activity and is applied late in the dormant season. By rotating paraquat with glyphosate, growers could potentially be selecting for early-emerging weeds that may be too large to control at the typical timing for these herbicides. In addition, they could be selecting for late emerging weeds that germinate after the application.

Rotate Herbicides Early in Stand Life So Glyphosate Remains Effective

Weed control during the last year of an alfalfa stand is often challenging because the stand is typically less dense and competitive and also there are fewer herbicide options from which to choose. There are significant plant-back restrictions associated with many of the soil-residual herbicides used in alfalfa, so glyphosate is a good choice for controlling weeds in the final year of RR alfalfa field. The preference to use glyphosate in the final year of an alfalfa stand underscores the importance of rotating herbicides earlier so that glyphosate will remain effective and continue to control the majority of the weeds.

Consider a Soil-Residual Herbicide for Summer Annual Weed Control

Summer annual grass weeds such as yellow and green foxtail (Setaria spp.), barnyardgrass (*Echinochloa crus-galli*), cupgrass (*Eriochloa* spp.), and jungle rice (*Echinochloa colona*), and less frequently, broadleaf weeds like pigweed (*Amaranthus* spp.) or lambsquarters (*Chenopodium album*), can be problematic in established alfalfa. These weeds emerge over an extended time period whenever soil temperatures and moisture are adequate, typically from late winter or early spring (as early as February in the Central Valley) throughout the summer. Weeds may emerge between alfalfa cuttings, so several applications may be necessary in California's Central Valley for a foliar herbicide without residual activity like glyphosate to provide season-long control.

Multiple applications of a single herbicide during a season is cited as promoting weed resistance. Therefore, growers should not rely solely on glyphosate for summer grass control for multiple seasons. It remains to be seen how many applications of glyphosate will be required for season-long summer grass control. In some of the long growing-season areas of California, as many as two to three applications per season may be needed in older, thinner stands. Rather than making multiple applications of glyphosate, a better approach may be to apply a pre-emergence soil-residual dinitroaniline herbicide like trifluralin (Treflan) or pendimethalin (Prowl), or possibly EPTC (Eptam), and follow up with glyphosate later in the season as needed for escapes. Not only is this approach more in line with management practices to avoid weed shifts and resistance, but it may be more economical as well, compared with multiple applications of glyphosate.

The practice of rotating herbicides or applying tank mixtures is recommended for both dormant applications aimed at winter annual weeds and for spring/summer applications intended to control summer annual weeds. For example, rotating to hexazinone (Velpar) for winter annual weed control for a year does nothing to prevent weed species shifts or the evolution of resistance in the summer annual weed spectrum. Herbicides for summer annual weed control should be rotated as well.

Frequency of Rotation Depends on Weed Species and Escapes

There is no definitive rule on how often herbicides should be rotated. Our suggestion to rotate or tank mix at least once in the middle years of the life of a stand (or more often for long-lived alfalfa stands) may need to be modified depending upon actual observations of evolving weed problems. The key point, which cannot be overemphasized, is the importance of diligent monitoring for weed escapes. Producers should stay alert to the appearance of weed species shifts and evolution of resistant weeds. If the relative frequency of occurrence of a weed species increases dramatically, chances are that it is tolerant to glyphosate and immediate rotation of herbicides or a tank mix is advised. If a few weeds survive among a weed species that is normally controlled easily with glyphosate, it could be an indication of weed resistance, assuming misapplication and other factors can be eliminated as possible causes. Weed resistance should be confirmed by controlled studies conducted by a weed scientist. However, in these situations, it is imperative to prevent reproduction of a potentially resistant biotype. Treat weed escapes with an alternative herbicide or other effective control measure.

CONCLUSIONS

The Roundup Ready alfalfa production system has the potential to simplify weed management, while also improving the spectrum of weed control. However, growers should learn from the experience gained in other crops and stay alert to the occurrence of weed shifts and evolution of resistant weeds. The key is for growers to reduce selection pressure, not to rely on repeated applications of glyphosate year after year, application after application. Well-known management principles are available to manage weed shifts and weed resistance in RR alfalfa. Rotate crops, rotate herbicides, and utilize tank mixes as needed, depending on the weed species and weed escapes present. A grower should not wait for a problem to occur before he or she employs these practices; a preemptive approach is strongly encouraged.

METRIC CONVERSIONS

English	Conversion factor for English to metric	Conversion factor for metric to English	Metric
pound (lb)	0.454	2.205	kilogram (kg)
acre (ac)	0.4047	2.47	hectare (ha)
pound per acre (lb/ac)	1.12	0.89	kilogram per hectare (kg/ha)

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WARNING ON THE USE OF CHEMICALS

Pesticides are poisonous. Always read and carefully follow all precautions and safety recommendations given on the container label. Store all chemicals in their original labeled containers in a locked cabinet or shed, away from foods or feeds, and out of the reach of children, unauthorized persons, pets, and livestock.

Recommendations are based on the best information currently available, and treatments based on them should not leave residues exceeding the tolerance established for any particular chemical. Confine chemicals to the area being treated. THE GROWER IS LEGALLY RESPONSIBLE for residues on the grower's crops as well as for problems caused by drift from the grower's property to other properties or crops.

Consult your county agricultural commissioner for correct methods of disposing of leftover spray materials and empty containers. Never burn pesticide containers.

PHYTOTOXICITY: Certain chemicals may cause plant injury if used at the wrong stage of plant development or when temperatures are too high. Injury may also result from excessive amounts or the wrong formulation or from mixing incompatible materials. Inert ingredients, such as wetters, spreaders, emulsifiers, diluents, and solvents, can cause plant injury. Since formulations are often changed by manufacturers, it is possible that plant injury may occur, even though no injury was noted in previous seasons.

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Appendix
E

Effects of Glyphosate-Resistant Weeds in Agricultural Systems (Appendix G from Draft EIS)

Appendix G. Effects of Glyphosate-Resisant Weeds in Agricultural Systems

Effects of Glyphosate-Resisant Weeds in Agricultural Systems

Executive Summary

Alfalfa is grown for forage, grazing, seed production (forage and sprouts), human consumption, and honey production. The most acreage is for dry hay forage. In 2005, 22,439,000 acres of dry hay alfalfa was harvested and 204,380 (0.9%) of those acres were certified organic. In addition to mechanical and cultivation techniques, conventional farming allows the use of 16 different herbicides to control weeds in alfalfa. Organic farming does not allow synthetic pesticides or the use of crop varieties produced through genetic engineering. Glyphosate-tolerant (GT) alfalfa allows for the application of glyphosate directly onto growing plants, which provides increased options for weed control over conventional and organic systems. GT alfalfa allows for flexibility in timing of glyphosate application to control weeds. In the two years that GT alfalfa seed was on the market ~200,000 acres were planted in 1,552 counties in 48 states.

Alfalfa Growing Regions

The seven growing regions in the United States have varying optimal alfalfa varieties and farming practices, such as frequency of cutting, companion cropping, and irrigation. California, South Dakota, Idaho, Nebraska, Montana, and Wisconsin are the top six alfalfa hay producing states (in 2007). South Dakota, Montana, Wisconsin, and North Dakota, have the largest acreage of alfalfa hay. California's acreage is highly productive.

Crop Rotations

Crop rotation options may be different between conventional and GT farming systems. Many of the non-glyphosate herbicides have follow-up planting restrictions that limit crop rotation choices in conventional farming. Farmers using GT cropping systems are advised to include some years of non-GT crops in rotation, so there may be limitations in the use of other GT crops if GT alfalfa is used in a rotation plan.

Alfalfa Stand Removal

Glyphosate is the primary tool used to remove conventional alfalfa stands. Use of herbicides other than glyphosate for removal of GT alfalfa is a major difference between GT alfalfa and conventional alfalfa. Non-glyphosate herbicides and tillage are recommended for effective GT alfalfa stand removal.

Volunteer Alfalfa

Farmers are not able to use glyphosate to control volunteer GT alfalfa in other GT crops. However, 11 other herbicides and mixtures of those herbicides are available to control volunteer GT alfalfa. These are the same herbicides that are used to control non-GT alfalfa with the exception that glyphosate can be used to control non-GT alfalfa.

Weeds in Alfalfa

Weeds are controlled in conventional alfalfa with chemicals (herbicides), cultural methods (rotation, companion crops, monitoring), and mechanical methods (tillage). The cultural and mechanical methods are permitted for organic farmers. GT systems allow for the use of one additional herbicide, glyphosate. Weeds are undesirable because they compete with crops, leading to lower yields, can lower the nutritional value of crops, can be poisonous or unpalatable to livestock, can cause off flavors in milk, and can cause trouble with bailing. At least 129 different weed species are identified as minor or major problems in alfalfa. Out of 14 new glyphosate resistant weeds found since 1998, eight are known to be weeds in alfalfa. Out of at least 21 weeds that have natural resistance to glyphosate, ten are known to be a problem in alfalfa. These 18 weeds that are both resistant to glyphosate and traditionally listed as problems in alfalfa include: common ragweed, horseweed, Italian ryegrass, Johnsongrass, Palmer Amaranth, buckhorn plantain, goosegrass, junglerice, bermudagrass, burning nettle, cheeseweed, common lambsquarters, field bindweed, filaree, large crabgrass, morningglory, nutsedge, and purslane. Although the composition of weed shifts is based on the local seedbank, these 18 weeds are candidates for becoming more prevalent than glyphosate-resistant sensitive weeds in rotations that include GT alfalfa.

Glyphosate Resistant Weed Distribution

Nineteen states and over two million acres of cropland contain new glyphosate resistant weeds. The heaviest infestation is in the Southeast and Midwest. Overlap with the major alfalfa producing states in the Intermountain regions (Washington, Oregon, Idaho, Montana, Wyoming, Colorado, Utah, Nevada, and parts of California) seems to be minimal at this point. However, given that there is overlap between glyphosate resistant weed locations and alfalfa hay acreage there is potential for rapid shifts of glyphosate resistant weeds into GT alfalfa fields if GT alfalfa were to be widely adopted. California is a concern because glyphosate resistant weeds are present and alfalfa is a major crop in California.

1.0 Introduction

The scope of this report covers how glyphosate-tolerant (GT) alfalfa could impact weed dynamics in agricultural systems. Gene flow from GT alfalfa is covered in another technical report in this series (Appendix J). In this report, different types of alfalfa crops and cropping systems are described. Regional differences in alfalfa farming are summarized and discussed within the context of weed management. Glyphosate resistant weeds and the potential risks from volunteer GT alfalfa are also discussed. This report is limited to weed dynamics in agricultural systems. Potential effects of farming with GT alfalfa on ecosystems is discussed in other technical reports. This report is limited to practices involving weed management and does not include discussion of control of diseases, insects, nematodes, and vertebrate pests and management of field fertility and soil conservation.

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 (e.g., common groundsel, fiddleneck, yellow starthistle, and poison hemlock) can make alfalfa hay unmarketable.
- 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 (either beef or milk).
- Some weeds can contribute to off flavors in milk (wild celery, Mexican tea, creeping swinegrass, and mustards).
- Weeds that contain higher moisture content than alfalfa (dandelion) can cause bail problems such as mold, off-color hay, and high bale temperatures, which are a fire hazard.

Without weeds, alfalfa can grow at a density of about 12 plants per square foot. Heavily infested stands can have less than one alfalfa plant per square foot (Canevari et al., 2007). In California, if weeds are not effectively controlled weeds can represent up to 76 percent of the first cutting yields (Gianessi et al, 2002). The limiting factor for weed control in alfalfa is that, by the time alfalfa reaches the stage of growth that is tolerant to herbicides, weeds are also beyond their susceptible stage (Gianessi et al., 2002). Glyphosate-tolerant alfalfa was developed so that the broad spectrum herbicide, glyphosate, could be applied directly to alfalfa fields to control weeds. The glyphosate-tolerant (GT) trait was introduced through genetic engineering. Although glyphosate-tolerance has arisen naturally in some plants due to decades of glyphosate use, so far, all crops with glyphosate-tolerance have had the trait introduced through genetic engineering.

1.1 Methodology

A literature search was designed to identify peer review articles and grey literature (e.g., government reports, State Agricultural Extension Office publications) on weeds in alfalfa (Appendix G-2 of this technical report). Several DIALOG databases were searched. Google, Google Scholar, Scirus, and Yahoo search engines supplemented the DIALOG search. Calculations for percentages of harvest were done with Microsoft Excel. Alfalfa harvest statistics were obtained from USDA's National Agricultural Statistics Service (http://www.nass.usda.gov/index.asp). In addition, USDA's Economics, Statistics and Market Information System (ESMIS), which is a collaborative project between Albert R. Mann Library at Cornell University and USDA, provided information on alfalfa harvesting (http://usda.mannlib.cornell.edu/MannUsda/homepage.do). USDA's Agricultural Marketing Service also provided information on harvests (http://www.ams.usda.gov). The common and scientific names for weeds (Appendix G-3 of this technical report) were found in the USDA Plants database (http://plants.usda.gov/java/invasiveOne).

2.0 Alfalfa Cropping Systems

This chapter discusses how alfalfa is used, the farming practices for growing alfalfa, and the alfalfa growing regions in the United States.

2.1 Alfalfa Uses

Alfalfa is grown for seed production, human food, honey, grazing, and forage. Forage comprises the largest acreage for alfalfa stands. In 2007, 72.5 million tons of dry hay alfalfa was produced from 21.6 million acres harvested (www.nass.usda.gov).

2.1.1 Forage

Alfalfa is considered the "Queen of Forages" because of its high nutritional content when fed to cattle and horse livestock (Putnam et al., 2001). Due to climate and other differences, farming practices differ regionally. However, some farming characteristics are shared among growing regions. Alfalfa stands have two growing phases, establishment of seedlings (first year) and established (two to eight years). Weed management differs for each phase (Orloff et al., 1997). During the seedling establishment phase, companion or nursery crops, such as oats, wheat, and barley can be used to help shelter the alfalfa seedlings, help prevent soil erosion, and suppress weeds because they germinate and grow faster than alfalfa (Canevari et al, 2007). Well established alfalfa that is not thinning has fewer issues with weeds because established alfalfa is a good competitor. Alfalfa can be harvested (mowed) every 30 to 50 days depending on growth conditions in the region, local weather patterns, and alfalfa variety. In most of the growing regions, alfalfa is only cut three to four times a year, but in the Southwestern U.S. growers can cut up to10 or 11 times per year (Putnam et al., 2001). To determine when to harvest, farmers balance yield and nutritional content. Yield increases as plants grow and peaks at 100% bloom, but nutritional content is highest in young vegetative plants and decreases until full flower. There is no optimal harvest schedule, because farmers make different decisions based on changing market demand. Farmers may choose to harvest between late bud stage and full bloom, however, alfalfa hay production experts recommend cutting alfalfa for hay at 10% bloom, as this stage provides the most valuable and nutritious forage (e.g., Sheaffer et al. 2000). . The highest quality hay (bud stage) is generally used for active dairy cows. Whereas hay that is lower in protein and higher in fiber, is fed to beef cattle, horses, heifers (too young to milk) and non-lactating dairy cows (Ball et al., no year). Alfalfa for livestock feed can be stored in a variety of forms:

- Hay - dry bailed at 18-20% moisture
- Haylage - round bale silage, baled at 50-60% moisture, wrapped in plastic
- Silage - chopped and blown into a silo or a truck

2.1.2 Grazing

Grazing is sometimes used as an alternative to harvesting alfalfa. Grazing allows for high nutritional gains per animal, but the risks include animal losses due to bloating and difficulties in alfalfa stand maintenance if continuous grazing is present. Farmers may choose grazing for dormant-season alfalfa stubble, a substitute for early or late season cutting, and rotational grazing during the growing season. It is strongly recommended that animals not graze before flowering begins. Alfalfa root carbohydrate reserves may not be sufficient if early grazing is permitted and the potential for bloat decreases with flowering (Orloff et al., 1997).

2.1.3 Seed Production (Hay and Sprouts)

Alfalfa is also consumed by humans (e.g., sprouts, dietary supplements, and herbal teas). Sprouts have been the source of several foodborne outbreaks due to bacterial contamination (FDA 1999). Epidemiological investigations suggest that seeds are the likely source in most, if not all, sprout-associated illness outbreaks. Seed grown for sprouts have more stringent restrictions for chemical applications during growing since the chemicals must be evaluated as food residues. Sources of animal waste in fields, such as grazing areas and irrigation water, must also be controlled to reduce the likelihood of pathogens from animal waste coming into to contact with seeds. For these reasons, sprout seed and hay seed are usually grown separately (FDA 1999).

FDA considers GT alfalfa not materially different from conventional alfalfa; therefore it is permitted for human consumption (FDA 2004). However, Monsanto does not allow GT alfalfa to be planted for sprouts (Hubbard 2008). If GT alfalfa was present in human food, it would not be considered adulterated and would not need to be removed from the market.

2.1.4 Honey

Alfalfa and clover are common nectar sources for honey bee hives. Although alfalfa is not specifically grown for bees, both managed and wild bee hives are often associated with alfalfa fields (Hammon et al., 2007).

2.2 Alfalfa Farming Practices

Alfalfa framing practices are broken into three categories, organic, conventional, and glyphosate-tolerant alfalfa. Only aspects of farming related to weed control are discussed. Practices for controlling disease, insects, nematodes, and vertebrate pests and management of field fertility and soil conservation are not discussed.

2.2.1 Organic Farming

For this report, organic production is only those cropping systems that fall under the USDA National Organic Program (NOP) definition of organic farming and are certified organic production systems. In organic systems, the use of synthetic pesticides, fertilizers, and genetically engineered crops is strictly limited. NOP publishes a list of approved substances for organic farming inputs (http://www.ams.usda.gov/AMSv1.0).

GT alfalfa is not approved for use in organic systems because it is genetically engineered and because glyphosate application is not permitted in organic systems.

In organic systems, where herbicides are not permitted, alfalfa is tilled and allowed to sit for seven to ten days. Two or more discing passes may be necessary if weed germination is observed. The field should also be treated with nutrients, such as compost and boron, and left for a week to check for further weed germination. Planting can occur once weed growth potential is minimized (Guerena and Sullivan 2003). Manure fertilizer should be composted to kill weed seeds (Canevari et al., 2007).

2.2.2 Conventional Farming

Conventional farming includes any farming system where synthetic pesticides or fertilizers are used. The definition of conventional farming usually includes the use of genetically engineered crops, but genetically engineered GT alfalfa is considered separately for this report (Harker et al., 2005). Conventional farming covers a broad scope of farming practices, ranging from farmers who only occasionally use synthetic pesticides to those farmers whose harvest depends on regular pesticide and fertilizer inputs. The 16 herbicides that may be used in conventional farming are summarized in table G-1 (based on OMAFRA 2008; Canevari et al., 2007; Rogan and Fitzpatrick 2004; Loux et al., 2007).

Table G-1. Herbicides Used in Conventional Alfalfa Farming

Herbicide (Brand)	Stand Stage	Weed	Notes
2,4-DB (Butyrac, Butoxone)	1-4 trifoliolate or established stands	Prickly lettuce Annual sowthistle Mustards Curly dock	• No harvesting or grazing allowed for 60 days following treatment
Benefin (Balan)	Before seeding	Annual grasses Broadleaf	• Not for use on soils high in organic matter
Bromoxynil (Buctril)	2-4 trifoliolate	Coastal fiddleneck Mustard0s Common groundsel Annual sowthistle	• Often tank mixed with other herbicides
Clethodim (Prism, Select)	2-4 trifoliolate or established stands	Summer grasses Yellow foxtail Green foxtail Barnyardgrass Bermudagrass Johnsongrass Goosegrass Volunteer cereals	• Well established perennials require multiple applications • Allow 15 days between application and grazing, feeding, or harvesting of alfalfa
Diuron (Karmex, Direx)	Established stands	Winter annuals Broadleaf Some grasses	• Persists in soil for one year, so cannot be used in last year of stand
EPTC (Eptam)	Established stands	Summer grasses Nutsedge	• Applied before germination • Controls for 30 to 45 days so repeated applications may be necessary

Hexazinone (Velpar)	6 inches of root growth in new stands or established stands	Broadleaf Grasses Common groundsel Chickweed miners Lettuce annual Bluegrass dandelion Buckhorn plantain Speedwell	• Many crops cannot be planted for 18 months without yield damage
Imazamox (Raptor)	2-4 trifoliolate or established stands	Winter annual Grasses Broadleaf	• Preharvest interval is 20 days
Imazethapyr (Pursuit)	2-4 trifoliolate or established stands	Winter annuals Mustards Shepherd's purse Creeping swinecress Chickweed	• Follow-up planting restrictions range from 4 to 40 months
Metribuzin (Sencor)	Established stands	Lamb's-quarters Wild mustard Redroot pigweed Common ragweed Shepherd's-purse Lady's-thumb Velvetleaf Jimsonweed Prostrate pigweed Russian thistle Yellow wood-sorrel Prickly mallow Chickweed Cocklebur Carpetweed Dandelion seedlings Barnyard grass Crab grass Foxtail Fall panicum Witch grass Johnson grass Cheat grass	• No grazing or harvesting allowed for 28 days following application
Norfluzaon (Solicam)	Established stands	Broadleaf Grasses Nutsedge	• Cannot be applied within 28 days of harvest • Does not control emerged weeds • 24 month rotation interval
Paraquat (Gramoxone Inteon)	3, 6, or 9 trifoliolate; established stands	Broad spectrum	• Rescue treatment when weeds form a canopy over alfalfa • No harvest or grazing until 60 days after application • Often used in the last year of the stand
Pronamide (Kerb)	First trifoliate leaf stage	Perennial grasses Quack grass Annual grasses Volunteer cereals Common chickweed	• No grazing or harvesting allowed for 120 days following application
Sethoxydim (Poast)	2-4 trifoliolate or established stands	Summer grasses Yellow foxtail Green foxtail Barnyardgrass Bermudagrass Johnsongrass Goosegrass	• Well established perennials require multiple applications
Terbacil (Sinbar)	Established stands	Barnyard grass Bluegrass Crab grass Foxtail Chickweed Cheat grass Perennial rye grass Wild barley Mustard Prickly lettuce Stinkweed Annual sow-thistle Henbit Lamb's-quarters Pigweed	• Can not plant any other crop for 2 years after Sinbar application

		Purslane Ragweed Partial control of: Quack grass Horsenettle Vetch Yellow nut sedge	
Trifluralin (Treflan/TR-10)	Established stands	Summer grasses	• Applied before germination • Rainfall or sprinkler irrigation is required within 3 days after irrigation to incorporate the herbicide • Controls dodder before germination

2.2.3 GT Farming

GT alfalfa can be integrated into conventional farming practices. Farming GT alfalfa is mostly the same as farming conventional alfalfa, with two important exceptions. Weeds can be controlled by the application of glyphosate directly on top of growing alfalfa and, when alfalfa stands reach the end of their life cycle (typically after 3-8 years depending on growing region), glyphosate cannot be used to kill the stand to prepare for another rotation (Miller et al., 2006). In GT alfalfa, herbicides other than glyphosate combined with tillage are required to obtain 100 percent removal. Several of the recommended GT alfalfa stand removal herbicides result in restrictions regarding what crops can be planted next, so careful crop rotation plans are necessary when using GT alfalfa. Stand removal is discussed in the technical report *Effects of Changes in Farming Practices on Water, Soil and Air Due to Use of Glyphosate-Tolerant Alfalfa* (appendix J).

Another important difference to some farmers is that non-GT crops cannot be used as companion crops for GT alfalfa. For farmers that plant pure alfalfa stands this difference does not matter. For farmers that traditionally use companion crops, this difference is important. Companion crops can increase overall forage yield but decrease hay quality (McCordick et al., 2008).

2.2.4 Crop Rotation in Alfalfa

For weed, insect, and disease management, it is recommended that alfalfa be used in rotation with other crops. It is also advised to rotate alfalfa because mature alfalfa produces medicarpin, which is auto toxic to seedling alfalfa (Guerena and Sullivan 2003). This autotoxicity is the primary problem for alfalfa seeded after alfalfa (Jennings, no year). Table G-2 presents rotation recommendations for control of several common alfalfa pests.

Table G-2. Recommended Rotations for Pest Reduction (Goodell 2006)

Pest	Recommended Rotation
Root knot nematode	1 year rotation with cotton
Stem nematode	3-4 year rotation with small grains, beans, cotton, corn, sorghum, lettuce, carrots, tomatoes, or forage grasses.*
Diseases: Bacterial wilt Anthracnose Spring blackstem Common leafspot Stagonospora	3-4 year rotation with small grains, beans, corn, sorghum, forage grasses.*
Winter weeds	A minimum of 1 year (preferably longer) in crops such as small grains, wheat, oats, winter forage grasses that allow the use of selective herbicides that are not registered in alfalfa.
Summer weeds	A minimum of 1 year (preferably longer) in crops such as small grains, beans, cotton, corn, sorghum, summer forage grasses that allow the use of selective herbicides that are not registered in alfalfa.
Dodder	At least 2 years with cotton or other nonhost crops such as small grains, beans, corn, sorghum, or forage grasses. Avoid rotations with crops such as tomatoes, onions, and carrots that also serve as a host for this weed.
Nutsedge	Two year rotation with corn or sorghum rotation that includes application of herbicide to control nutsedge.

* Three to four-year rotations give satisfactory results. A rotation for fewer years will provide minimal suppression.

Herbicides that can be used to remove GT alfalfa have rotation restrictions. For example, following clopyralid (Curtail® or Stinger®), pea, lentil, potato, and dry bean cannot be planted for 18 months. Picloram (Tordon®) can only be followed by grasses for the year after application. Sunflower, dry bean, and potato should not be planted for several years following picloram (Miller et al., 2006). Dicamba (Banvel®) should not be used prior to soybean and is also limited seasonally in California (Dillehay and Curran 2006). Because of these restrictions, alfalfa stand removal and rotation schedules should be closely coordinated. Non-glyphosate herbicides are available to manage alfalfa volunteers in wheat, oats, barley, sugar beet, and corn. Therefore rotations from GT alfalfa to those crops should be similar to rotations with non-GT alfalfa (Rogan and Fitzpatrick 2004).

Smother crops planted before alfalfa can suppress weeds. For example, sorghum-sudangrass hybrid or foxtail millet both suppressed weeds and enhanced subsequent alfalfa establishment (Forney et al., 1985).

No-till GT corn can be planted directly into alfalfa. In a study comparing no-till GT corn planted into cut or uncut alfalfa and various herbicide applications to control the alfalfa, corn yield was 13% higher following herbicide applications to uncut alfalfa. Application of glyphosate and dicamba at planting resulted in the greatest corn yield. Given that alfalfa is also a valuable crop, whether the corn yield gain is worth the loss of an alfalfa harvest should be weighed (Glenn and Meyers 2006).

2.3 Alfalfa Growing Regions

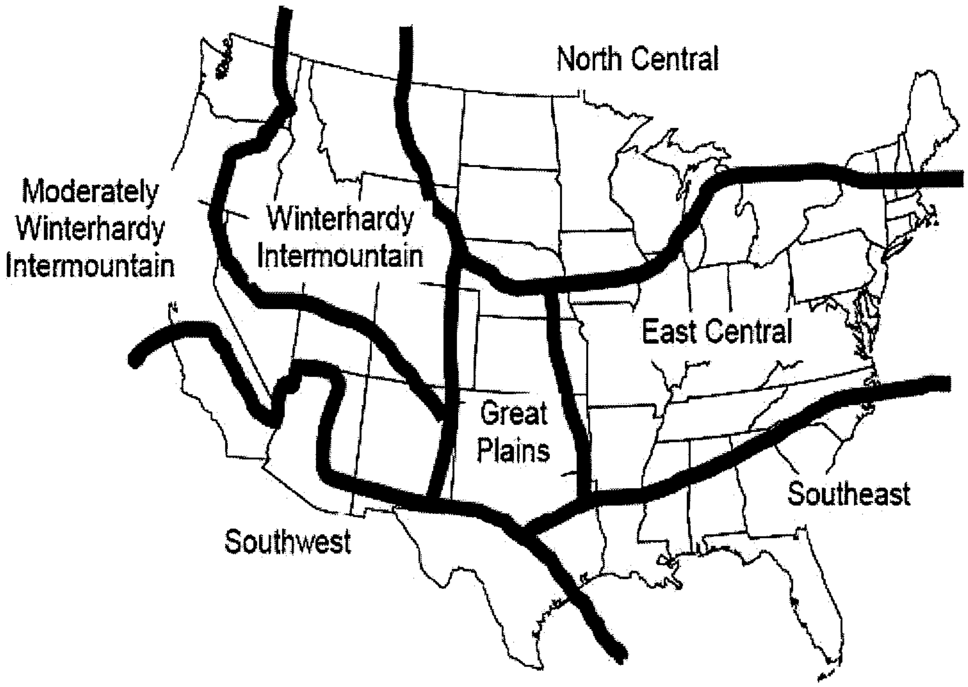

Figure G-1: Alfalfa growing regions (Rogan and Fitzpatrick 2004)

The Association of Official Seed Certifying Agencies, National Alfalfa and Miscellaneous Legumes Variety Review Board and USDA Plant Variety Protection Office recognizes seven growing regions in the United States, Moderately Winterhardy Intermountain, Winterhardy Intermountain, Southeast, Great Plains, North Central, East Central, and Southeast (figure G-1) (http://www.aosca.org/VarietyReviewBoards/Alfalfa.html). In addition, the Pacific Northwest, which includes Moderately Winterhardy Intermountain and Winterhardy Intermountain, is also sometimes recognized as a distinct growing region.

Table G-3 and table G-4 summarize the winter survival and fall dormancy ratings for alfalfa varieties. The National Alfalfa & Forage Alliance (NAFA) publishes a list of varieties and their winter survival ratings, fall dormancy ratings, and susceptibility to 17 different crop stresses (e.g., diseases, insects, grazing). The list is updated yearly and the 2007/2008 version lists 242 varieties of alfalfa (NAFA 2008). When selecting a variety, farmers consider yield, stand persistence, dormancy, pest and disease resistance, herbicide resistance, hay quality, price, seed certification, and other factors that may be specific to their farming situation (Orloff et al., 1997).

Table G-3. Winter Survival Ratings

Category	Check Variety	Score
Superior	ZG 9830	1
Very Good	5262	2
Good	WL325HQ	3
Moderate	G-2852	4
Low	Archer	5
Non Winterhardy	Cuf 101	6

Table G-4. Fall Dormancy Ratings

Check Variety	Rating
Maverick	1
Vernal	2
5246	3
Legend	4
Archer	5
ABI 700	6
Dona Ana	7
Pierce	8
CUF 101	9
UC-1887	10
UC-1465	11

1 is very dormant, 11 is extremely non-dormant

Table G-5 presents the U.S. states in order of percentage of alfalfa harvest (in 2005). For each state, the growing region, the percentage of the total national harvest of all alfalfa are presented for 2002, 2005, and 2007; and the percentage of the national organic certified harvest are presented for 2002 and 2005. In 2005, the most recent USDA organic harvest report, 22,439,000 acres of dry hay alfalfa was harvested and 204,380 (0.9 percent) of those acres were certified organic. The number of acres harvested in a state does not indicate the quantity of the harvest. For example, as shown in table G-5, because of the growing season length, California ranks top in production (in 2007, ~11 percent of the national harvest and ~7 million pounds) and South Dakota ranks second (in 2007, ~6.8 percent of the national harvest and ~4 million pounds) even though South Dakota has ~2 million acres and California has less than 1 million acres of alfalfa.In addition, even though the Northeastern states rank low in the percentage of acres and quantity of harvest, alfalfa is the number one crop for several of those states (NAFA 2007).

Table G-5. Alfalfa Growing Regions and Percentage of Dry Hay Harvest by State

State	Growing Region	Percent of harvest acres			Percent of organic harvest	
		2002	2005	2007	2002	2005
South Dakota	North Central	10.57	10.70	9.86	8.58	6.82
Montana	Winter Hardy Intermountain	6.76	7.80	9.23	3.66	2.60
North Dakota	North Central	6.13	7.35	7.20	11.22	10.09
Wisconsin	North Central	7.32	6.91	7.50	16.34	14.38
Minnesota	North Central	5.59	6.02	4.67	6.40	10.44
Iowa	North Central	5.16	5.57	4.10	6.11	4.50
Nebraska	North Central	5.92	5.57	5.36	2.71	4.01
Idaho	PNW-Intermountain	4.57	5.08	5.12	24.69	24.22
California	Moderate Winter Hardy Intermountain/ Southwest	5.19	4.63	4.88	2.92	6.48
Michigan	East Central	3.56	4.01	3.45	2.07	0.35
Kansas	Great Plains	4.14	3.79	3.92	1.40	0.32
Colorado	Winter Hardy Intermountain	3.40	3.57	4.25	3.45	4.38
Wyoming	Winter Hardy Intermountain	2.16	2.67	3.33	0.19	0.84
Utah	Moderate Winter Hardy Intermountain	2.48	2.41	2.71	0.60	0.45
Ohio	East Central	2.71	2.27	2.16	1.89	0.50
Pennsylvania	East Central	2.96	2.27	2.35	0.96	0.60
Missouri	East Central	1.77	2.01	1.46	0.23	0.58
New York	East Central	2.90	2.01	2.22	1.34	0.16
Washington	PNW-Intermountain	2.37	2.01	2.22	1.19	0.56
Illinois	East Central	1.84	1.78	1.59	0.80	1.22
Oregon	PNW-Intermountain	2.15	1.78	2.12	0.42	3.23
Indiana	East Central	1.41	1.52	1.19	0.03	0.29
Oklahoma	Great Plains	1.54	1.43	1.65	0.00	0.04
Kentucky	East Central	1.37	1.16	1.33	0.00	0.01
Nevada	Moderate Winter Hardy Intermountain	1.34	1.16	1.35	1.25	1.47
Arizona	Moderate Winter Hardy Intermountain/ Southwest	1.03	1.16	1.27	0.91	0.24
New Mexico	Moderate Winter Hardy Intermountain	0.83	1.07	1.17	0.14	0.33
Texas	Great Plains/ Southwest/ Southeast	0.72	0.67	0.76	0.18	0.55
Virginia	East Central	0.62	0.49	0.44	0.31	0.14
Vermont	East Central	0.20	0.20	0.16	0.00	0.00
Maryland	East Central	0.25	0.18	0.20	0.00	0.01
Tennessee	East Central	0.13	0.16	0.10	0.00	0.00
West Virginia	East Central	0.23	0.16	0.14	0.00	0.00
New Jersey	East Central	0.12	0.11	0.10	0.00	0.00
Arkansas	East Central	0.07	0.09	0.06	0.00	0.00
Massachusetts	East Central	0.07	0.06	0.05	0.00	0.00

State	Growing Region	Percent of harvest acres			Percent of organic harvest	
		2002	2005	2007	2002	2005
Maine	North Central	0.06	0.05	0.05	0.00	0.17
North Carolina	Southeast	0.10	0.05	0.05	0.00	0.00
Connecticut	East Central	0.04	0.04	0.04	0.00	0.05
New Hampshire	East Central	0.04	0.04	0.03	0.00	0.00
Delaware	East Central	ND	0.02	0.02	0.00	0.00
Rhode Island	East Central	0.01	0.01	0.01	0.00	0.00
Florida	Southeast	0.02	0.00	0.03	0.00	0.00
Georgia	Southeast	0.01	0.00	0.01	0.00	0.00
Louisiana	Southeast	0.03	0.00	0.01	0.00	0.00
Mississippi	Southeast	ND	ND	0.02	ND	ND
South Carolina	Southeast	0.01	0.00	0.02	0.00	0.00
Alabama	Southeast	0.04	ND	0.04	0.00	ND
Alaska		0.00	ND	0	0.00	ND
Hawaii		ND	0.00	0.00	0.00	0.00

ND = no data provided by USDA

Other differences in alfalfa farming are revealed by examining the number of farms that grow alfalfa and the number of farms that irrigate. Comparison of California and Wisconsin (table G-6) shows that in California ~97 percent of the farms irrigate, whereas in Wisconsin only 0.5 percent of the farms irrigate. In addition, the average farm size in California is much larger than in Wisconsin. It should be noted that the average farm size calculation is a bit misleading because in California mainly two farm sizes exist, small and very large (4,000 acres). In general, because farm size does not fit a normal distribution, the average farm size does not give a full picture of farm sizes. However average farm size does relay the general trend of farm size in a state. Like any census, these data may not include all alfalfa farms.

Table G-6. Alfalfa Dry Hay Harvest 2007 U.S. Agricultural Census

State	Number of Farms	Acres Harvested	Quantity (pounds) Harvested	Farms Irrigated	Acres Irrigated	% of Acres	% of Pounds	Avg. Acres per Farm
United States	290,726	20,244,497	65,349,074	56,390	6,556,652	100.0	100.0	70
California	3,587	986,982	7,057,014	3,488	963,086	4.9	10.8	275
South Dakota	12,653	1,996,599	4,414,338	716	75,913	9.9	6.8	158
Idaho	8,817	1,037,520	4,254,543	7,605	861,092	5.1	6.5	118
Nebraska	14,820	1,085,921	3,955,881	4,405	389,516	5.4	6.1	73
Montana	9,711	1,868,756	3,936,445	5,444	703,960	9.2	6.0	192
Wisconsin	30,810	1,517,522	3,673,619	171	8,809	7.5	5.6	49
North Dakota	8,985	1,457,604	3,072,682	240	21,773	7.2	4.7	162

Iowa	22,040	830,440	3,054,729	62	1,198	4.1	4.7	38
Kansas	9,643	793,140	2,986,134	1,115	207,455	3.9	4.6	82
Colorado	8,648	861,053	2,887,865	7,347	707,234	4.3	4.4	100
Minnesota	20,398	944,775	2,671,173	384	15,603	4.7	4.1	46
Washington	4,294	448,588	2,192,001	2,822	334,005	2.2	3.4	104
Utah	7,780	548,570	2,172,218	7,413	507,798	2.7	3.3	71
Arizona	943	257,407	1,968,043	920	257,263	1.3	3.0	273
Oregon	3,569	428,812	1,777,894	3,043	380,679	2.1	2.7	120
Michigan	16,431	698,595	1,707,036	291	8,080	3.5	2.6	43
Wyoming	4,007	674,284	1,696,438	3,357	471,126	3.3	2.6	168
Pennsylvania	14,402	475,873	1,357,225	109	462	2.4	2.1	33
Ohio	15,354	437,658	1,256,174	17	536	2.2	1.9	29
Nevada	1,128	274,004	1,217,586	1,128	274,004	1.4	1.9	243
New Mexico	4,272	236,103	1,176,242	4,091	222,018	1.2	1.8	55
Illinois	12,913	322,339	1,138,512	47	906	1.6	1.7	25
Oklahoma	3,781	334,990	1,131,938	294	33,000	1.7	1.7	89
New York	7,707	450,144	1,119,421	31	901	2.2	1.7	58
Missouri	8,229	295,021	782,847	63	1823	1.5	1.2	36
Texas	2,391	153,763	721,303	1,154	98,831	0.8	1.1	64
Indiana	10,775	241,129	665,767	139	2,185	1.2	1.0	22
Kentucky	10,538	269,610	524,565	109	1,210	1.3	0.8	26
Virginia	3,063	89,213	233,807	76	679	0.4	0.4	29
Maryland	1,429	40,576	120,402	49	712	0.2	0.2	28
Vermont	571	31,769	68,624	2	(D)	0.2	0.1	56
West Virginia	1,185	28,465	62,484	5	(D)	0.1	0.1	24
New Jersey	728	20,310	51,483	39	799	0.1	0.1	28
Tennessee	1,655	20,074	45,819	28	(D)	0.1	0.1	12
Arkansas	278	11,732	28,647	15	932	0.1	0.0	42
Maine	246	10,089	23,876	0	0	0.0	0.0	41
Massachusetts	406	9,921	22,537	1	(D)	0.0	0.0	24

Connecticut	349	8,343	18,441	0	0	0.0	0.0	24
Alabama	340	7,526	16,944	13	91	0.0	0.0	22
North Carolina	758	10,322	16,755	67	360	0.1	0.0	14
Florida	141	6,951	14,993	13	1,071	0.0	0.0	49
Delaware	177	3,687	13,530	22	421	0.0	0.0	21
New Hampshire	218	5,373	13,475	5	(D)	0.0	0.0	25
South Carolina	143	4,070	8,860	20	274	0.0	0.0	28
Mississippi	159	3,931	7,113	4	35	0.0	0.0	25
Georgia	134	1,655	4,810	18	243	0.0	0.0	12
Louisiana	52	2,164	4,768	2	(D)	0.0	0.0	42
Rhode Island	63	1,035	1,806	1	(D)	0.0	0.0	16
Hawaii	5	89	267	5	89	0.0	0.0	18

D = data withheld to protect identify of individual farms

2.4 Summary of Findings

Alfalfa is grown for forage, grazing, seed production (forage and sprouts), human consumption, and honey production. The most acreage is for dry hay forage. Alfalfa is currently grown through conventional farming practices, organic farming, and in glyphosate-tolerant systems. In addition to mechanical and cultivation techniques, conventional farming allows the use of 16 different herbicides to control weeds in alfalfa. Organic farming does not allow synthetic pesticides or the use of crop varieties produced through genetic engineering. GT alfalfa allows for the application of glyphosate directly onto growing plants, which provides increased options for weed control over conventional and organic systems. In 2005, 22,439,000 acres of dry hay alfalfa was harvested and 204,380 of those acres were certified organic.

Crop rotation options may be different between conventional and GT systems. Many of the non-glyphosate herbicides have follow-up planting restrictions that limit crop rotation choices in conventional farming. Farmers using GT cropping systems are advised to include some years of non-GT crops in rotation, so there may be limitations in the use of other GT crops if GT alfalfa is used in a rotation plan.

The seven growing regions in the United States have varying optimal alfalfa varieties and farming practices, such as frequency of cutting, companion cropping, and irrigation. California, South Dakota, Idaho, Nebraska, Montana, and Wisconsin are the top six alfalfa hay producing states (in 2007). South Dakota, Montana, Wisconsin, and North Dakota, have the largest acreage of alfalfa hay. California's acreage is highly productive.

3.0 Glyphosate-Tolerant Alfalfa (Roundup Ready®)

Glyphosate-tolerant (GT)[23] alfalfa was deregulated in 2005 and by 2006, ~80,000 ha (~200,000 acres) were planted in the United States (Beckie and Owen 2007).[24] USDA APHIS lists all the counties in the United States where GT alfalfa has been planted (http://www.aosca.org/ VarietyReviewBoards Alfalfa.html). GT alfalfa has been planted in 1,552 counties and 48 states. Alaska and Hawaii do not have GT alfalfa. In March of 2007 USDA published notice in the Federal Register that GT alfalfa is a regulated article and GT alfalfa seed sales and plantings were halted. GT alfalfa planted in the 2005 and 2006 growing seasons is still permitted to be harvested, but has court ordered stewardship practices to minimize risk of co-mingling GT and non-GT alfalfa (Hubbard 2008).

3.1 Using GT Alfalfa

Van Deynze et al., (2004) reported that in field trials when Roundup® (glyphosate) was applied during alfalfa stand establishment at the 3 to 4 trifoliolate stage, weeds were controlled and usually no second application was needed. Early applications allowed for late germination of weeds and later applications allowed weeds to compete with alfalfa. For example in the intermountain region applications at the unifoliolate to first trifoliolate stage resulted in invasion by prickly lettuces and henbit and required a second application. In the Southwest annual bluegrass and canarygrass germinated in early December and required a second application of glyphosate for control. The effectiveness of the first application during stand establishment is a function of which weed species are present and their germination period as well as how soon after application the alfalfa canopy covers the soil surface. In California there is period of time in the winter when alfalfa stands are dormant and rain causes winter weeds to germinate.

Recommended application of glyphosate to GT alfalfa is 0.75 to 1.5 pounds acid equivalent per acre (22 to 44 fluid ounces Roundup Weathermax 4.5S® per acre) at the three to five trifoliolate stage during stand establishment and up to five days before harvest in established stands (Dillehay and Curran, 2006). The maximum labeled rate for a single use of glyphosate on GT alfalfa is 1.55 pounds glyphosate acid equivalent per acre.

Alfalfa is polyploid (tetraploid), so small percentages (three to seven percent) of the seedlings do not have the GT trait. This is similar for other genetic traits. If glyphosate is sprayed early enough, plants containing the GT trait will fill in gaps left by dead weeds and non-GT alfalfa that was killed (Van Deynze et al., 2004). Up to six percent injury was observed after the first glyphosate application in a new stand, but was gone by the time of first harvest (McCordick et al., 2008). In GT alfalfa, crop injury from glyphosate application is much less than for other herbicides (Canevari et al, 2007).

GT alfalfa is an option for weed control; however it may not be appropriate in the following situations (Dillehay and Curran, 2006):

[23] "Resistance' and" tolerance" are usually synonyms and are often used interchangeably. In this report "tolerance" is used to indicate crop varieties that are intentionally engineered to withstand glyphosate application. "Resistance" is used to indicate weeds and weed biotypes that can withstand glyphosate application.
[24] 2.471 acres = 1 ha = 104 m^2

- Alfalfa-grass mixtures and alfalfa seeded with companion/nursery crops
- Fields that have a history of low weed populations
- Fields that are rotated between alfalfa and other GT crop varieties (e.g. Roundup Ready® soybean)

McCordick et al. (2008) tested GT alfalfa in 2004 and 2005 growing seasons in field studies in Michigan. Two seeding regimes were used, clear seeded (only alfalfa seed) and oat companion crop. In both of these seeding regimes glyphosate, imazamox, and untreated conditions were tested. For the oat companion crop stands, clethodim was added to the imazamox treatment to increase control of oat. In the first year (stand establishment), temporary stunting was observed with glyphosate treatment, but it did not affect yield or stand density. Clear seeded alfalfa treated with glyphosate yielded the highest alfalfa dry matter in both years, even though combined forage yield was higher in the oat companion crop. When no herbicide was applied the oat companion crop had lower weed biomass than clear seeded alfalfa.

3.1.1 Stand Establishment

Forage alfalfa is planted in the spring and in the early fall in the Southwest and western regions. Currently trifluralin, EPTC, imazethapyr, imazamox, sethoxydim, clethodim, and bromoxynil herbicides are sometimes used during spring stand establishment and could be replaced with glyphosate if GT alfalfa is used. Use of GT alfalfa also allows weed control during late-summer and fall establishment (Rogan and Fitzpatrick 2004).

3.1.2 Stand Removal

One of the major differences between conventional alfalfa and GT alfalfa occurs during stand removal. Whereas glyphosate is often used to kill old stands of conventional alfalfa for crop rotations, GT alfalfa has to be removed through other mechanisms. Application of an herbicide (e.g., 2,4-D, dicamba (Banvel®), and clopyralid (Stinger®)) and tillage is effective. In no-till systems 2,4-D and dicamba can be applied together. However dicamba cannot be used before planting soybean (Dillehay and Curran, 2006).

Renz 2007 reported that dicamba and 2,4-D (WeedMaster®) applied at 2 pt/A achieved zero resprouting of alfalfa in the spring following herbicide application. Lower concentrations of WeedMaster resulted in 0.3 to 2.5 percent resprouting. The other herbicides applications (dicamba or 2,4-D only) resulted in 0.5 to 26.5 percent resprouting. In another study, picloram and 2,4-D was more effective than dicamba and 2,4-D (Miller et al., 2006). Combined with plowing, clopyralid, clopyralid plus 2,4-D, dicamba plus 2,4-D, picloram, and picloram plus 2,4-D all controlled alfalfa 100 percent. Plowing alone provided 75 percent control (Miller et al., 2006).

Potential effects of changes in tillage practices due to the use of GT alfalfa are discussed in the technical report *Effects of Changes in Farming Practices on Water, Soil and Air Due to Use of Glyphosate-Tolerant Alfalfa* (appendix K).

Figure G-2 shows Monsanto's guidance for GT alfalfa stand removal (Monsanto 2008).

STAND TAKEOUT AND VOLUNTEER MANAGEMENT

Crop rotations can be divided into two main groups, alfalfa rotated to: 1) grass crops (e.g. corn and cereal crops); and 2) broadleaf crops. More herbicide alternatives exist for management of volunteer alfalfa in grass crops. The recommended steps for controlling volunteer Roundup Ready Alfalfa are:

Diligent Stand Takeout

Use appropriate commercially available herbicide treatments alone for reduced tillage systems or in combination with tillage to terminate the Roundup Ready Alfalfa stand. Refer to your regional technical bulletin for specific stand takeout recommendations. NOTE: Roundup agricultural herbicides are **not** effective for terminating Roundup Ready Alfalfa stands.

Start Clean

If necessary, utilize tillage and/or additional herbicide application(s) after stand takeout, and before planting of the subsequent rotational crop to manage any newly emerged or surviving alfalfa.

Plan for Success

Rotate to crops with known and available mechanical or herbicidal methods for managing volunteer alfalfa, keeping in mind that Roundup agricultural herbicides will not terminate Roundup Ready Alfalfa stands.

- Rotations to certain broadleaf crops are not advisable if the grower is not willing to implement recommended stand termination practices.
- In the event that no known mechanical or herbicidal methods are available to manage volunteer alfalfa in the desired rotational crop, it is suggested that a crop with established volunteer alfalfa management practices be introduced into the rotation.

Timely Execution

Implement in-crop mechanical or herbicide treatments for managing alfalfa volunteers in a timely manner; that is, before the volunteers become too large to control or begin to compete with the rotational crop.

Figure G-2: Monsanto's guidance for GT alfalfa stand removal (Monsanto 2008)

3.2 Volunteer GT Alfalfa

Crop rotation is the practice of alternating crop species in the same field in different years. Crops are considered volunteer when they grow in a field during a year when they have not been planted intentionally. Volunteer crops are weeds because they compete with the current crop for resources and they may harbor insect and disease pests. For example, volunteer GT cotton in GT soybean can harbor boll weevil. Boll weevil is a serious cotton pest and is monitored aggressively in cotton for eradication. However boll weevil is not monitored in soybean (York, et al., 2004).

Volunteer GT crops have to be controlled through the use of other herbicides. For example GT wheat and canola is best controlled through paraquat and diuron (Rainbolt et al., 2004). Volunteer GT canola needs to be controlled before replanting canola because cultivars with different resistance genes can cross and result in multiple herbicide resistance (Rainbolt et al., 2004).

Herbicides that are used to control alfalfa, including GT alfalfa include (Rogan and Fitzpatrick 2004; Renz 2007; Dillehay and Curran, 2006; Miller et al., 2006):

- 2,4-D
- Clopyralid
- Dicamba
- Dicamba and diflufenzopyr
- Glufosinate
- Primsulfuron-methyl

- Mixtures of dicamba, 2,4-D, and clopyralid
- Picloram
- Picloram and 2,4-D
- Halsulfuron and dicamba
- Acetochlor
- Acetochlor and atrizine
- Acetochlor and atrizine and dicamba
- Atrizine and dicamba
- Clopyralid and flumetsulam

Monsanto demonstrated in their Deregulation Petition that the last five herbicides and mixes on the above list can control volunteer GT alfalfa in corn (Rogan and Fitzpatrick 2004). Clopyralid is effective at controlling volunteer alfalfa in broccoli (Tickes 2002). Clopyralid or 2,4-D provide control of volunteer alfalfa in 33 different crops. Exceptions include potatoes and popcorn (Rogan and Fitzpatrick 2004).

Feral alfalfa (alfalfa not in fields) is discussed in more depth in the technical report *Effects of Glyphosate-tolerant Weeds in Non-agricultural Ecosystems* (appendix H).

3.3 Summary of Findings

GT alfalfa allows for flexibility in timing of glyphosate application to control weeds. In the two years that GT alfalfa seed was on the market ~200,000 acres were planted in 1,552 counties in 48 states.

Glyphosate is the primary tool used to remove conventional alfalfa stands. Use of herbicides other than glyphosate for removal of GT alfalfa is a major difference between GT alfalfa and conventional alfalfa. Non-glyphosate herbicides and tillage are recommended for effective GT alfalfa stand removal.

Farmers are not able to use glyphosate to control volunteer GT alfalfa in other GT crops. However, eleven other herbicides and mixtures of those herbicides are available to control volunteer GT alfalfa. These are the same herbicides that are used to control non-GT alfalfa with the exception that glyphosate can be used to control non-GT alfalfa.

4.0 Weeds in Alfalfa

Although weeds can be a problem in alfalfa, once alfalfa is established, it acts as a suppressor of weeds and is commonly used in rotations for weed reduction. For example, prior rotation in alfalfa can reduce weed densities in sunflower to the same level as herbicide treatment and alfalfa in corn rotations also benefited corn yield and suppressed weeds (Clay and Aguilar 1998). Fields with a history of perennial weed infestation are not well suited for alfalfa (Canevari et al, 2007).

Wilson (1981) tested seven herbicides on dormant alfalfa in Nebraska and found good weed control that resulted in increased protein and total digestible nutrients (except for hexazinone application) compared to untreated control plots. Weeds that were successfully controlled included kochia, downy brome, tansymustard, Russian thistle, and prickly lettuce. Out of 48 weeds in alfalfa listed by the University of California Pest Management Guidelines, five weeds are not controlled by glyphosate: green foxtail, filed bindweed, yellow nutsedge, buckhorn plantain, and burning nettle. There was no data on pepperweeds. Three weeds stand out (field bindweed, yellow nutsedge, and buckhorn plantain) because they are not controlled well by glyphosate or any of the other 16 herbicides evaluated (table VII-3 in Rogan and Fitzpatrick 2004).

A list of 129 weeds that are known to infest alfalfa are in Appendix G-3 of this technical report, including the U.S. region where they are most prevalent as well as their scientific and common names.

General rules for managing weeds at establishment or in the seedling year include (Loux et al., 2007):

- Weeds that emerge with the crop are generally more destructive.
- Maintain the forage relatively weed-free for the first 60 days.
- Weeds that emerge beyond 60 days will not influence that year's forage yield.
- Later-emerging weeds may still influence forage quality.
- Winter annual weed competition in early spring is most damaging to forages.
- Broadleaved weeds are generally more competitive against legumes than grassy weeds.

4.1 Glyphosate Resistance in Weeds

Herbicide resistance can be defined as the inherited ability of a weed population to survive and reproduce following a herbicide application that is normally lethal to the vast majority of individuals of that species (lethal to the wild type) (Puricelli and Tuesca, 2005; Stoltenberg and Jeschke, no year). Farmers are concerned about glyphosate-tolerant weeds (Johnson and Gibson 2006). Figure G-3 represents the different weed populations in alfalfa. Since 1998, 14 new glyphosate resistant weeds have been found globally. Nine of these have glyphosate resistant biotypes in the United States. Eight of the new glyphosate resistant weeds known globally are also known to be weeds in alfalfa stands (see Appendix G-3 in this technical report for list of weeds in alfalfa). At least 21 weeds that have natural resistance to glyphosate exist. Ten of these naturally glyphosate resistant weeds are known to be a problem in alfalfa. Table G-7 lists the weeds known to be glyphosate resistant in general or have glyphosate resistant biotypes. Figure G-4 summarizes the results of a recent farmer survey regarding their satisfaction with GT alfalfa and which weeds were controlled.

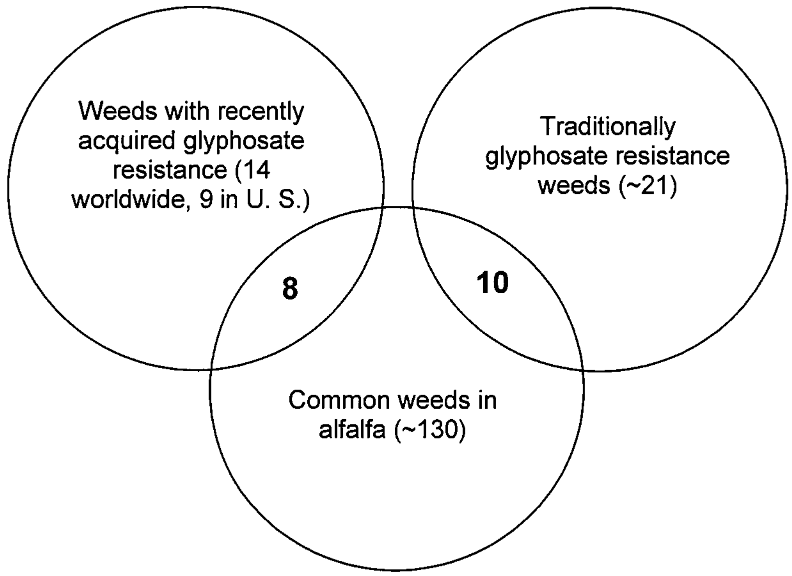

Figure G-7: Weeds in alfalfa

Table G-7. Glyphosate-resistant weeds

Common Name	Scientific Name	Resistant Biotype Reported in U.S.	Identified Problem in Alfalfa (Appendix G-3)	Listed on Roundup® Label	Source
Recently Evolved or Selected Resistant Biotypes					
Common Ragweed	*Ambrosia artemisiifolia*	Yes	Yes	Yes (with resistant biotype note)	Heap et al., 2008
Common Waterhemp	*Amaranthus rudis* and *Amaranthus tuberculatus*	Yes	No	Yes (with resistant biotype note)	Heap et al., 2008; Nandula et al., 2005
Giant Ragweed	*Ambrosia trifida*	Yes	No	Yes (with resistant biotype note)	Heap et al., 2008
Hairy Fleabane	*Conyza bonariensis*	Yes	No	Yes	Heap et al., 2008; Nandula et al., 2005
Horseweed	*Conyza canadensis*	Yes	Yes	Yes (with resistant biotype note)	Heap et al., 2008; Nandula et al., 2005

Italian Ryegrass	*Lolium multiflorum*	Yes	Yes	Yes (with resistant biotype note)	Heap et al., 2008; Nandula et al., 2005
Johnsongrass	*Sorghum halepense*	Yes	Yes	Yes (mixture also recommended)	Heap et al., 2008
Palmer Amaranth	*Amaranthus palmeri*	Yes	Yes	Yes (with resistant biotype note)	Heap et al., 2008
Rigid Ryegrass	*Lolium rigidum*	Yes	No	Yes (with resistant biotype note)	Heap et al., 2008; Nandula et al., 2005
Buckhorn Plantain*	*Plantago lanceolata*	No	Yes	No	Heap et al., 2008
Goosegrass	*Eleusine indica*	No	Yes	Yes	Heap et al., 2008; Nandula et al., 2005
Junglerice	*Echinochloa colona*	No	Yes	Yes (mixture also recommended)	Heap et al., 2008
Sourgrass	*Digitaria insularis*	No	No	No	Heap et al., 2008
Wild Poinsettia	*Euphorbia heterophylla*	No	No	No	Heap et al., 2008

Historically Naturally Resistant					
Asiatic dayflower	*Commelina communis*		No	No	Nandula et al., 2005
Birdsfoot trefoil	*Lotus corniculatus*		No	No	Nandula et al., 2005
Bermudagrass	*Cynodon dactylon*		Yes	Yes (partial control notes)	Cerdeira and Duke 2006
Burning nettle	*Urtica uren*		Yes	No (mixture recommended)	Van Deynze et al., 2004; Canevari et al., 2004
Cheeseweed	*Malva parviflora*		Yes	No (mixture recommended)	Van Deynze et al., 2004
Chinese foldwig	*Dicliptera chinensis*		No	No	Nandula et al., 2005
Common lambsquarters	*Chenopodium album*		Yes	Yes (mixture also recommended)	Nandula et al., 2005

Field bindweed*	*Convolvulus arvensis*		Yes	No (mixture recommended)	Nandula et al., 2005
Filaree	*Erodium* spp.		Yes	Yes (mixture also recommended)	Van Deynze et al., 2004
Florida pellitory	*Parietara debilis*		No	No	Cerdeira and Duke 2006
Hemp sesbania	*Sesbania exalta*		No	Yes	Cerdeira and Duke 2006
Large crabgrass	*Digitaria sanguinalis*		Yes	Yes (mixture also recommended)	Cerdeira and Duke 2006
Morning glory	*Ipomoea purpurea*		Yes	Yes (mixture also recommended)	Hilgenfeld et al. (2004; Cerdeira and Duke 2006
Nutsedge*	*Cyperus* spp.		Yes	Yes	Cerdeira and Duke 2006
Oval-leaf false buttonweed	*Spermacoce latifolia*		No	No	Cerdeira and Duke 2006
pillpod sandmat	*Chamaesyce hirta*		No	No	Cerdeira and Duke 2006
Purslane	*Portulaca oleracea*		Yes	Yes (mixture also recommended)	Van Deynze et al., 2004
Tropical Mexican clover	*Richardia brasiliensis*		No	No	Cerdeira and Duke 2006
Tropical spiderwort	*Commelina benghalensis*		No	No	Nandula et al., 2005
Velvet leaf	*Abutilon theophrasti*		No	Yes (mixture also recommended)	Nandula et al., 2005
Waterhemp	*Amarathus rudis and A. tuberculatus*		No	Yes (with resistant biotype note)	Cerdeira and Duke 2006

Cline 2004 reports that fleabane and henbit are also difficult to control with glyphosate. * These 3 weeds are not fully controlled by any of the 16 herbicides listed in the University of California Pest Management Guidelines (Rogan and Fitzpatrick 2004).

Survey of GT Alfalfa Farmers

Canevari (2007) reported survey results from interviews with alfalfa growers and industry representatives from California, Idaho, Nevada, Arizona, Washington, and New Mexico (43 respondents). The major weeds in alfalfa that were controlled by using a GT alfalfa system are listed below. Weeds that were cited as causing problems in alfalfa but were not mentioned by farmers as being controlled by glyphosate are highlighted in grey. A more comprehensive list of weeds in alfalfa is in appendix B.

Of the 24 growers surveyed all were satisfied with GT alfalfa. Advantages included less herbicide needed, yield increase, control of volunteer crops, excellent weed control, hay quality increase, better stand and water efficiency. Farmer concerns were that the seed is no longer available, the need for bale identification due to court order, and reluctance of the horse market. For the pest consultants, dealers, and researchers, concerns included export concerns, seed costs, weed resistance, weed shifts, market acceptance.

Bindweed	Dandelion	Knapweed	Morningglory
Bur clover	Dodder	Knotweed	Nutsedge
Canada thistle	Fiddleneck	Kochia	Pepperweed
Cocklebur	Foxtail	London rocket	Plantain
Common groundsel	Hoary cress	Lovegrass	Pigweed
Curly dock	Johnson grass	Mexican tea	Quackgrass
			Water grass

Figure G-4: Survey of GT alfalfa farmers

The 18 weed species (table G-7) that are both resistant to glyphosate and traditionally present problems in alfalfa likely pose the greatest threat for weed shifts in a GT cropping system. Eight weeds with newly identified resistance and ten weeds known to have some natural resistance to glyphosate are briefly described below.

4.1.1 New Glyphosate Resistant Weeds

Glyphosate resistant biotypes have recently been identified for the following eight weeds that are also common in alfalfa: common ragweed, horseweed, Italian ryegrass, Johnsongrass, Palmer Amaranth, buckhorn plantain, goosegrass, and junglerice. Each is briefly discussed below.

Common ragweed (*Ambrosia artemisiifolia*) germinates in May and early June, flowers in August to September, and sets seed in September. Each plant can release more than 30,000, three mm-long seeds, which can remain viable for more than 39 years buried. Seeds are dispersed by water and animals and can be blown across crusted snow in the winter. Common ragweed can thrive in soil containing high amounts of clay, gravel, or sand. It is found in cropland, abandoned fields, vacant lots, fence rows, waste areas, and along roadsides and railroads. Because it can accumulate large quantities of trace metals, it is very competitive and can cause nutritional deficiencies in crops. Not only does it taste bitter to livestock but it also causes nausea and mouth sores in livestock. It is very difficult to control as it can tolerate mowing, trampling, and grazing (Lanini, no year a). Common ragweed has a biotype that has multiple herbicide resistance to acetolactate synthase (ALS) inhibitors and PPO inhibitors (Heap et al., 2008).

Horseweed (*Conyza canadensis*) is a summer or winter annual that grows 1.5 to 6 feet tall (Loux et al., 2006). It produces a large number of seeds (200,000 per plant) that are wind-dispersed. Seed dispersal in a corn field ranged from 12,500 seeds per square yard at 20 feet from the seed source, to more than 125 seeds per square yard at 400 feet from the seed source (Loux et al., 2006). Seeds can disperse a quarter mile when winds are only 10 miles per hour (Barnes et al., 2003). Seeds are able to germinate in no-till fields (undisturbed soil, includes non-crop sites) and tilled fields. Outcrossing among horseweed occurs at 1.2 to 14.5 percent which facilitates the spread of resistance traits (Stoltenberg and Jeschke, no year; Nandula et al., 2005; Loux et al., 2006). The known cases of glyphosate-resistant horseweed are characterized by frequent use of glyphosate, little or no use of alternative herbicides that control horseweed, and long-term no-tillage crop production practices (Loux et al., 2006). In addition to direct competition for light, water, and nutrients, horseweed can host the tarnished plant bug, an alfalfa pest, and the viral disease aster yellows, which is transmitted by aster leafhoppers to a wide variety of plants (Loux et al., 2006). Horseweed contains volatile oils, tannic acid and gallic acid that may cause mucosal and skin irritation in livestock (especially horses) and humans (Steckel, no year a). There are horseweed biotypes that are also resistant to ALS inhibitors. Several herbicides are effective at the rosette stage, but once horseweed is over six inches tall a three-way mixture of glyphosate, plus 2,4-D ester, plus chlorimuron or cloransulam, is recommended. Biotypes that are resistance to glyphosate and/or ALS inhibitors cannot be effectively controlled (Loux et al., 2006). In Ohio, a biotype that is resistant to both ALS inhibitors and glyphosate and a biotype in Michigan that is resistant to photosystem II inhibitors and ureas and amides have been identified (Heap et al., 2008). Over 500,000 acres in the Midwest are reported to be infested with glyphosate-resistant horseweed (Cline 2004). Others estimate that over two million acres in the U.S. are infested (Heap et al., 2008).

Italian Ryegrass (*Lolium multiflorum*) is an annual grass and is related to perennial ryegrass (*Lolium perenne*). Italian ryegrass can be intentionally cultivated with alfalfa as a companion crop and is good for grazing, hay, and silage (Hall 1992). However in cool, wet environments, it may outcompete alfalfa and, in very dry situations, it might not provide adequate ground cover (Schneider and Undersander 2008). Italian ryegrass is a weed in wheat because it stays green longer than wheat and causes cut wheat to heat and spoil (Peeper 2000). There are biotypes that exhibit multiple herbicide resistance to acetyl-CoA carboxylase (ACCase) inhibitors, ALS inhibitors, and Chloroacetamides (Heap et al., 2008). At least 5,000 acres in CA are reported to be infested with glyphosate resistant ryegrass (Cline 2004).

Johnsongrass (*Sorghum halapense*) is one of the ten most noxious weeds in the world. It is a fast-growing competitive perennial grass. Established Johnsongrass can be seven to nine feet tall and releases chemicals that inhibit surrounding plant growth. A plant produces 100 to 400 seeds that withstand silage and passage through livestock digestive systems. Seeds can germinate from 6 inches deep and are viable for three years. Stresses that interrupt normal growth, such as freezing, cutting, wilting, trampling, and herbicide exposure, can cause the release of toxic amounts of hydrocyanic acid which are poisonous to livestock. Johnsongrass is thought to be introduced from Egypt sometime after the Revolutionary War and was previously grown as forage in the south. If herbicides are not used it can be controlled by intense grazing and mowing for two years until the rhizomes are depleted. (CDFA, no year a; Lanini no year b). There are separate biotypes of Johnsongrass that have resistance to ACCase inhibitors, Dinitroanilines and ALS inhibitors (Heap et al., 2008).

Palmer amaranth (*Amaranthus palmeri*) is closely related to waterhemp and is the dominant pigweed in the Southwest. It is the most competitive and rapidly growing species of the weedy pigweeds and can reach a height of six feet (Steckel no year b). It is susceptible to herbicides when it is 4 to 6 inches tall (Scarpitti et al., 2007). Biotypes of Palmer amaranth have been identified with resistance to Dinitroanilines, photosystem II inhibitors, and ALS inhibitors (Heap et al., 2008).

Buckhorn Plantain (***Plantago lanceotata***) competes with crops for soil nutrients, water, and light and does well in droughts. It reproduces by seed and by tap root. Buckhorn plantain establishes slowly in alfalfa, but, once established, is difficult to control because of its extensive crown system (Wall and Whitesides, 2008). Glyphosate resistance is the only identified herbicide resistance in buckhorn plantain and has only been found in South Africa, so far (Heap et al., 2008).

Goosegrass (***Eleusine indica***) is an annual grass with an extensive root system that can produce 50,000 seeds per plant (Duble, no year). It is one of the five most troublesome weeds world-wide. It is found in agricultural fields, homeowner lawns, waste areas, roadsides, pastures, and golf courses. When it emerges with or shortly after a crop it can be a very competitive weed. Later in the growing season, it can produce enough biomass to hinder harvest (Steckel no year c). Some goosegrass biotypes exist that are known to be resistant to ACCase inhibitors, Bipyridiliums, Dinitroanilines, and ALS inhibitors. In Malaysia, a case of multiple resistance to ACCase inhibitors and glyphosate was found (Heap et al., 2008).

Junglerice (***Echinochloa colonum***) is a summer annual grass that is invasive in Tennessee, Hawaii, and Arizona (NPS 2007). It has little or no dormancy in tropical areas and germinates throughout the year. It can grow two to three feet high (Virginia Tech, no year). In Costa Rica, a biotype has been identified that has multiple resistance to ACCase inhibitors, ALS inhibitors, and ureas and amides. A glyphosate resistant biotype has been identified in Australia (Heap et al., 2008).

4.1.2 Traditionally Glyphosate Resistant Weeds

Ten weeds that are common in alfalfa and historically have some tolerance for glyphosate include bermudagrass, burning nettle, cheeseweed, common lambsquarters, field bindweed, filaree, large crabgrass, morningglory, nutsedge, and purslane. Each is briefly discussed below.

Bermudagrass (***Cynodon dactylon***) is a perennial grass that propagates through seed, root, or stem cuttings. If bermudagrass is cultivated, the soil should be dry because, if it is moist, the cut shoots will form new plants (Cudney and Elmore 2007). Bermudagrass is also grown as a forage crop (Undersander and Pinkerton 1988).

Burning nettle (***Urtica urens***) is a summer annual that flowers from June to November and is wind-pollinated. One plant can produce from 1,000 to 40,000 seeds. When left undisturbed in soil for six years, germination declined by 61 percent. However, 20 to 100 year-old seeds from excavations have been known to germinate. Seeds can also survive livestock digestive systems (Organic Garden 2007). Burning nettle stinging hairs contain histamine, formic acid, acetylcholine, acetic acid, butyric acid, leukotrienes, 5-hydroxytryptamine, and other irritants.

Dermal contact with the hairs leads to a mildly painful sting and itching or numbness for a period lasting from minutes to days (Thorne Research 2007). In Australia, a biotype resistant to photosystem II inhibitors has been identified (Heap et al., 2008).

Cheeseweed (*Malva neglecta*) is an annual or biennial dicot that reproduces from seeds. It is found on cultivated ground, new lawns, farmyards, and waste places (Mitich, no year). It is very competitive in alfalfa and, once established, is difficult to control. The fatty acids malvalic acid and sterculic acid may cause the plant to be toxic to horse, cattle, and sheep (Canevari 1997). Selenium or nitrate concentration has also been cited as the cause of toxicity (Hill 1993; USU, no year; Barnard, 1996).

Common lambsquarters (*Chenopodium album*) is a summer annual dicot that is adaptable to many environments. A plant can produce 100,000 seeds which can survive 30 to 40 years in soil (Lanini, no year c). Biotypes that are resistant to photosystem II inhibitors and ALS inhibitors have been identified in the United States (Heap et al., 2008). Glyphosate resistant lambsquarters has been reported in the Midwest and in a Madera, CA almond orchard (Cline 2004).

Field bindweed (*Convolvulus arvensis*) is a perennial dicot that reproduces by seed and vegetatively from deep-creeping roots and rhizomes. Young plants seldom produce seed in the first year, but one plant can produce 500 seeds. In fields, seeds can survive 20 years or more. Field binweed can harbor the viruses that cause potato X disease, tomato spotted wilt, and vaccinium false bottom. In addition, it contains tropane alkaloids and can cause intestinal problems in grazing horses (CDFA no year b).

Filaree (*Erodium cicutarium*) is a winter annual dicot that grows two to five inches high. It is adapted to a broad range of soil types and is found in oak woodlands, semi-desert grassland, desert shrublands, fields, lawns, and wasteplaces. Redstem filaree can be excellent forage for livestock and wildlife, but can cause bloating under heavy grazing (Pratt et al., 2002). It is competitive with crops and can cause yield reductions (Trainor and Bussan 2001).

Large crabgrass (*Digitaria sanguinalis*) is a summer annual that reproduces by seeds (Stritzke, no year). It is primarily a turfgrass weed, but can be founding thinning alfalfa stands (Elmore 2002). A biotype with multiple resistance to ACCase inhibitors and ALS inhibitors has been identified in Australia. Photosystem II inhibitor resistant biotypes have also been identified (Heap et al., 2008).

Morning glory (*Ipomoea purpurea*) is a perennial climbing vine that reproduces by seed (Pittwater Council, no year). It is a problem in crops because of competition. Morning glory seeds are toxic to humans (Filmer, no year). Morning glory foliage is toxic to livestock due to nitrates. Symptoms of acute nitrate poisoning are trembling, staggering, rapid breathing, and death. Chronic poisoning may result in poor growth, poor milk production and abortions. In cattle, there is evidence that vitamin A storage is affected (Robinson and Alex 1989).

Nutsedge (*Cyperus* spp.) is a hardy weed due to tubers that grow 8 to 14 inches below the ground and, when mature, can re-sprout 10 to 12 times after cutting before tuber resources are depleted. In addition, many herbicides are not translocated to tuber, and, therefore, do not effectively control growth (Wilen et al., 2003). Alfalfa should not be planted in a field where nutsedge is a known problem (Canevari et al., 2003). In a study in California, nutsedge was reduced 96 to 98 percent using crop rotation and herbicides. The rotation was two years alfalfa with applications of EPTC herbicide, two years of barley double-cropped with corn and application of thiocarbamate herbicide, and two years of barley followed by fallow glyphosate applications (Canevari et al., 2007). Biotypes of *Cyperus difformis* that are resistant to ALS inhibitors have been found in California and globally (Heap et al., 2008).

Purslane (*Portulaca oleracea*) is a summer annual dicot that produces 240,000 seeds per plant and can survive five to 40 years. It can re-root after cultivation or hoeing, so it is difficult to control mechanically. It is a minor crop in the United States because it is edible and is used in ethnic cooking. In other crops, it is a weed because of competition (Cudney et al., 2007).

4.1.3 Mechanisms of Glyphosate-Tolerance

Glyphosate inhibits 5-enolpyruvylshikimate-3-phosphate (EPSP) synthase, which is a key enzyme in the shikimate pathway in plants and is required for plant growth. The effects of glyphosate can be stopped in several ways (Cerdeira and Duke, 2006; Stoltenberg and Jeschke, no year; Nandula et al., 2005):

Resistant EPSP synthase - A version of EPSP synthase that is not affected by glyphosate has been found in bacteria (*Agrobacterium*) and has been transferred into crop plant genomes. Also, the maize version of EPSP synthase has been modified by site directed mutagenesis to be resistant to glyphosate. A version of EPSP synthase with decreased binding to glyphosate has been found in the weed goosegrass (*Eleucine indica*).

Degrade glyphosate - A glyphosate-degrading enzyme has been found in bacteria (*Ochrobactrun anathropi*) and has been transferred into crop plant genomes.

Inactivate glyphosate - An enzyme found in bacteria (*Bacillus licheniformis*) has a weak ability to inactivate glyphosate through N-acetylation. The efficiency of this enzyme was increased by directed evolution in the lab and, when transferred to plants, confers resistance to glyphosate in field settings. A fungal gene encoding glyphosate decarboxylase has been discovered and patented for eventual use in crop plants.

Altered translocation of glyphosate – There is limited evidence that, in some glyphosate resistant ryegrass, glyphosate accumulates in mature leaf tissue rather than in the growing parts. Although the mechanism of resistance in horseweed is unknown, translocation experiments suggest that resistant biotypes do not translocate glyphosate to the growing parts of the plant (e.g., roots, young leaves, and crown).

Other – Resistant plants exist for which the mechanism of glyphosate resistance is not known. In addition, it is likely that there are mechanisms of resistance that have yet to evolve.

4.2 Weed Shifts in GT Alfalfa

Adopting new weed control strategies eventually leads to shifts in the weeds that are of greatest concern. Weed shifts can occur due to changes in tillage, irrigation, soil fertility, planting date, crop rotation, and herbicide use (Hilgenfeld et al., 2004). Changes to a no-till system results in a more diverse seedbank. Within weedy species variations in characteristics help weeds escape or tolerate weed management. These characteristics include seed dormancy, emergence patterns, growth plasticity, life cycle, life duration, shade tolerance, late-season competitive ability, seed dispersal mechanisms, and morphological and physiological variations (Hilgenfeld et al., 2004).

Because weed seedbanks in the soil can contain large reservoirs of dormant weed seed, short-term studies (a few years) might not detect the full potential shift in weed communities (Harker et al., 2005). However sometimes weeds shift can be observed within a few years. For example, in a field trial in an established GT alfalfa stand in the Southwest (San Joaquin Valley) burning nettle was not controlled and the population of burning nettle increased significantly over the three-year trail period (Canevari et al., 2004; Van Deynze et al., 2004). Tank mixtures with Velpar (hexazinone) or paraquat controlled burning nettle. Weeds that are difficult to control with glyphosate, such as dodder and cheeseweed, may need to be treated early and require a second application. Van Deynze et al (2004) recommend that the best way to prevent weed shifts is to avoid using the same herbicide year after year, rotate herbicides and crops, and include non-herbicide strategies to control weeds.

Puricelli and Tuesca (2005) found that continuous (once before planting, once at 40 days after planting, once in winter fallow in August) glyphosate application in field studies on three crop rotation sequences and two tillage systems lead to quantitative and qualitative changes in weed communities. They found that glyphosate application was a more important factor than crop sequence to explain weed community changes in summer crops. They also predicted that continual glyphosate application for longer than the five years in their study might lead to the development or higher increases in abundance of weeds tolerant to glyphosate. Weed species diversity in conventional versus no-tillage plots did not differ significantly.
Harker et al., (2005) reported that field studies of spring wheat-canola-spring wheat rotations of various combinations of GT and non-GT varieties under conventional tillage or low soil disturbance direct seeding systems indicate that weed community shifts are dependent on rotation pattern in a site-dependent manner. In the western Canada field locations, within 3 years, crop systems without GT varieties were associated (using canonical discriminant analysis) with green foxtail, redroot pigweed, sowthistle spp., wild buckwheat, and wild oat. The specific weeds associated with all GT variety systems included Canada thistle at the Brandon site, henbit at the Lacombe site, and volunteer wheat, volunteer canola, and round-leaved mallow at the Lethbridge site. One surprising finding was that high variability in wild buckwheat between the systems. Glyphosate is not very effective on wild buckwheat, so the authors propose that wild buckwheat seed production or viability may be restricted by glyphosate more than the wild buckwheat biomass. Therefore after glyphosate application the plant may appear visually robust, but its ability to reproduce has been effected, so in following years less wild buckwheat is observed (Harker et al., 2005).

It is plausible that the 18 weeds discussed in section 4.1 are the first candidates for weed shifts in GT alfalfa. However, as discussed in the studies summarized above, weed shifts are dependent on the composition of the weed seedbank in the soil and surrounding sources of weeds.

4.2.1 Weed Management Options

Weed management strategies in organic alfalfa systems, conventional alfalfa systems, and glyphosate-tolerant alfalfa systems differ. Management options for conventional systems include (Nandula et al., 2005; Guerena and Sullivan 2003):

- Chemical (See table G-6)
  - Alternating herbicides with different modes of action
  - Tank mixing herbicides
  - Sequences of herbicides
  - Application timing
- Cultural
  - Rotation between GT cultivars and non-GT cultivars
  - Winter crops in rotation
  - Companion crops/co-cultivation/interseeding/nurse crop)
  - Cover crops (smother crops) (prior to planting alfalfa)
  - Field scouting for early detection
  - Monitor for weed species and population shifts
- Mechanical
- Tillage cultivation

Organic alfalfa systems can use the cultural and mechanical strategies (except for use of GT cultivars). Nurse crops of peas or oats produce good hay for the horse market (Guerena and Sullivan 2003). GT alfalfa systems can use all of the strategies of conventional systems plus application of glyphosate directly on growing alfalfa. Options for rotating between GT cultivars and non-GT cultivars are reduced with GT alfalfa, since GT corn and GT soybean are popular rotation crops for alfalfa.

Cutting intervals affect weed infestation. For example, if alfalfa is cut too frequently (20 to 25 days) there is not enough time for root storage of carbohydrates so growth after cutting is not vigorous and weeds have a competitive advantage. However sometimes early harvest can rescue a heavily weed-infested new stand if the weeds are beyond the stage of optimum herbicide treatment (Canevari et al, 2007). Alternating long and short intervals between cuttings enables alfalfa to maintain root reserves so plants can recover from defoliation quickly and more vigorously compete with weeds (Canevari et al, 2007).

4.3 Distribution of Glyphosate Resistant Weeds

Table G-8 shows that currently 19 U.S. states are affected by glyphosate resistant weeds. The majority of new glyphosate resistant weeds are located in the Southeast and Midwest. The overlap with the major alfalfa producing states in the Intermountain regions seems to be minimal at this point (table G-6). However, given that there is overlap between glyphosate resistant weed locations and alfalfa hay acreage there is potential for rapid shifts of glyphosate resistant weeds into GT alfalfa fields if GT alfalfa were to be widely adopted. California is a concern because glyphosate resistant weeds are present and alfalfa is a major crop in California. More detailed records of local weed infestations may be kept by state extension offices.

Table G-8. Glyphosate-Resistant Weed Infestations by State (Heap et al., 2008)

State	Weed species	~ Number of Sites in State Infested	~ Number of Acres in State Infested	Situation	Year Reported
Arkansas	***Conyza canadensis*** Horseweed	6-10 increasing	1,001-10,000 increasing	Cotton	2003
	Ambrosia artemisiifolia Common Ragweed	1	11-50	Soybean	2004
	Ambrosia trifida Giant Ragweed	6-10 increasing	101-500 increasing	Soybean	2005
	Amaranthus palmeri Palmer Amaranth	1 increasing	unknown	Soybean	2006
	Sorghum halepense Johnsongrass	1	unknown	Soybean	2007
California	***Lolium rigidum*** Rigid Ryegrass	11-50 increasing	1,001-10,000 increasing	Almonds	1998
	Conyza canadensis Horseweed	1	unknown	Roadside	2005
	Conyza bonariensis Hairy Fleabane	2-5	unknown	Roadside	2007
Delaware	***Conyza canadensis*** Horseweed	101-500	10,001-100,000	Soybean	2000
Georgia	***Amaranthus palmeri*** Palmer Amaranth	101-500 increasing	100,001-1,000,000 increasing	Cotton Soybean	2005
Illinois	***Conyza canadensis*** Horseweed	1,001-10,000 increasing	10,0001-1,000,000 increasing	Soybean	2005
	Amaranthus rudis Common Waterhemp***	1 increasing	51-100 increasing	Corn Soybean	2006
Indiana	***Conyza canadensis*** Horseweed	2-5 increasing	101-500 increasing	Soybean	2002
	Ambrosia trifida Giant Ragweed	1 increasing	11-50 increasing	Soybean	2005
Kansas	***Conyza canadensis*** Horseweed	51-100 increasing	10,001-100,000 increasing	Cotton Soybean	2005
	Ambrosia trifida Giant Ragweed	2-5 increasing	501-1,000 increasing	Soybean	2006
	Amaranthus rudis Common Waterhemp	2-5 increasing	101-500 increasing	Soybean	2006
	Ambrosia artemisiifolia Common Ragweed	1 increasing	11-50 increasing	Soybean	2007
Kentucky	***Conyza canadensis*** Horseweed	2-5 increasing	51-100 increasing	Soybean	2001
Maryland	***Conyza canadensis*** Horseweed	6-10 increasing	501-1,000 increasing	Soybean	2002
Michigan	***Conyza canadensis*** Horseweed	1 increasing	51-100 increasing	Nursery	2007

Minnesota	***Ambrosia trifida*** Giant Ragweed	2-5 increasing	101-500 increasing	Soybean	2006
	Amaranthus rudis Common Waterhemp	2-5 increasing	51-100 increasing	Soybean	2007
Mississippi	***Conyza canadensis*** Horseweed	101-500 increasing	1,001-10,000 increasing	corn, cotton, rice, and soybean	2003
	Lolium multiflorum Italian Ryegrass	unknown	1,001-10,000 increasing	Cotton Soybean	2005
Missouri	***Conyza canadensis*** Horseweed	101-500 increasing	10,001-100,000 increasing	Cotton	2002
	Ambrosia artemisiifolia Common Ragweed	1	11-50	Soybean	2004
	Amaranthus rudis Common Waterhemp**	1 increasing	1,001-10,000 increasing	Corn Soybean	2005
New Jersey	***Conyza canadensis*** Horseweed	6-10 increasing	101-500 increasing	Soybean	2002
North Carolina	***Conyza canadensis*** Horseweed	2-5 increasing	6-10 increasing	Cotton	2003
Ohio	***Conyza canadensis*** Horseweed	101-500 increasing	1,001-10,000 increasing	Soybean	2002
	Conyza canadensis Horseweed*	2-5 increasing	101-500 increasing	Soybean	2003
	Ambrosia trifida Giant Ragweed	2-5 increasing	101-500 increasing	Soybean	2004
Oregon	***Lolium multiflorum*** Italian Ryegrass	1 stable	1-5 stable	Orchards	2004
Pennsylvania	***Conyza canadensis*** Horseweed	2-5 increasing	101-500 increasing	Soybean	2003
Tennessee	***Conyza canadensis*** Horseweed	501-1,000 increasing	>2,000,000 increasing	Cotton Soybean	2001
	Amaranthus palmeri Palmer Amaranth	2-5 increasing	101-500 increasing	Cotton	2006
	Ambrosia trifida Giant Ragweed	101-500 increasing	1,001-10,000 increasing	Cotton Soybean	2007

* resistant to chlorimuron-ethyl, cloransulam-methyl, and glyphosate ** resistant to acifluorfen-Na, cloransulam-methyl, fomesafen, glyphosate, imazamox, imazethapyr, and lactofen *** resistant to chlorimuron-ethyl, glyphosate, and imazethapyr

Monsanto's guidance for weed resistance management in GT alfalfa is as follows (Monsanto 2008):

- Scout fields before and after each herbicide application.
- Use the right herbicide product at the right rate and at the right time.
- To control flushes of weeds in established alfalfa, make applications of Roundup WeatherMAX herbicide at 22 to 44 oz/A before weeds exceed 6", up to 5 days before cutting.
- Use other herbicide products tank-mixed or in sequence with Roundup agricultural herbicide if appropriate for the weed control program.
- Report repeated non-performance to Monsanto or your local retailer.

4.4 Summary of Findings

At least 129 different weed species are identified as minor or major problems in alfalfa. Out of 14 new glyphosate resistant weeds found since 1998, eight are known to be weeds in alfalfa. Out of at least 21 weeds that have natural resistance to glyphosate, ten are known to be a problem in alfalfa. These 18 weeds that are both resistant to glyphosate and traditionally listed as problems in alfalfa include: common ragweed, horseweed, Italian ryegrass, Johnsongrass, Palmer Amaranth, buckhorn plantain, goosegrass, junglerice, bermudagrass, burning nettle, cheeseweed, common lambsquarters, field bindweed, filaree, large crabgrass, morningglory, nutsedge, and purslane. Although the composition of weed shifts is based on the local seedbank, these 18 weeds are candidates for becoming more prevalent than GT sensitive weeds in rotations that include GT alfalfa.

Mechanisms of glyphosate resistance include resistant EPSP synthase, degradation of glyphosate, inactivation of glyphosate, and altered translocation of glyphosate.

Nineteen states and over two million acres of cropland are infested with new glyphosate resistant weeds. The heaviest infestation is in the Southeast and Midwest. Overlap with the major alfalfa producing states in the Intermountain regions seems to be minimal at this point. However, given that there is overlap between glyphosate resistant weed locations and alfalfa hay acreage there is potential for rapid shifts of glyphosate resistant weeds into GT alfalfa fields if GT alfalfa were to be widely adopted. California is a concern because glyphosate resistant weeds are present and alfalfa is a major crop in California.

Weeds are controlled in conventional alfalfa with chemicals (herbicides), cultural methods (rotation, companion crops, monitoring), and mechanical methods (tillage). The cultural and mechanical methods are permitted for organic farmers. GT systems allow for the use of one additional herbicide, glyphosate.

Appendix G-1. References

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Appendix G-2. Literature Search

1.0 Literature Search Strategy

The following literature search was done for two of the technical reports:

Effects of Glyphosate-tolerant weeds in agricultural systems (former title: Increase in RR resistant weeds in crops)

Effects of Glyphosate-tolerant weeds in non-agricultural ecosystems (former title: Increase in RR resistant weeds in non-crop ecosystems)

1.1 Purpose

The purpose of this literature search is to locate references about the potential impacts of glyphosate-tolerant weeds in agricultural systems and in natural ecosystems.

The following DIALOG databases were included in the search:

- File 10:AGRICOLA 70-2008/Jun
- (c) format only 2008 Dialog
- File 156:ToxFile 1965-2008/Jun W2
- (c) format only 2008 Dialog
- File 266:FEDRIP 2008/Feb
- Comp & dist by NTIS, Intl Copyright All Rights Res
- File 245:WATERNET(TM) 1971-2008Apr
- (c) 2008 American Water Works Association

File 55:Biosis Previews(R) 1993-2008/Jun W2
- (c) 2008 The Thomson Corporation

File 6:NTIS 1964-2008/Jun W4
- (c) 2008 NTIS, Intl Cpyrght All Rights Res

File 41:Pollution Abstracts 1966-2008/May
- (c) 2008 CSA.

File 40:Enviroline(R) 1975-2008/Apr
- (c) 2008 Congressional Information Service

File 76:Environmental Sciences 1966-2008/Jun
- (c) 2008 CSA.

File 24:CSA Life Sciences Abstracts 1966-2008/Mar
- (c) 2008 CSA.

File 117:Water Resources Abstracts 1966-2008/Mar
- (c) 2008 CSA.

File 144:Pascal 1973-2008/Jun W2
- (c) 2008 INIST/CNRS

File 50:CAB Abstracts 1972-2008/Apr

(c) 2008 CAB International

File 44:Aquatic Science & Fisheries Abstracts 1966-2008/Mar
(c) 2008 CSA.

File 71:ELSEVIER BIOBASE 1994-2008/May W4
(c) 2008 Elsevier B.V.

File 143:Biol. & Agric. Index 1983-2008/Apr
(c) 2008 The HW Wilson Co

File 203:AGRIS 1974-2008/Feb
Dist by NAL, Intl Copr. All rights reserved

Descriptions of these files are available at http://library.dialog.com/bluesheets/.

1.2 Scope of Search

The search focused on any published references between 2000 and the present. A list of titles was screened followed by screening of abstracts for relevant titles. There were no limits on language for titles but only English language publications were retrieved for evaluation.

1.3 Keywords

A list of search parameters is listed below.

Synonyms of key topic
Glyphosate toleran*
Glyphosate resistan*
Roundup® Ready

Key words in combination with key topic Weed management Weed mitigation Weed control
Alfalfa
Medicago
Evolution

1.4 Results

S1 4711 GLYPHOSATE()(TOLERAN? OR RESIST?) OR ROUNDUP()READYS2 3534 S1/2000:2008S3 121649 ALFALFA OR MEDICAGO S4 1796168 WEED? OR EVOLUTION
S5 27 S2 AND S3 AND S4
S6 14 RD S5 (unique items)

7/K,6/1 (Item 1 from file: 144)DIALOG(R)File 144:(c) 2008 INIST/CNRS. All rts. reserv.
17594709 PASCAL No.: 06-0183713
Alfalfa management in no-tillage corn
2006
Glyphosate-*resistant* corn was no-till planted into *alfalfa* that wasin the early bud stage (UNCUT) or had been cut 3 to 4 d earlier and baledfor hay (CUT). *Alfalfa* control and corn yield were measured in nontreatedplots as well as plots treated with......or tank-mixed with 2,4-D or dicamba applied at planting (AP) or POST.*Alfalfa* control was greater for all AP treatments of UNCUT compared toCUT *alfalfa*. Glyphosate plus dicamba applied AP controlled *alfalfa*better than the other AP treatments resulting in increased corn yieldcompared with other

AP...Postemergence applications of glyphosate alone ortank-mixed with 2,4-D or dicamba controlled *alfalfa* better 6 weeks after treatment than AP applications of the same herbicides; however, corn yield...... same herbicides. Corn yield averaged 13% higher following herbicideapplications to UNCUT compared with CUT *alfalfa*, so the value of *alfalfa* hay must be weighed against the loss of corn yield when makingdecisions concerning the management of an *alfalfa*-corn rotation.Descriptors: Zero tillage; *Weed* control; *Weed* science; *Medicago* sativa

□ 7/K,6/2 (Item 2 from file: 10)DIALOG(R)File 10:(c) format only 2008 Dialog. All rts. reserv.4712341 43956730 Holding Library: AGL

Comparing *Roundup* *Ready* and Conventional Systems of *Alfalfa* Establishment

2007

URL: http://dx.doi.org/10.1094/FG-2007-0724-01-RS

Roundup *Ready* (RR) technology provides a new approach for *weed*

□ control during *alfalfa* (*Medicago* sativa L.) establishment. We determined the effect of RR and conventional establishment systems on*alfalfa* yield, *weed* yield, and forage quality when *alfalfa* was established using solo-seeding or oat mulch methods. A RR system was a RR*alfalfa* in combination with glyphosate (Roundup) and a conventional system was a non-RR variety with imazamox (Raptor). Non-RR and RR alfalfaswere also seeded with an oat companion crop. *Alfalfa* yields, plantpopulations, and forage quality were similar for the RR and conventionalsystems within solo-seeding and oat establishment methods in the seedingyear. Total seeding-year *alfalfa* yield was greater when solo-seeded usingan herbicide than when seeded with an oat companion crop harvested at boot.*Alfalfa* yield for the oat mulch and oat companion crop treatments werenot consistently different over...

DESCRIPTORS: *Medicago* sativa......*alfalfa*; ......*weeds*; ......*weed* control;
Identifiers: *Roundup* *Ready* *alfalfa*Section Headings: F120 PLANT PRODUCTION-FIELD CROPS; F900 *WEEDS*

□ 7/K,6/3 (Item 3 from file: 55)DIALOG(R)File 55:(c) 2008 The Thomson Corporation. All rts. reserv.18335235 BIOSIS NO.: 200510029735 Influence of *Roundup* *Ready* (R) soybean production systems and

glyphosate application on pest and beneficial insects in wide-row soybean*2004* ABSTRACT: *Roundup* *Ready* (R) soybean, Glycine max (L.) Merrill, in

widerow planting systems were investigated in 1997 and...

□ ...pest and beneficial insects. Populations of adult bean leaf beetle,Cerotoma trifurcata (Forster), and threecornered *alfalfa* hopper,Spissistilus festinus (Say), and larvae of green cloverworm, Hypenascabra (F.), and velvetbean caterpillar, Anticarsia gemmatalis (Hubner),were not affected by genetically altered *Roundup* *Ready* soybean or byapplications of glyphosate. Numbers of adult big-eyed bug, Geocoris punctipes (Say...influenced G. punctipes densities in 3 of 11 weeks. These

1.0 effects were attributed to increased *weed* densities having a positive effect on G.punctipes numbers during this 3-week period. Increased...

□ ...1 of 2 years. These elevated numbers, however, were also related tohigher densities of *weeds*. The results presented herein demonstratedthat the *Roundup* *Ready* soybean system, including applications ofglyphosate, had no detrimental effects on pest and beneficial insects......ORGANISMS: Spissistilus festinus {threecornered *alfalfa* hopper}

(Homoptera......strain-*Roundup* *Ready*;

□ 7/K,6/4 (Item 4 from file: 55)DIALOG(R)File 55:(c) 2008 The Thomson Corporation. All rts. reserv.17883376 BIOSIS NO.: 200400254133 Influence of *Roundup* *Ready* soybean production systems and glyphosate

application on pest and beneficial insects in narrow-row soybean.*2004* ABSTRACT: *Roundup* *Ready*(R) soybeans, Glycine max (L.) Merrill, in

narrow-row planting systems were investigated in 1998...

...numbers for meaningful analysis included adult bean leaf beetle,Cerotoma trifurcata (Forster); adult three-cornered *alfalfa* hopper,Spissistilus festinus (Say); adult big-eyed bug, Geocoris punctipes (Say), and; larvae of green...

...C. trifurcata, S. festinus, P. scabra and A. gemmatalis were not reducedin genetically altered *Roundup* *Ready* soybean, or by recommended (bylabel) or delayed applications of glyphosate. Numbers of G. punctipesalso were not reduced in *Roundup* *Ready* soybean, but were reduced byrecommended applications of glyphosate during weeks three and four
following......been indirectly reduced by glyphosate within sample weeks two
and threebecause of variations in *weed* densities after treatment with the
herbicide.

...ORGANISMS: Spissistilus festinus {*alfalfa* hopper} (Homoptera......oil crop, *Roundup* *Ready* line...
Roundup *Ready* productionsystems......*weed* densities

□ 7/K,6/5 (Item 5 from file: 10)DIALOG(R)File 10:(c) format only 2008 Dialog. All rts. reserv.4598987
43898530 Holding Library: AGL

□ Evaluating Glyphosate Treatments on *Roundup* *Ready* *Alfalfa* for Crop

2.0 Injury and Feed Quality*2007* URL: http://dx.doi.org/10.1094/FG-2007-0201-01-RS*Weed* control is one of the factors that impact *alfalfa* producers,
with negative effects on quality often in the year of establishment.Glyphosate is a broad-spectrum herbicide that controls many troublesomeannual and perennial *weeds* , and new cultivars that are tolerant of glyphosate application have been developed. The crop response of glyphosateon these new varieties has not been reported. This research examined*alfalfa* tolerance under field conditions, and high rates were used tochallenge the plants to determine......ranging from 0.75 to 3 lb a.e./acre sprayed before each of four *alfalfa* harvests had no meaningful crop injury in the establishment yearor in the subsequent two...of 9 lb a.e./acre over a 3-year period caused noreduction in *alfalfa* yield or nutritive value at any cutting in any of thethree years.

DESCRIPTORS: *Medicago* sativa......*alfalfa*;
......postemergent *weed*control;Identifiers: *Roundup*
Ready *alfalfa*

□ 7/K,6/6 (Item 6 from file: 55)DIALOG(R)File 55:(c) 2008 The Thomson Corporation. All rts. reserv.0020265061 BIOSIS NO.: 200800312000 Establishment systems for *glyphosate*-*resistant* *alfalfa**2008* ABSTRACT: Glyphosare-resistant *alfalfa* offers new *weed* control options for *alfalfa* establishment. Field studies were conducted in 2004 and 2005 to determine the effect of establishment method and *weed* control method on forage production and *alfalfa* stand establishment. Seedingmethods included clear seeding and companion seeding with oats. Herbicidetreatments included...reduce forage yield or stand density in 2004. No
glyphosate injury was observed in 2005. *Weed* control with glyphosate was

3.0 more consistent than with imazamox or imazarnox + clethodim. In 2004, total seasonal forageyield, which consisted of *alfalfa*, *weeds*, and oats (in sometreatments), was the highest where no herbicide was applied in the...

...was reduced where herbicides were applied in both establishment systems.In 2005, seeding method or *weed* control method did not affect totalseasonal forage production. *Alfalfa* established with the clear-seededmethod and treated with glyphosate yielded the highest *alfalfa* dry

matter in both years. Imazamox injury reduced first-harvest *alfalfa*yield in the clear-seeded system in both years. When no herbicide wasapplied, *alfalfa* yield was higher in the clear-seeded system. The oatcompanion crop suppressed *alfalfa* yield significantly in both years.*Alfalfa* established with an oat companion crop had a lower *weed*biomass than the clear-seeded system where no herbicide was applied in both
years....ORGANISMS: *Medicago* sativa {*alfalfa*} (Leguminosae)

□ 7/K,6/7 (Item 7 from file: 10)DIALOG(R)File 10:(c) format only 2008 Dialog. All rts. reserv.4823604
44034732 Holding Library: AGL

Glyphosate-*resistant* crops: adoption, use and future considerations*2008* URL: http://dx.doi.org/10.1002/ps.1501BACKGROUND: *Glyphosate*-*resistant* crops (GRCs) were first introduced
in the United States in soybeans in 1996. Adoption has......13.2 million ha), cotton (5.1 million ha), canola (2.3 million ha) and*alfalfa* (0.1 million ha). Currently, the USA, Argentina, Brazil andCanada have the largest plantings of GRCs. Herbicide use patterns wouldindicate that over 50% of *glyphosate*-*resistant* (GR) maize hectares and70% of GR cotton hectares receive alternative mode-of-action treatments... ...production system. Tillage

was likely used for multiple purposes rangingfrom seed-bed preparation to *weed* management.CONCLUSION: GRCs representone of the more rapidly adopted *weed* management technologies in recenthistory. Current use patterns would indicate that GRCs will likely continueto be a popular *weed* management choice that may also include the use ofother herbicides to complement glyphosate. Stacking...

☐ 7/K,6/8 (Item 8 from file: 55)DIALOG(R)File 55:(c) 2008 The Thomson Corporation. All rts. reserv.18808410 BIOSIS NO.: 200600153805 *Glyphosate*-*resistant* crops: History, current status, and future*2004*

...ORGANISMS: *alfalfa* (Leguminosae MISCELLANEOUS TERMS: *weed* management...

☐ 7/K,6/9 (Item 9 from file: 50)DIALOG(R)File 50:(c) 2008 CAB International. All rts. reserv.0009113458 CAB Accession Number: 20063199990

☐ *Glyphosate*-*tolerant* *alfalfa* is compositionally equivalent to conventional *alfalfa* (*Medicago* sativa L.).Publication Year: 2006 *Glyphosate*-*tolerant* *alfalfa* (GTA) was developed to withstand

☐ over-the-top applications of glyphosate, the active ingredient in...

☐ ... United States during the 2001 and 2003 field seasons along with controland other conventional *alfalfa* varieties for compositional assessment.Field trials were conducted using a randomized complete block design withfour replication blocks at each site. *Alfalfa* forage was harvested atthe late bud to early bloom stage from each plot at...

... from GTA J101 x J163 is compositionally equivalent to forage from the control and conventional *alfalfa* varieties. IDENTIFIERS: *alfalfa*; ....*weedicides*; ...*weedkillers*...*Medicago*sativa

☐ 7/K,6/10 (Item 10 from file: 50)DIALOG(R)File 50:(c) 2008 CAB International. All rts. reserv.0007976368 CAB Accession Number: 20003004906

Roundup *Ready* *alfalfa*.Publication Year: 2000 Genetic engineering has been used to develop *Roundup* *Ready* SUP TM

☐ (i.e. glyphosate herbicide tolerant) *alfalfa*. There is a significant interest in the use of RR *alfalfa* to improve options for effective, crop-safe *weed* control, both for establishment and for the control of tough perennial *weeds* in established stands. The project to develop *Roundup* *Ready* *alfalfa* is a collaboration between Monsanto, Montana State University and Forage Genetics International (FGI). Transformation,

event...

... application of Roundup Ultra. Applications at later reproductive stagesreduced seed yield. The current RR *alfalfa* timeline predicts thecommercial release of a wide range of RR *alfalfa* varieties in 2004.ORGANISM DESCRIPTORS: *Medicago* sativa...CABICODES: *Weeds* and Noxious Plants

☐ 7/K,6/11 (Item 11 from file: 10)DIALOG(R)File 10:(c) format only 2008 Dialog. All rts. reserv.4660649 43931909 Holding Library: AGL

Is *Roundup* *Ready* *alfalfa* right for you
2007
URL: http://cropwatch.unl.edu/
DESCRIPTORS: *alfalfa*; ......*weed* control;
Section Headings: F120 PLANT PRODUCTION-FIELD CROPS; H000

PESTICIDES-GENERAL; F200 PLANT BREEDING; F900 *WEEDS*

7/K,6/12 (Item 12 from file: 10)DIALOG(R)File 10:(c) format only 2008 Dialog. All rts. reserv.

☐ 4442412 30961704 Holding Library: WYU; AGX *Roundup* *Ready*.reg. *alfalfa* a new technology for high plains hay

producers / Stephen D. Miller ... [et al.]*2006* URL:
http://www.uwyo.edu/CES/PUBS/B1173.pdfDESCRIPTORS:
Alfalfa; ......*Weeds*;

□ 7/K,6/13 (Item 13 from file: 50)DIALOG(R)File 50:(c) 2008 CAB International. All rts. reserv.0008500330 CAB Accession Number: 20033167182

□ Seed bank changes following the adoption of *glyphosate*-*tolerant*

□ crops.Publication Year: 2003 *Weed* seed banks in long-term tillage/rotation plots were sampled in the early spring of 1999 and 2002, before and after the adoption of*glyphosate*-*tolerant* soyabean (Glycine max) and maize (Zea mays),respectively. Canonical discriminant analysis was used to characterize......first canonical function was strongly associated with crop rotation. Themaize-oat (Avena sativa)-lucerne (*Medicago* sativa) rotation clustered separately from continuous maize and maize-soyabean rotations when visualized in a...05), suggesting that practices used in the varyingsystems selected for divergent communities. After employing *glyphosate**tolerant* maize and soyabean varieties for three growing seasons (1999-2001), differences incommunity composition between...use of a single, non-selective herbicideacross all treatments resulted in a more homogeneous *weed* seed bankcommunity.
...ORGANISM DESCRIPTORS: *Medicago*; ...

S9 9600 HERBICIDE? ?()(TOLERAN? OR RESIST?)/2000:2008S3 121649 ALFALFA OR MEDICAGO S4 1796168 WEED? OR EVOLUTION S5 27 S2 AND S3 AND S4 S10 35 S9 AND S3 AND S4 NOT S5 S11 20 RD S10 (unique items)

□ 12/K,6/1 (Item 1 from file: 55)DIALOG(R)File 55:(c) 2008 The Thomson Corporation. All rts. reserv.18075829 BIOSIS NO.: 200400443748 Development of 2,4-D-resistant transgenics in Indian oilseed mustard(Brassica juncea)*2004* ...ABSTRACT: monooxygenase, cloned downstream to the 35S promoter along with a leader sequence from RNA4 of *alfalfa* mosaic virus (AMV leader

□ sequence), for improved expression of the transgene in plant cells.Southern... ...available transgenic lines can be used for testing the potential of
2,4-D in *weed* control including the control of parasitic *weeds*
(Orobanche spp) of mustard and for low-till cultivation of mustard.
ORGANISMS: *Alfalfa* mosaic virus (Bromoviridae...vegetable crop,

herbicide *resistant* transgenic line......pest, *weed*

□ 12/K,6/2 (Item 2 from file: 50)DIALOG(R)File 50:(c) 2008 CAB International. All rts. reserv.0008797522 CAB Accession Number: 20053050074

□ Efficacy of imidazolinone herbicides applied to imidazolinone-resistant maize and their carryover effect on rotational crops.Publication Year: 2005 ... a 31% petroleum hydrocarbon adjuvant at 125 and 250 mL ha SUP -1 ,

□ respectively. Overall *weed* control varied from 85%, up to 95%. *Weed*species controlled were Setaria sp., Chenopodium album , Solanum sp.,Amaranthus retroflexus and Digitaria sanguinalis , and...
...to low, was the following: Beta vulgaris > Capsicum annum > Lycopersicumesculentum > Cucumis melo > Hordeum vulgare > *Medicago* sativa > Loliummultiflorum > Avena sativa > Pisum sativum > Allium cepa > Zea mays ....DESCRIPTORS: *herbicide* *resistance*; ......*weed* control......*weeds*...ORGANISM DESCRIPTORS: *Medicago*; ...

□ 12/K,6/3 (Item 3 from file: 50)DIALOG(R)File 50:(c) 2008 CAB International. All rts. reserv.0009065754 CAB Accession Number: 20063137864

□ Influence of forage legume species, seeding rate and seed size on competitiveness with annual ryegrass (Lolium rigidum) seedlings.Publication Year: 2006 ... as short-term forage crops are an important non-chemical option for
the control of *herbicide*-*resistant* annual ryegrass (Lolium rigidum L.). The relative ability of 5 annual forage legume species (Trifoliumsubterraneum L., T. michelianum Savi., T. alexandrinum L., *Medicago*murex Wild and Vicia benghalensis L.) to suppress annual ryegrassseedlings was examined in a......DESCRIPTORS: *weed* control ...ORGANISM DESCRIPTORS: *Medicago* murex

☐ 12/K,6/4 (Item 4 from file: 156)DIALOG(R)File 156:(c) format only 2008 Dialog. All rts. reserv.3840082 NLM Doc No: 12852606

Influence of *herbicide* *tolerant* soybean production systems on insectpest populations and pest-induced crop damage.Jun *2003*

Conventional soybean *weed* management and transgenic *herbicide*-*tolerant* management were examined to assess their effects on soybeaninsect pest populations in south Georgia...... leafhopper, Empoasca fabae (Harris), and grasshoppers Melanoplus spp.were more numerous on either conventional or *herbicide*-*tolerant* varieties on certain dates, although these differences were not consistentthroughout the season. Soybean looper, Pseudoplusia includens (Walker),threecornered *alfalfa* hopper, Spissistilus festinus (Say), and whitefringed beetles, Graphognathus spp , demonstrated no varietal preference in this study. Few *weed* treatment differences were observed,but if present on certain sampling dates, then pest numbers were higher inplots where *weeds* were reduced (either postemergence herbicides or preplant herbicide plus postemergence herbicide). The exception to this*weed* treatment effect was grasshoppers, which were more numerous in *weedy* plots when differences were present. In post emergence herbicideplots, there were no differences in...the conventional herbicides (e.g.,Classic, Select, Cobra, and Storm) compared with specific gene-inserted*herbicide*-*tolerant* materials (i.e., Roundup and Liberty).Defoliation, primarily by velvetbean caterpillar, was different betweensoybean...... We did not observe differences in seasonal abundance of arthropod pestsbetween conventional and transgenic *herbicide*-*tolerant* soybean.

☐ 12/K,6/5 (Item 5 from file: 50)DIALOG(R)File 50:(c) 2008 CAB International. All rts. reserv.0008298057 CAB Accession Number: 20023152152

Effect of herbicide treatment on the productivity of some annual pasturelegumes.

Book Title: 13th Australian *Weeds* Conference: *weeds* "threats now and forever?", Sheraton Perth Hotel, Perth, Western Australia, 8-13September 2002: papers and proceedings

Publication Year: 2002

... seed production of 11 pasture legume cultivars (Trifolium subterraneum cultivars Dalkeith and Urana, burr medic [*Medicago*polymorpha] cv. Santiago, French serradella [Ornithopus sativus] cv.Cadiz, yellow serradella [O. compressus] cv. Charano......DESCRIPTORS: *herbicide* *resistance*; ......*weed* control......*weeds*...ORGANISM DESCRIPTORS: *Medicago* polymorpha

☐ 12/K,6/6 (Item 6 from file: 55)DIALOG(R)File 55:(c) 2008 The Thomson Corporation. All rts. reserv.18860532 BIOSIS NO.: 200600205927

Effects of Artemisia afra leaf extracts on seed germination of selected crop
and *weed* species
2005

ABSTRACT: *Herbicide* *resistance* in *weeds* is a phenomenon threateningsustainable cereal production in the winter rainfall region of SouthAfrica. Every possible *weed* control measure that may be used tocomplement chemical *weed* control measures should be investigated. Theeffect of aqueous leaf extracts of the aromatic shrub African wormwood(Artemisia afra) on germination of selected crop and *weed* species wereinvestigated. The selected plant species included wheat (Triticumaestivum L.), *herbicide* *resistant* and non-resistant ryegrass (Lolium,spp.), canola (Brassica napus) and lucerne (*Medicago* sativa). Various dilutions were investigated and the original extract was the most effective in inhibiting......ORGANISMS: *Medicago* sativa (Leguminosae

☐ 12/K,6/7 (Item 7 from file: 50)
DIALOG(R)File 50:(c) 2008 CAB International. All rts. reserv.

0008298120 CAB Accession Number: 20023152089 *Evolution* of paraquat resistance in barley grass (Hordeum leporinumLink. and H. glaucum Steud.).Book Title: 13th Australian *Weeds* Conference: *weeds* "threats now and forever?", Sheraton Perth Hotel, Perth, Western Australia, 8-13September 2002: papers and proceedingsPublication Year: 2002

Herbicide *resistance* in *weed* species can eliminate the usefulnessof herbicides. In Australia, 25 *weed* species have been documented withresistance to one or more of nine herbicide groups. Two *weedy* barleygrass species, H. glaucum and H. leporinum [H. murinum subsp. leporinum],infest crops and...paraquat on these two

species, principally in lucerne and
grain crops,has resulted in the *evolution* of paraquat resistance at a number ofsites in southern Australia. The *evolution* of paraquat resistance occursafter a prolonged period of use, often up to 20 years...
... will lead to a better understanding of how resistance is spread as wellas the *evolution* of paraquat resistance in field populations....DESCRIPTORS: *evolution*; ......*herbicide* *resistance*; ......*weeds*
...*Medicago* sativa...CABICODES: *Weeds* and Noxious Plants (FF500...

□ 12/K,6/8 (Item 8 from file: 50)
DIALOG(R)File 50:(c) 2008 CAB International. All rts. reserv.
0008751520 CAB Accession Number: 20053008750 *Evolution* and spread of *herbicide* *resistant* barley grass (Hordeumglaucum Steud. and H. leporinum Link.) in South Australia.Book Title: *Weed* management: balancing people, planet, profit. 14thAustralian *Weeds* Conference, Wagga Wagga, New South Wales, Australia,6-9 September 2004: papers and proceedingsPublication Year: 2004 The barley grasses (H. glaucum and H. leporinum (H. murinum subsp.leporinum)) are important *weeds* of crops and pastures in South Australia. Populations of both species have evolved resistance to paraquat, primarily following intensive use of paraquat for winter *weed*
control in lucerne (*Medicago* sativa) crops. In the past few years,agricultural consultants have been reporting an increase in......This research was conducted to determine the relative importance of seedmovement compared with independent *evolution* for paraquat resistance in
□ Hordeum spp. H. glaucum and H. leporinum seeds were collected from...
... by 7 km appeared to be the same genotype. These results suggest thatboth independent *evolution* and seed movement are important in thedistribution of paraquat-resistant Hordeum spp. in South...DESCRIPTORS: *evolution*; ......*herbicide* *resistance*; ......*weeds*
...*Medicago* sativa...CABICODES: *Weeds* and Noxious Plants (FF500

□ 12/K,6/9 (Item 9 from file: 50)DIALOG(R)File 50:(c) 2008 CAB International. All rts. reserv.0008324661 CAB Accession Number: 20023162508
Herbicides in *alfalfa* culture.
Original Title: Herbicidas na cultura da alfafa.
Publication Year: 2002
... the tolerance of lucerne cv. Crioula and the efficiency of

□ pre-emergent herbicides on broadleaved *weed* control, in 2 differentsoils having (a) 0.96% organic matter (OM) and pH of 5.4 and (b) 2.61% OMand pH of 6.1. The *weed* control efficiency of oxyfluorfen and mixture ofdiuron+paraquat was also evaluated one day after...
... 24 and 0.36 of oxyfluorfen. Two controls were added to all experiments,
□ i.e. *weeded* and unweeded. Pre-emergence herbicides were sprayed one dayafter planting in moistened soil. In...
□ ... plants. Oryzalin was selective to the crop, providing a better controlof grasses and broadleaved *weeds* at the 2 highest doses, regardless ofthe amount of OM and soil pH. Acetochlor...
□ ... both contents of OM and soil pH, with excellent control of the broadleaved and grass *weeds*. Flumetsulam and imazaquin may be appliedonly at the lowest dose tested, regardless of OM content in the soil,providing good control of some broadleaved *weeds*, with spraying offluazifop-P-butyl [fluazifop-P] needed in post-emergence. The herbicidesshowed, in average, 10% more control of the *weeds* in soil with 2.61% ofOM and pH of 6.1, in comparison to the *weeds* in the soil with 0.96% ofOM and pH of 5.4. Lucerne budding...
□ .. oxyfluorfen up to 12 days after application; this herbicide presentedgood potential for post-lasting *weed* control and excellent pre-emergencecontrol. Mixture application in tank (diuron+paraquat) just after cutting
... ...DESCRIPTORS: *herbicide* *resistance*; ......*weed* control......*weeds*...*Medicago* sativa

□ 12/K,6/10 (Item 10 from file: 50)DIALOG(R)File 50:(c) 2008 CAB International. All rts. reserv.0009320611 CAB Accession Number: 20073193351

Herbicide-*resistant* crops as *weeds* in North America.
Publication Year: 2007
Growers have rapidly adopted transgenic *herbicide*-*resistant* (HR)

□ crops, such as canola (Brassica napus L.), soyabean [Glycine max (L.) Merr.], maize (Zea...crops and subsequent potential for volunteerism of these crops are assessed. HR volunteers are common *weeds* and the relative *weediness*
□ depends on species, genotype, seed shatter prior to harvest and disbursement of seed at harvest...limited if the crop volunteers are HR.There are generally no marked changes in volunteer *weed* problemsassociated with these crops, except in no-tillage systems when glyphosate(GLY) is used...
...DESCRIPTORS: *Herbicide* *resistance*; ......*Weed*control......*Weeds*;
IDENTIFIERS: *alfalfa*; ......*weedicides*; ......*weedkillers*
...ORGANISM DESCRIPTORS: *Medicago* sativa

12/K,6/11 (Item 11 from file: 50)
DIALOG(R)File 50:(c) 2008 CAB International. All rts. reserv.
0008751696 CAB Accession Number: 20053008458

How profitable are perennial pasture phases in Western Australian cropping systems?
Book Title: *Weed* management: balancing people, planet, profit. 14thAustralian *Weeds* Conference, Wagga Wagga, New South Wales, Australia,6-9 September 2004: papers and proceedings
Publication Year: 2004
... that, in most parts of Western Australia, it is not currentlyprofitable to plant lucerne (*Medicago* sativa) on the scale requiredfor salinity abatement. However, these investigations have not incorporated the long-term benefits that accrue from the use of lucerne toenhance management of *weeds* , especially for those growers facing thethreat or actual presence of *herbicide* *resistance*. This work is an investigation of the economics of lucerne when these various benefits are considered simultaneously. An existing model for analysing *herbicide**resistance* in annual ryegrass (Lolium rigidum) in Western Australia(Ryegrass Resistance and Integrated Management) is extended...
... pasture phase increase long-term profitability, relative to that ofcontinuous cropping, because of improved *weed* management, reduced chemical use and through increasing yields in subsequent cereal crops. Thefirst two benefits help reduce the *evolution* of *herbicide* *resistance* . In addition, the incorporation of lucerne in a rotation can significantly reduce recharge. These results......DESCRIPTORS: *herbicide* *resistance*; ......*herbicide* *resistant*
weeds; ...
...*weed* control......*weeds*...*Medicago* sativa

□ 12/K,6/12 (Item 12 from file: 55)
DIALOG(R)File 55:(c) 2008 The Thomson Corporation. All rts. reserv.
0019917724 BIOSIS NO.: 200700577465
New annual and short-lived perennial pasture legumes for Australianagriculture - 15 years of revolution
2007
ABSTRACT: Fifteen years ago subterranean clover (Trifolium subterraneum)and annual medics (*Medicago* spp.) dominated annual pasture legumesowings in southern Australia, while limited pasture legume options
existed...
...glanduliferum), arrowleaf (Trifolium vesiculosum), eastern star(Trifolium dasyurttm) and crimson (Trifolium incarnatum) clovers andsphere (*Medicago* sphaerocarpos), button (*Medicago* orbicularis) andhybrid disc (*Medicago* tornata x *Medicago* littoralis) medics have beencommercialised. Improved cultivars have also been developed ofsubterranean (T. subterraneum), balansa (Trifolium michelianum), rose(Trifolium hirtum), Persian (Trifolium resupinatum) and purple (Trifoliumpurpureum) clovers, burr (*Medicago* polymorpha), strand (M. littoralis),snail (*Medicago* scutellata) and barrel (*Medicago* 'truncatula) medicsand yellow serradella (Ornithopus compressus). New tropical legumes for
pasture phases in subtropical...likely to increase due to the increasing cost

of inorganic nitrogen, the need to combat *herbicide*-*resistant* crop
weeds and improved livestock prices. Mixtures of these legumes allows for
more robust pastures buffered against...
12/K,6/13 (Item 13 from file: 50)

0008415606 CAB Accession Number: 20033074295

□ Preharvest glyphosate in *alfalfa* for seed production: control of
□ Canada thistle. Publication Year: 2003 Canada thistle (Cirsium arvense) is increasing in both frequency and
density in Saskatchewan lucerne (*Medicago* sativa) seed fields. Application of preharvest glyphosate is an effective means of controllingCanada thistle...
...DESCRIPTORS: *herbicide* *resistance*; ......*weed* control......*weeds*...*Medicago* sativa

□ 12/K,6/14 (Item 14 from file: 10)DIALOG(R)File 10:(c) format only 2008 Dialog. All rts. reserv.4818901 44029738 Holding Library: AGL
Role and value of including lucerne (*Medicago* sativa L.) phases in croprotations for the management of *herbicide*-*resistant* Lolium rigidum inWestern Australia
2008 URL: http://dx.doi.org/10.1016/j.cropro.2007.07.018Use of lucerne (*Medicago* sativa L.) pastures in crop rotations has been
proposed as a method to enhance *weed* management options for growersfacing *herbicide* *resistance* in Western Australia. An existing model foranalysing *herbicide* *resistance* in the important crop *weed* annualryegrass (Lolium rigidum Gaud.) is consequently extended to include lucerne, used for grazing by...options are analysed, including variouscombinations of lucerne, annual pastures, and crops. Lucerne providesadditional *weed* management benefits across the rotation, but in the region studied these benefits are only sufficient...

□ 12/K,6/15 (Item 15 from file: 50)DIALOG(R)File 50:(c) 2008 CAB International. All rts. reserv.0008983866 CAB Accession Number: 20063055062
□ Sensitivity of selected crops to isoxaflutole in soil and irrigation
□ water. Publication Year: 2005 ... hectarage crops grown in Michigan, USA. The crops evaluated were:
□ adzuki bean (Vigna angularis), lucerne (*Medicago* sativa), carrot (Daucus carota), cucumber (Cucumis sativus), dry bean (navy and blackbeans; Phaseolus vulgaris...of the rates that resulted in injury were substantially less than the rates used for *weed* control in maize.
Carryover from isoxaflutoleapplications in maize production may require plant back restrictions......DESCRIPTORS: *herbicide* *resistance*;...*Medicago* sativa

□ 12/K,6/17 (Item 17 from file: 55)DIALOG(R)File 55:(c) 2008 The Thomson Corporation. All rts. reserv.17533797 BIOSIS NO.: 200300491454 Tolerance of annual forage legumes to herbicides in Alberta.*2003*
...ABSTRACT: under irrigation. Results indicate that recommended rates of
either ethalfluralin or imazethapyr have potential for *weed* control in

alfalfa, berseem clover, balansa clover, fenugreek, pea, and vetches.*alfalfa* (Leguminosae...*herbicide* *tolerance*; ....*weed* controlpotential

□ 12/K,6/18 (Item 18 from file: 50)

□ 0008566544 CAB Accession Number: 20043017840 *Weed* control in lucerne and pastures 2004.Publication Year: 2003 Information to aid the planning of *weed* control in lucerne and pastures in Australia, is presented under the following headings:
identification of...
...establishing pasture legumes; poison warnings on herbicide labels; usingherbicides successfully; using herbicides in pastures; *weed* glossary;time interval needed between herbicide application and rainfall; *weed*control in seedling lucerne - grass *weeds*; *weed* control in seedlinglucerne - broadleaf *weeds*; *weed* control in established lucerne stands(over one-year-old) -broadleaf *weeds*; *weed* control in establishedlucerne stands (over one-year-old) -grass *weeds*; clover and medic pastures -grass *weeds* -for

presowing, seedling and establishment;clover and medic pastures - broadleaf *weeds* - for presowing, seedlingand established pastures; *weed* control in grass pastures only -broadleaf *weeds*; *herbicide* *resistance* management; direct drill andsurface sowing; perennial grass *weed* control; approximate retail pricesof chemicals used on lucerne and pastures; herbicide volatility; winter crop......DESCRIPTORS: *herbicide* *resistance*; ......*weed* control......*weeds* ...*Medicago* sativa

12/K,6/19 (Item 19 from file: 50)DIALOG(R)File 50:(c) 2008 CAB International. All rts. reserv.

0008415608 CAB Accession Number: 20033074293 *Weed* management in irrigated fenugreek grown for forage in rotationwith other annual crops.Publication Year: 2003 ... determine the tolerance of fenugreek (cv. Amber) to several herbicides and their efficacy on various *weeds* (Avena fatua, Setariaviridis and Amaranthus retroflexus) in 1997-99 in Alberta, Canada.Potentially, fenugreek...effect of herbicides, seeding method, and 11 previous crops on fenugreek yield. Without herbicide application, *weeds* contributed 37-86% to total dry matter production. When imazamox/imazethapyr, or combinations of imazamoz/imazethapyr or imazethapyr with ethalfluralin was applied, *weed*contents were 5% of the total dry matter and the herbicides did notreduce fenugreek yield compared to the hand-*weeded* control. Total foragesamples with a low *weed* content had lower fibre content and higherprotein and digestible dry matter content than forages with a high *weed*content. When imazamox/imazethapyr was used for *weed* control, fenugreekyields and *weed* biomass were similar after direct seeding and aftercultivation plus seeding. In addition, the effect...
... and the previous crop by seeding method interaction was not significantfor fenugreek yield and *weed* biomass. Therefore, irrigated fenugreek canbe successfully grown in conservation tillage systems in rotation withseveral crops provided an effective herbicide is used for *weed* control.

...DESCRIPTORS: *herbicide* *resistance*; ......*weed* control...*Medicago*sativa

□ 12/K,6/20 (Item 20 from file: 55)
DIALOG(R)File 55:(c) 2008 The Thomson Corporation. All rts. reserv.
0020265062 BIOSIS NO.: 200800312001
Winter annual *weed* control with herbicides in *alfalfa*-orchardgrass mixtures
2008
4.0 ABSTRACT: *Alfalfa*-orchardgrass hay is popular in the Western UnitedStates because of an expanding horse-hay market. However, *weed* controlin mixed *alfalfa*-orchardgrass stands is problematic, as herbicides mustbe safe for both species. Most growers rely solely on the competitivenessof the crop for *weed* control, which is often insufficient, especiallyin older stands. Field experiments were established in northernCalifornia to determine the efficacy and crop safety of severalherbicides for winter annual *weed* control in established *alfalfa* -orchardgrass. Metribuzin at 560 or 840 g/ha and hexazinone at 420 g/ha applied...
...Paraquat at 560 g/ha applied shortly after crop green-up gave 50 to 82%*weed* control and caused significant injury to orchardgrass, which wasstill noticeable at first cutting....ORGANISMS: *Medicago* sativa {*alfalfa*} (Leguminosae)MISCELLANEOUS TERMS: *herbicide* *tolerance*

1.5 Supplemental Searches

www.scirus.com
Terms:
alfalfa AND glyphosate (40 titles evaluated)

www.scholar.google.com
Terms:
alfalfa AND glyphosate

www.yahoo.com

Terms:

Alfalfa hay
Alfalfa sprouts
Organic alfalfa sprouts
Alfalfa seeds
Alfalfa glyphosate
Feral alfalfa
Wild alfalfa
Alfalfa state extension guidance
Perennial bluegrass
Quackgrass
Red horned poppy
Sprangletop weed
Tall waterhemp
White cockle weed
Butyrac
Butoxone
Benefin
Balan herbicide
Bromoxynil herbicide
Clethodim herbicide
Prism herbicide
Select herbicide
Diuron herbicide
EPTC herbicide
Velpar herbicide
Raptor herbicide
Pursuit herbicide
Sencor herbicide
Solicam herbicide
Paraquat herbicide
Pronamide herbicide
Kerb herbicide
Poast herbicide
Terbacil herbicide
Sinbar herbicide
Trifluralin herbicide
Treflan/TR-10 herbicide

www.google.com

Terms:

alfalfa bloom
alfalfa crop rotation
alfalfa cultivation
alfalfa harvest
alfalfa quality definitions
alfalfa quality standards
alfalfa quality statistics
alfalfa sprouts
alfalfa weeds
dandelion off-taste milk
dairy cows
Eleucine indica
Burdock weed
Certified organic alfalfa seed
Common ragweed
Common ragweed weed problem
Gene flow simulation
GENESYS gene flow
Glyphosate
Glyphosate resistant weeds
Growing regions
Herbicide active ingredients
Horseweed
Lucerne Medicago
Meadow foxtail
Organic alfalfa acres
Organic alfalfa acres USDA
Organic alfalfa certified
Organic alfalfa seeds
Organic alfalfa statistics
Pigweed
Roundup ready label
Tansymustard
Tansyweed
Teuber gene flow alfalfa
Visual definition for alfalfa quality
Weed interference with rhyzobium
Weeds off tasting milk
Weeds taste in milk
Horseweed Italian ryegrass
Italian ryegrass weed
Palmer amaranth
Buckhorn plantain
Goosegrass

Junglerice
Echinochloa junglerice
Burning nettle
Utica uren
Erodium filaree
Purslane weed
Large crabgrass in alfalfa
Bermudagrass weed alfalfa
Large crabgrass weed
Morning glory toxic livestock
Morning glory weed
Nutsedge
Nutsedge toxic livestock
alfalfa stand removal
volunteer alfalfa
alfalfa autotoxicity

Appendix G-3. Weeds in Alfalfa

Table G-9. Weeds in Alfalfa

Common Name	Scientific Name and Synonyms[25]	Type	Season	East Central	North Central	Southeast	Winter Hardy Inter-mountain	Great Plains	PNW	Moderate Inter-mountain	Southwest	Source
African mustard	*Brassica tournefortii* Asian mustard wild turnip	Broadleaf	WA								X	Rogan and Fitzpatrick 2004
Barnyardgrass	*Echinochloa crus-galli,* cockspur grass, Japanese millet watergrass cockspur watergrass	Grass	SA	X	X			X	X	X	X	Rogan and Fitzpatrick 2004
Bermudagrass	*Cynodon spp.*	Grass	P			X		X			X	Rogan and Fitzpatrick 2004
Blessed milk thistle	*Silyburn marianum* blessed milkthistle milk thistle spotted thistle variegated thistle	Dicot	A								X	Canevari et al., 2007
Blue mustard	*Chorispora tenella,* beanpodded mustard chorispora crossflower purple mustard tenella mustard	Broadleaf	WA		X		X					Rogan and Fitzpatrick 2004
Bluegrass (annual)	*Poa annua* walkgrass, annual bluegrass	Grass	WA			X		X			X	Rogan and Fitzpatrick 2004
Bluegrass (perennial)	*Poca* spp. Perennial bluegrass	Broadleaf	P		X							Rogan and Fitzpatrick 2004
Bristly oxtongue*	*Picris echioides*	Dicot	WA								X	Canevari et al., 2007
Bromes	*Bromus* spp.	Grass	WA								X	Rogan and Fitzpatrick 2004
Buckhorn plantain	*Plantago lanceolata*	Broadleaf	P					X		X		Rogan and

[25] Source: http://plants.usda.gov/java/invasiveOne.

Common Name	Scientific Name and Synonyms[25]	Type	Season	East Central	North Central	Southeast	Winter Hardy Inter-mountain	Great Plains	PNW	Moderate Inter-mountain	Southwest	Source
	English plantain buckhorn plantain lanceleaf plantain narrowleaf plantain ribgrass ribwort *Plantago major* broadleaf plantain buckhorn plantain common plantain rippleseed plantain											Fitzpatrick 2004
Buffalobur	*Solanum rostratum* Colorado bur Kansas thistle Mexican thistle Texas thistle Buffalobur nightshade	Broadleaf	SA					X				Rogan and Fitzpatrick 2004
Bulbous bluegrass	*Poa bulbosa*	Grass	P							X		Rogan and Fitzpatrick 2004
Bull thistle	*Cirsium lanceolatum*	Broadleaf	P							X		Rogan and Fitzpatrick 2004
Burcucumber	*Sicyos angulatus* Wall bur cucumber	Broadleaf	SA			X						Rogan and Fitzpatrick 2004
Burning nettle	*Urtica dioica* California nettle slender nettle stinging nettle tall nettle	Broadleaf	A								X	Canevari et al., 2004; Canevari et al., 2006b
Bushy wallflower	*Ersimum repandum* Treacle mustard	Broadleaf	WA					X				Rogan and Fitzpatrick 2004
California burclover	*Medicago polymorpha* burclover	Dicot	WA-P								X	Canevari et al., 2007
Canada thistle	*Cirsium arvense* Californian thistle creeping thistle	Broadleaf	P	X	X		X			X		Rogan and Fitzpatrick 2004

Common Name	Scientific Name and Synonyms[25]	Type	Season	East Central	North Central	Southeast	Winter Hardy Inter-mountain	Great Plains	PNW	Moderate Inter-mountain	Southwest	Source
	field thistle Cirsium thistle											
Canarygrass	*Phalaris arundinacea* canary grass reed canarygrass *Phalaris canariensis* canary grass *Phalaris minor* canarygrass littleseed canarygrass	Grass	WA								X	Rogan and Fitzpatrick 2004
Carolina geranium	*Geranium carolinianum*	Broadleaf	WA			X						Rogan and Fitzpatrick 2004
Cheatgrass	*Bromus tectorum* downy brome early chess military grass thatch bromegrass	Grass	WA	X	X		X	X	X	X	X	Rogan and Fitzpatrick 2004
Cheeseweed	*Malva neglecta* buttonweed cheeseplant little mallow common mallow	Broadleaf	WA-P							X	X	Rogan and Fitzpatrick 2004
Chickweed (common)	*Stellaria media*	Broadleaf	WA	X	X	X		X	X			Rogan and Fitzpatrick 2004
Chicory	*Cichorium intybus* blue sailors chicory coffeeweed succory	Broadleaf	P							X		Rogan and Fitzpatrick 2004
Coastal fiddleneck	*Amsinckia menziesii* var. *intermedia* coast buckthorn coast fiddleneck common fiddleneck fiddleneck	Broadleaf	WA							X		Rogan and Fitzpatrick 2004
Cocklebur (common)	*Xanthium strumarium* cocklebur common cocklebur rough cocklebur	Broadleaf	SA	X	X	X			X			Rogan and Fitzpatrick 2004
Cornflower	*Centaurea cyanus*	Broadleaf	WA			X						Rogan and

Common Name	Scientific Name and Synonyms[25]	Type	Season	East Central	North Central	Southeast	Winter Hardy Inter-mountain	Great Plains	PNW	Moderate Inter-mountain	Southwest	Source
	bachelor's button garden cornflower											Fitzpatrick 2004
Crabgrass	*Digitaria bicornis* Asian crabgrass *Digitaria ciliaris* Henry's crabgrass fingergrass kukaepua'a saulangi smooth crabgrass tropical crabgrass *Digitaria ischaemum* small crabgrass smooth crabgrass *Digitaria Sanguinalis* hairy crabgrass large crabgrass purple crabgrass	Grass	SA	X	X	X		X				Rogan and Fitzpatrick 2004
Creeping swinecress	*Coronopus didymus* lesser swinecress *Coronopus squamatus* creeping wartcress swinecress	Dicot	WA								X	Canevari et al., 2007
Cupgrasses	*Eriochloa gracilis* southwestern cupgrass tapertip Cupgrass *Eriochloa contracta* prairie cupgrass *Eriochloa villosa* woolly cupgrass	Grass	SA					X			X	Rogan and Fitzpatrick 2004
Curly dock	*Rumex crispus* narrowleaf dock sour dock yellow dock Rumex dock	Broadleaf	P	X	X	X		X				Rogan and Fitzpatrick 2004
Cutleaf	*Oenothera*	Broadl	WA					X				Rogan

Common Name	Scientific Name and Synonyms[25]	Type	Season	East Central	North Central	Southeast	Winter Hardy Inter-mountain	Great Plains	PNW	Moderate Inter-mountain	Southwest	Source
eveningprimrose	*laciniata* cut-leaved evening primrose	eaf										and Fitzpatrick 2004
Dallisgrass	*Paspalum dilatatum* dallies grass herbe de miel herbe sirop hiku nua palpalum dilate water grass	Grass	P								X	Canevari et al., 2007
Dandelion (common)	*Taraxacum officinale* blowball common dandelion faceclock	Broadleaf	P	X	X		X	X		X		Rogan and Fitzpatrick 2004
Dodder	*Cuscuta* 50 common names for species in the genus	Broadleaf	SA					X	X	X	X	Rogan and Fitzpatrick 2004
Fall panicum	*Panicum dichotomiforum* western witchgrass	Grass	SA	X		X						Rogan and Fitzpatrick 2004
Fescue	*Festuca* spp. 66 common names for species in the genus	Grass	P			X				X		Rogan and Fitzpatrick 2004
Fescue (tall)	*Festuca arundinacea* *Festuca pratensis* Alta fescue coarse fescue reed fescue tall fescue	Grass	SA							X		Rogan and Fitzpatrick 2004
Field bindweed	*Convolvulus arvensis* creeping jenny European bindweed morningglory perennial morningglory smallflowered morningglory	Broadleaf	P	X			X					Rogan and Fitzpatrick 2004
Field pepperweed	*Lepidium campestre*	Dicot	WA				X			X		Orloff et al., 1997
Flixweed	*Descurainia sophia*	Broadleaf	WA				X	X		X		Rogan and

Common Name	Scientific Name and Synonyms[25]	Type	Season	East Central	North Central	Southeast	Winter Hardy Inter-mountain	Great Plains	PNW	Moderate Inter-mountain	Southwest	Source
	flixweed pinnate tansymustard											Fitzpatrick 2004
Foxtail (giant)	*Setaria faberi* Chinese foxtail Chinese millet giant bristlegrass giant foxtail nodding foxtail	Grass	SA	X	X	X		X	X			Rogan and Fitzpatrick 2004
Foxtail (green)	*Setaria viridis* bottle grass green bristlegrass green foxtail green millet pigeongrass wild millet	Grass	SA	X	X	X	X	X	X	X		Rogan and Fitzpatrick 2004
Foxtail (yellow)	*Setaria glauca* pearl millet pigeongrass wild millet yellow bristlegrass yellow foxtail	Grass	SA	X	X	X	X	X	X			Rogan and Fitzpatrick 2004
Foxtail barley	*Hordeum jubatum*	Grass	P				X			X		Rogan and Fitzpatrick 2004
Goosegrass	*Eleusine indica* crowsfoot grass Indian goosegrass manienie ali'I silver crabgrass wiregrass	Grass	SA			X		X				Rogan and Fitzpatrick 2004
Groundsel (common)	*Senecio vulgaris* ragwort old-man-in-the-Spring	Dicot	WA								X	Canevari et al., 2007
Hairy nightshade	*Solanum sarrachoides* hairy nightshade hoe nightshade	Broadleaf	SA							X		Rogan and Fitzpatrick 2004
Hare barley	*Hordeum leporinum* hare barley leporinum barley wild barley	Dicot	WA				X			X	X	Orloff et al., 1997
Henbit	*Lamium amplexicaule* deadnettle	Broadleaf	WA	X	X	X		X		X		Rogan and Fitzpatrick 2004

Common Name	Scientific Name and Synonyms[25]	Type	Season	East Central	North Central	Southeast	Winter Hardy Inter-mountain	Great Plains	PNW	Moderate Inter-mountain	Southwest	Source
Hoary alyssum	*Berteroa incana* hoary false alyssum hoary false madwort	Broadleaf	P		X							Rogan and Fitzpatrick 2004
Hoary alyssum	*Berteroa incana* hoary false alyssum hoary false madwort	Broadleaf	SA	X								Rogan and Fitzpatrick 2004
Horseweed	*Conyza canadeniss* horseweed fleabane mares tail fleabane	Broadleaf	SA/WA					X				Rogan and Fitzpatrick 2004
Japanese brome	*Bromus japonicus* Japanese bromegrass Japanese chess	Grass	WA					X				Rogan and Fitzpatrick 2004
Jimsonweed	*Datura stramonium* Jamestown weed mad apple moonflower stinkwort thorn apple	Broadleaf	SA	X		X						Rogan and Fitzpatrick 2004
Johnsongrass	*Sorghum halepense* aleppo milletgrass herbe de cuba sorgho d' Alep sorgo de alepo zacate johnson	Grass	P			X		X				Rogan and Fitzpatrick 2004
Jointed goatgrass	*Aegilops cylindrical* jointgrass	Grass	P					X				Rogan and Fitzpatrick 2004
Junglerice	*Echinochloa colona* junglerice watergrass	Grass	SA								X	Rogan and Fitzpatrick 2004
Kentucky bluegrass	*Poa prantensis*	Grass	P							X		Rogan and Fitzpatrick 2004
Knawel	*Sclerantus annus* German knotgrass	Broadleaf	WA			X						Rogan and Fitzpatrick 2004
Knotweed	*Polygonum arenastrum*	Broadleaf	SA						X		X	Rogan and

Common Name	Scientific Name and Synonyms[25]	Type	Season	East Central	North Central	Southeast	Winter Hardy Inter-mountain	Great Plains	PNW	Moderate Inter-mountain	Southwest	Source
	common knotweed doorweed matweed ovalleaf knotweed prostrate knotweed											Fitzpatrick 2004
Kochia	*Kochia scoparia* Mexican burningbush Mexican fireweed fireweed mock cypress summer cypress	Broadleaf	SA		X			X	X			Rogan and Fitzpatrick 2004
Lambsquarters (common)	*Chenopodium album* Lambsquarters White goosefoot	Broadleaf	SA	X	X	X	X	X	X	X	X	Rogan and Fitzpatrick 2004
Little barley	*Hordeum pusillum* little wildbarley	Grass	WA					X				Rogan and Fitzpatrick 2004
London rocket	*Sisymbrium irio*	Grass	WA								X	Rogan and Fitzpatrick 2004
Meadow foxtail*	*Alopecurus pratensis*	Grass	P							X		Rogan and Fitzpatrick 2004
Mexican sprangletop	*Leptochloa uninervia*	Grass	SA								X	Rogan and Fitzpatrick 2004
Mexican tea	*Chenopodium ambrosioides*	Dicot	P								X	Canevari et al., 2007
Miner's lettuce	*Claytonia perfoliata*	Dicot	WA-P								X	Canevari et al., 2007
Morningglory	*Ipomoea* spp.	Broadleaf	SA			X						Rogan and Fitzpatrick 2004
Muhly	*Muhlenbergia frondosa* wirestern muhly *Muhlenbergia racemosa* green muhly marsh muhly	Grass	P							X		Rogan and Fitzpatrick 2004
Musk thistle	*Caruus nutans*	Broadl	WA					X				Rogan

Common Name	Scientific Name and Synonyms[25]	Type	Season	East Central	North Central	Southeast	Winter Hardy Inter-mountain	Great Plains	PNW	Moderate Inter-mountain	Southwest	Source
	Nodding plumeless thistle chardon penche nodding thistle plumeless thistle	eaf										and Fitzpatrick 2004
Mustards	*Brassica* spp.	Broadl eaf	WA			X	X					Rogan and Fitzpatrick 2004
Mustards	*Brassica* spp.	Broadl eaf	SA			X						Rogan and Fitzpatrick 2004
Nettleleaf goosefoot	*Chenopodium* *murale*	Broadl eaf	SA								X	Rogan and Fitzpatrick 2004
Night-flowering catchfly	*Silene noctiflora* nightflowering silene sticky cockle	Broadl eaf	WA		X							Rogan and Fitzpatrick 2004
Nightshade	*Solanum* *sarrachoides* hairy nightshade hoe nightshade	Broadl eaf	SA			X			X			Rogan and Fitzpatrick 2004
Nightshade (E. black)	*Solanum* *ptychanthum* Eastern black nightshade black nightshade	Broadl eaf	SA	X	X							Rogan and Fitzpatrick 2004
Nutsedge (yellow)	*Cyperus* *esculentus* yellow nutgrass yellow nutsedge	Grass	P	X								Rogan and Fitzpatrick 2004
Nutsedges	*Cyperus* *esculentus* yellow nutgrass yellow nutsedge *Cyperus* *rotundus* chaguan humatag cocograss kili'o'opu nutgrass pakopako purple nutsedge	Grass	P								X	Rogan and Fitzpatrick 2004
Palmer amaranth	*Amaranthus* *palmeri* carelessweed (type of pigweed)	Broadl eaf	SA					X				Rogan and Fitzpatrick 2004
Pennycress	*Thlaspi arvense* Frenchweed	Broadl eaf	WA	X	X				X			Rogan and

Common Name	Scientific Name and Synonyms[25]	Type	Season	East Central	North Central	Southeast	Winter Hardy Inter-mountain	Great Plains	PNW	Moderate Inter-mountain	Southwest	Source
	Fanweed field pennycress pennycress stinkweed											Fitzpatrick 2004
Pepperweeds	*Lepidium densiflorum* common pepperweed greenflower pepperweed peppergrass	Broadleaf	WA					X		X		Rogan and Fitzpatrick 2004
Persian speedwell	*Veronica persica* birdeye speedwell winter speedwell	Broadleaf	WA							X		Rogan and Fitzpatrick 2004
Pigweed spp.	*Amaranthus* spp. redroot pigweed smooth pigweed Powell amaranth spiny amaranth tumble pigweed prostrate pigweed common waterhemp tall waterhemp Palmer amaranth	Broadleaf	SA	X	X	X	X	X	X	X	X	Rogan and Fitzpatrick 2004
Plains coreopsis	*Coreopsis tinctoria* golden tickseed	Broadleaf	WA					X				Rogan and Fitzpatrick 2004
Plantains	*Plantago major* common plantain broadleaf plantain buckhorn plantain rippleseed plantain	Broadleaf	P			X		X				Rogan and Fitzpatrick 2004
Poverty sumpweed	*Iva axillaris* Iva poverty weed Lesser marshelder mouseear povertyweed poverty sumpweed poverty weed smallflowered marshelder	Broadleaf	P							X		Rogan and Fitzpatrick 2004
Prickly lettuce	*Lactuca serriola* China lettuce	Broadleaf	WA					X	X	X		Rogan and

Common Name	Scientific Name and Synonyms[25]	Type	Season	East Central	North Central	Southeast	Winter Hardy Inter-mountain	Great Plains	PNW	Moderate Inter-mountain	Southwest	Source
	wild lettuce											Fitzpatrick 2004
Purslane	*Portulaca oleracea* akulikuli-kula common purslance duckweed parsley pusley wild portulaca	Broadleaf	SA						X			Rogan and Fitzpatrick 2004
Quackgrass	*Elytrigia repens* couchgrass quackgrass quickgrass quitch scutch twitch *Elymus repens* couchgrass dog grass	Grass	P	X	X				X	X		Rogan and Fitzpatrick 2004
Rabbitsfoot grass	*Polypogon monspelienisis* rabbitfoot polypogon rabbitfootgrass	Grass	WA								X	Rogan and Fitzpatrick 2004
Ragweed (common)	*Ambrosia artemisiifolia* Roman wormwood annual ragweed common ragweed low ragweed short ragweed small ragweed	Broadleaf	SA	X	X	X		X				Rogan and Fitzpatrick 2004
Red horned poppy*	*Glausium carniculatum*	Broadleaf	WA					X				Rogan and Fitzpatrick 2004
Red sprangletop*	*Leptochloa filiformis*	Grass	SA								X	Rogan and Fitzpatrick 2004
Redstem filaree	*Erodium cicutarium* redstem stork's bill alfilaree filaree stork's bill	Broadleaf	WA							X		Rogan and Fitzpatrick 2004
Rescuegrass	*Bromus catharticus* rescue brome	Grass	WA					X				Rogan and Fitzpatrick

Common Name	Scientific Name and Synonyms[25]	Type	Season	East Central	North Central	Southeast	Winter Hardy Inter-mountain	Great Plains	PNW	Moderate Inter-mountain	Southwest	Source
												2004
Roughseed buttercup*	*Ranunculus muricatus*	Dicot	WA-P								X	Canevari et al., 2007
Russian thistle	*Salsola kali* tumbleweed *Salsola iberica* prickly Russian thistle tumbleweed tumbling thistle	Broadl eaf	SA		X			X	X	X		Rogan and Fitzpatrick 2004
Ryegrass	*Lolium multiforum* Italian ryegrass annual ryegrass	Grass	WA			X				X		Rogan and Fitzpatrick 2004
Ryegrass (perennial)	*Lolium perenne* Perennial ryegrass	Grass	WA							X		Rogan and Fitzpatrick 2004
Sandbur	*Cenchrus echinatus* burgrass common sandbur field sandbur konpeito-gusa se mbulabula vao tui tui	Grass	SA					X	X			Rogan and Fitzpatrick 2004
Shepardspurse	*Capsella bursa-pastoris* Shephardspurse	Broadl eaf	WA	X	X	X	X	X	X	X	X	Rogan and Fitzpatrick 2004
Silversheath knotweed*	*Polygonum argyrocoleon*	Broadl eaf	WA								X	Rogan and Fitzpatrick 2004
Smartweed	*Polygonum persicaria* lady's thumb ladysthumb smartweed	Broadl eaf	SA	X	X	X						Rogan and Fitzpatrick 2004
Sowthistle	*Sonchus* spp. (5 species)	Broadl eaf	P						X			Rogan and Fitzpatrick 2004
Spiny sowthistle	*Sonchus asper* perennial sowthistle prickly sowthistle	Broadl eag	WA					X				Rogan and Fitzpatrick 2004
Sprangletops	*Leptochloa fascicularis* bearded sprangletop	Grass	SA					X				Rogan and Fitzpatrick 2004

Common Name	Scientific Name and Synonyms[25]	Type	Season	East Central	North Central	Southeast	Winter Hardy Inter-mountain	Great Plains	PNW	Moderate Inter-mountain	Southwest	Source
	Also other *leptochloa*											
Squirreltail*	*Sitanion hystrix*	Grass	P							X		Rogan and Fitzpatrick 2004
Stinkgrass	*Eragrostis cilianensis* candy grass lovegrass strongscented lovegrass	Grass	SA							X		Rogan and Fitzpatrick 2004
Sunflower (common)	*Helianthus annuus* annual sunflower common sunflower sunflower wild sunflower	Broadleaf	SA				X		X	X		Rogan and Fitzpatrick 2004
Swamp knotweed*	*Polygonum coccineum*	Broadleaf	P							X		Rogan and Fitzpatrick 2004
Tall waterhemp	*Amaranthus tuberculatus* roughfruit amaranth tall waterhemp	Broadleaf	SA		X			X				Rogan and Fitzpatrick 2004
Tansy mustard	*Descurainia pinnata* green tansymustard tansymustard	Broadleaf	SA		X			X	X	X		Rogan and Fitzpatrick 2004
Toad rush	*Juncus bufonius*	Grass	WA								X	Canevari et al., 2007
Tumble mustard	*Sisymbrium altissimum* Jim hill mustard tall mustard tumble mustard tumbleweed mustard	Broadleaf	SA						X	X	X	Rogan and Fitzpatrick 2004
Velvetleaf	*Abutilon theophrasti* Indian mallow butterprint buttonweed	Broadleaf	SA	X	X	X						Rogan and Fitzpatrick 2004
Virginia pepperweed	*Lepidium virginicum* Virginia Pepperweed Virginia	Broadleaf	WA			X						Rogan and Fitzpatrick 2004

Common Name	Scientific Name and Synonyms[25]	Type	Season	East Central	North Central	Southeast	Winter Hardy Inter-mountain	Great Plains	PNW	Moderate Inter-mountain	Southwest	Source
	peppercress peppergrass poorman's pepper											
Volunteer grains		Grass	WA-SA	X		X		X	X	X		Rogan and Fitzpatrick 2004
White cockle	*Silene latifolia* bladder campion evening lychnis white campion	Broadleaf	P		X							Rogan and Fitzpatrick 2004
Wild celery*	*Apium graveolens*	Dicot	SA-P								X	Canevari et al., 2007
Wild mustard	*Brassica arvensis* wild mustard *Brassica kaber* canola charlock mustard kaber mustard rapeseed wild mustard	Broadleaf	SA	X	X				X			Rogan and Fitzpatrick 2004
Wild oats	*Avena fatua* flaxgrass oatgrass wheat oats	Grass	SA-WA		X				X	X	X	Rogan and Fitzpatrick 2004
Wild radish	*Raphanus raphanistrum*	Broadleaf	SA	X	X	X						Rogan and Fitzpatrick 2004
Windmillgrass	*Chloris verticillata* tumble windmill grass windmillgrass	Grass	P					X				Rogan and Fitzpatrick 2004
Witchgrass	*Panicum capillare* panicgrass ticklegrass tumble panic tumbleweed grass witches hair	Grass	SA	X						X		Rogan and Fitzpatrick 2004
Yellow rocket	*Barbarea vulgaris* garden yellow rocket winter cress	Broadleaf	P	X	X							Rogan and Fitzpatrick 2004
Yellow starthistle	*Cantaurea solstitialis*	Dicot	WA				X			X		Canevari et al., 2007

Common Name	Scientific Name and Synonyms[25]	Type	Season	East Central	North Central	Southeast	Winter Hardy Inter-mountain	Great Plains	PNW	Moderate Inter-mountain	Southwest	Source
Yellowflower pepperweed	*Lepidium perfoliatum* clasping pepperweed	Dicot	WA				X			X		Orloff et al., 1997

Appendix F

Selected Comments to Draft Environmental Impact Statement form Farmers Using Roundup Ready Alfalfa

APHIS-2007-0044-0320

Name: Daniel M. Luckwaldt
Address: Woodville, WI

Submitter's Representative: Daniel Luckwaldt
Organization: Luckwaldt Agriculture Inc.

I am a dairy farmer who planted 100 acres of round-up ready alfalfa when it was available. I seemed to work very good. Additionally it allowed me to plant my alfalfa in a no-till manner (which leaves a smaller carbon footprint) and not worry about weeds. Seemed like it was the best alfalfa I ever grew and was very easy/simple to manage.

APHIS-2007-0044-0516.1

Name: Gene Robben
Address: Dixon, CA

Organization: Robben Ranch

Robben Ranch is a large farming operation located near the town of Dixon, California. This farming operation normally raises approximately 4,000 acres of alfalfa each year. The hay that is produced on this ranch supplies several dairy and cattle operations in the southern part of the Sacramento valley and the northern part of the San Joaquin valley. Each fall this ranch tries to replace older stands of alfalfa and replaces fields of alfalfa that are of poor quality. These fall plantings can range from 800 to 1,000 acres. Fall planting of alfalfa has been the most successful for Robben Ranch.

Three years ago, Robben Ranch planted 600 acres of Roundup Ready Alfalfa to see how this new variety would produce and what type of quality it would have. This fall was the third year of production for the new Roundup Ready variety. It was found from production records that the Roundup Read Alfalfa equaled other varieties in production per acre, and had outstanding tests in T.D.N. (total digestible nutrients). The other factor that was a concern was how resistant was this alfalfa to Roundup Herbicide. After a few Roundup sprays, there was no apparent loss of plants or stands over the three year period.

Many farmers know that with our standard varieties of alfalfa, w can spend form $50 - $100 per acre annually for weed control. With Roundup Ready Alfalfa, expenses range from $10 - $30 per acre per year, which is a considerable savings over standard weed control. It was also noticeable that in the Roundup Ready Alfalfa fields almost 100% weed control was obtained.

Robben Ranch hopes the government will release Roundup Ready Alfalfa seed for the 2010 planting season. If so, this ranch will probable plant 1,000 acres of Roundup Ready Alfalfa this coming fall season. I feel that the government regulators fully analyze the benefit that Roundup Ready Alfalfa has for the American farmer and the environment they will release the seed for sale.

From an environmental standpoint, one can only hope that the regulators will find that with the release of Roundup Ready Alfalfa seed, several million pounds of current herbicides will be greatly decrease or eliminated. Velpar, Sincor, Direx, Gramoxone, and Treflan TR-10 granules are just a few examples of these current herbicides being used. With the reduction of these herbicides, our streams and waterways will be much safer for our environment and us.

Document: APHIS-2007-0044-0813

Name: Kurt Robert Brink
Address: Richview, IL

Biotechnology-based breeding methods safely enhance and extend a crop's yield potential, feed value, adaptation, pest tolerance, environmental benefits, crop management and utilization options, as other biotech crops have demonstrated. The Roundup Ready alfalfa system provides dependable, cost-effective control of broadleaf and grassy weeds for the life of the alfalfa stand.
I have had a plot of RR Alfalfa now for at least 3 years and it has proven to be a major plus for our Dairy business in that we usually are able to maintain at least a RFV of 155 or better in each of 5 cuttings/year. With the ability to control weed growth, it is one of, if not the best stand I have among the 4 fields I do have in alfalfa.
It is imperative in these tough economic times that we are not deprived of whatever advantage we can glean from the seed technology this variety provides.Roundup Ready alfalfa can lead to more consistent, high-quality, weed-free hay, resulting in an increased supply of dairy-quality hay. The forage produced from Roundup Ready alfalfa is comparable in composition, nutritional value and safety to that produced from conventional alfalfa varieties, resulting in proven feed safety. Dairy farmers can benefit from increased milk production per ton of feed and fewer animals sickened by weeds in their feed.
I urge the USDA to consider biotechnology's long history of success and allow alfalfa growers to join other American farmers in the benefits and new opportunities offered by biotechnology.

Kurt Brink
B&B Dairy Farms
Illinois

Document: APHIS-2007-0044-1094
Comment from John Maddox

Name: John Maddox
Address: Burrell, CA

I am a dairyman and alfalfa grower. I currently grow 2,400acs of conventional alfalfa and I would like to have the ability to purchase and grow Roundup Ready alfalfa. I did grow 40acs of Roundup Ready alfalfa when it was first avialable and was extremely satisfied with it.
The Roundup Ready system is extremely effective in controlling some of our toughest weeds that we have in our hay fields especially nutgrass which is a big problem for us to control with the currently avialable products that we have.
It eliminates summer grasses in the alfalfa which gives me greater flexibility in my winter spray applications.
I firmly believe that if I am able to grow Roundup Ready alfalfa, I am going to be able to better protect my workers because they will not have to be exposed to the more toxic herbicides that I currently have to use to control my weeds. This is a huge issue for us in California especially

with the many worker safety regulations that we put in place to provide a safe work environment for our employees.

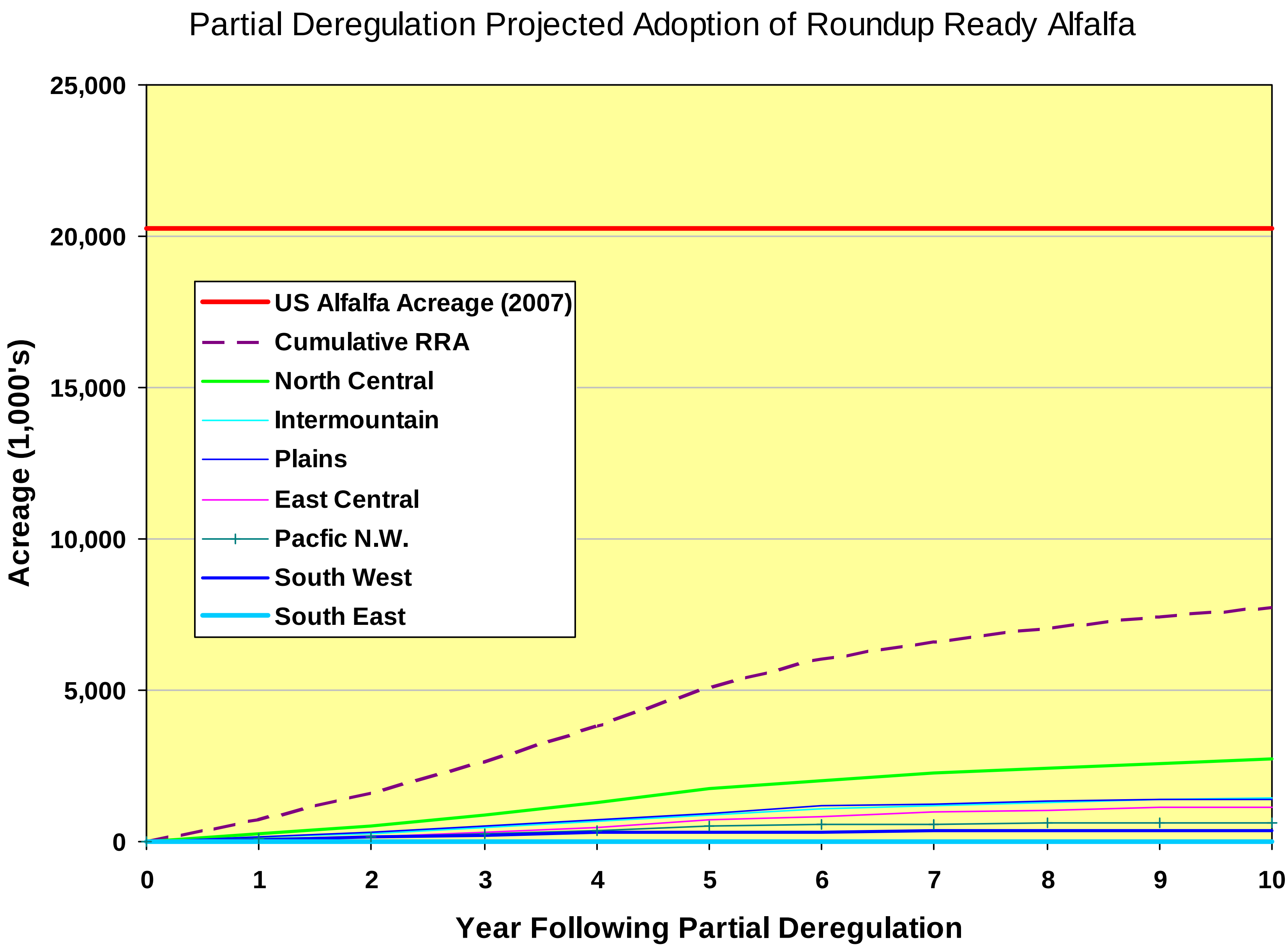
For our dairy, it is of high importance to us to provide the highest quality feed that we can find for our milk cows so that we can maximize their production of high quality milk and butterfat. By growing Roundup Ready alfalfa, I found that my alfalfa was higher in quality and tonnage per acre due to the fact that it was much cleaner than my conventional fields. My 40acres of Roundup Ready alfalfa was the first field that ever produced 10 tons/acre for the year. We have never been able to do that with our conventional varities. This higher production per acre allows me to use less alfalfa acres to provide me the same amount of hay that I currently get from my conventional fields. This frees up some ground for me to rotate into other crops.

Third, because herbicide resistance is a heritable trait, it takes multiple growing seasons for herbicide tolerant weeds to emerge and become the predominant biotype in a specific area (Cole, 2010a, p. 4). Researchers have concluded that even if growers completely relied on only one herbicide, it is likely to take at least five years for an herbicide-resistant weed population to develop (Kniss, 2010a, p4; Beckie 2006, Neve, 2008; Werth et al., 2008). This is a reason why crop monitoring and follow up by University and industry weed scientists in cases of suspected resistance are important parts of all herbicide resistance stewardship programs.

The practice of repeated, in-season mowing combined with alfalfa's perennial nature reduce the likelihood of glyphosate-resistant weed development in >99 percent of the crop's acreage. The ability for alfalfa to fix nitrogen encourages the decision to follow alfalfa in the rotation with a crop that requires additional nitrogen, such as the annual grasses of corn and various cereal crops. These subsequently rotated crops can tolerate a spectrum of herbicides substantially different from the herbicides used in alfalfa. This encourages rotation of crops and herbicides, both of which are highly recommended for reducing the probability of developing herbicide resistant weeds (Orloff et al., 2009; USDA APHIS, 2009, P. 109).

Appendix
G

Chart of Anticipated Adoption of RRA Under Partial Deregulation, Prepared by Monsanto/FGI (August 4, 2010)


Partial Deregulation Projected Adoption of Roundup Ready Alfalfa
25,000
20,000
15,000
10,000
5,000
0
Acreage (1,000's)
US Alfalfa Acreage (2007)
Cumulative RRA
North Central
Intermountain
Plains
East Central
Pacfic N.W.
South West
South East
0
1
2
3
4
5
6
7
8
9
10
Year Following Partial Deregulation

Appendix
H

Roundup Ready Alfalfa Satisfaction Study
(Study #091 113 1108)
Prepared by Market Probe, Inc., December 2008

ROUNDUP READY ALFALFA SATISFACTION STUDY

(Study #091 113 1108)

Prepared By:

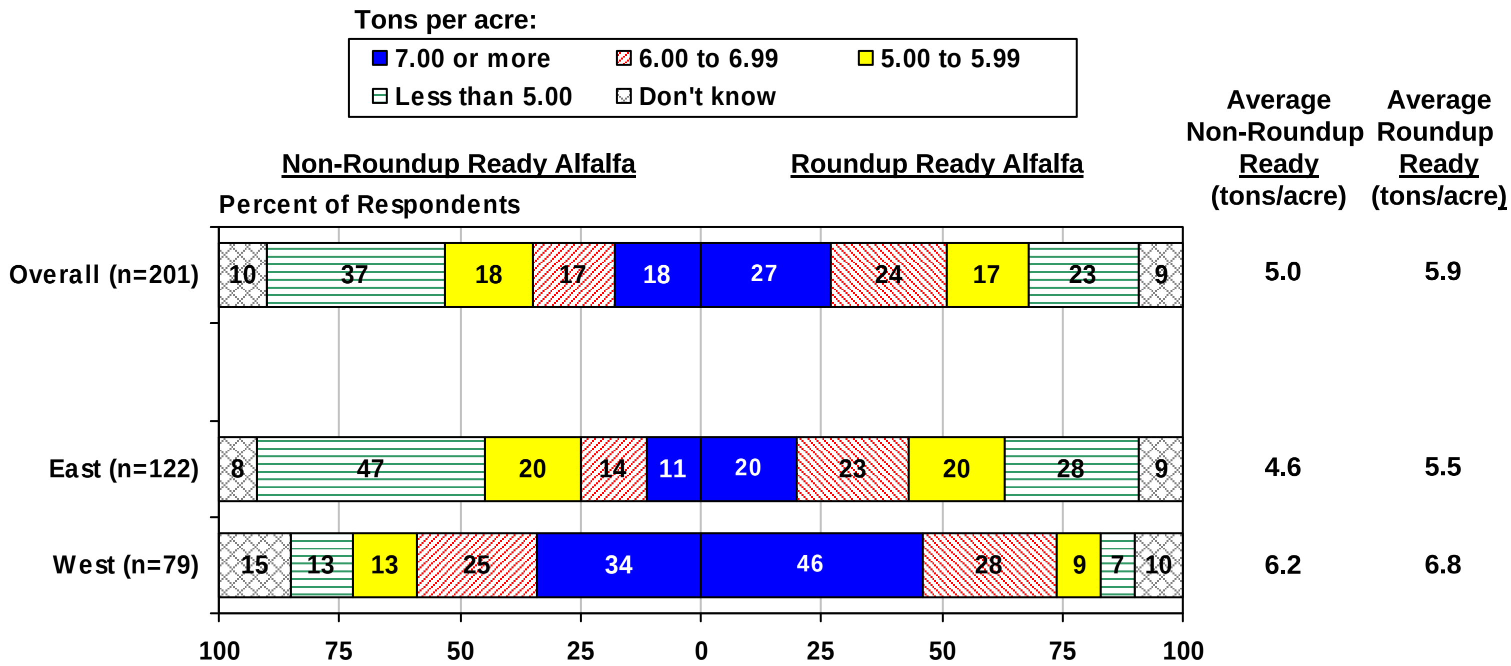
MARKET PROBE, INC.

St. Louis, Missouri

December 2008

Yields On Established Roundup Ready Acres Compared To Established Or Past Non-Roundup Ready Acres

[Base=All respondents]



Q.8b In terms of tons per acre, what was the annual yield on [Established Roundup Ready alfalfa acres][Established non-Roundup Ready alfalfa acres]?

Appendix
I

Putnam, D. and D. Undersander. 2009. Understanding Roundup Ready Alfalfa (Full Version). Originally Posted on the Hay and Forage Grower Magazine Web Site at: http://hayandforage.com/understanding_roundup_ready_alfalfa_revised.pdf (January 1, 2009)

Appendix I
Putnam and Undersander (2009)

Pages 1-3 of Appendix I:

Magazine Version

Holin, F. 2009. Roundup Ready Reality? (Partial version of Putnam and Undersander. 2009. Available at: http://license.icopyright.net/user/viewFreeUse.act?fuid=OTQxOTg4Mg%3D%3D (August 3, 2010)

Pages 4-6 of Appendix I:

Full Version

Putnam, D. and D. Undersander. 2009. Understanding Roundup Ready Alfalfa (full version). Originally posted on the Hay and Forage Grower Magazine web site at: http://hayandforage.com/understanding_roundup_ready_alfalfa_revised.pdf (January 1, 2009).

Hay & Forage GROWER

January 1, 2009

Roundup Ready Reality?

by Fae Holin

Is emotion trumping science in debates over the release of Roundup Ready alfalfa? Two forage specialists think so. They've put together a paper debunking what they call misinformation presented at annual conferences around the country.

"We want to dispel some of those myths," says Dan Undersander, University of Wisconsin extension forage specialist. Undersander and his colleague at University of California-Davis, Dan Putnam, offer "a scientific perspective" for alfalfa growers and industry representatives as they evaluate Roundup Ready (RR) alfalfa.

RR alfalfa, legalized in 2005, lost that designation with a court injunction just about two years later. A USDA environmental impact statement, required by the court, is nearing completion with a public comment period expected in the next month. A decision on whether the transgenic crop should again be made available to growers is expected to follow several months later.

In the meantime, the forage specialists want to make sure the alfalfa industry is well-informed. They've offered *Hay & Forage Grower* a preview of their paper, which will be published in its entirety at hayandforage.com [http://hayandforage.com/understanding_roundup_ready_alfalfa_revised.pdf].

Here's a synopsis of their concerns:

1. Once you release this gene, you can't call it back.

Undersander and Putnam respond that the gene is already out - more than 300,000 acres of RR alfalfa have been planted for hay and a limited amount planted for seed. The real question, they write, is whether growers can continue to plant conventional seed. Their answer: Only non-RR alfalfa is being planted now and, if concerned about contamination, growers can test it for the RR gene.

2. Won't contamination from neighboring fields result in all seed being Roundup Ready eventually?

"No," they emphasize, citing that seed production methods and isolation distances will keep the presence of the gene "at a very low level for seed" and that "non-genetically enhanced (non-GE) seed will always be available."

3. Won't my neighbor's RR hayfields contaminate my non-GE alfalfa hay production through pollen and gene flow?

"No," they write. "There is an extremely low probability of gene flow among hayfields. For this to happen, fields must flower at the same time, pollinators must be present to move pollen (it does not blow in wind), plants must remain in fields four to six weeks after flowering for viable seed production, seed must shatter to fall to the ground and establish on the soil surface, seedlings must overcome autotoxicity to germinate and seedlings must overcome competition from existing plants."

Pollen can only be carried by pollinators such as bees, and honey bees don't like to pollinate alfalfa, they add. The specialists discuss the difficulties of the seed germinating, concluding that if growers take care to plant non-RR seed, it's unlikely their hayfields will become contaminated with the gene.

4. Will the seed companies be able to keep seed from being contaminated?

"Yes. The greatest real potential for pollen flow and contamination is during seed production," Undersander and Putnam write. They cite ways the seed industry has agreed to keep track of transgenic seed and reasons why it's in the companies' best interests to do so.

5. Won't feral alfalfa be a source of contamination?

"Feral (wild growing) alfalfa can act as a bridge for moving genes from one seed field to another, and thus should be controlled to prevent gene flow in any area where seed production occurs, whether GE or not. Feral alfalfa is primarily an issue in portions of Western states because little occurs elsewhere," write the forage specialists. They discuss reasons why feral seed would have low production and suggest that removing plants from ditches and roads is a good idea to prevent gene flow.

6. Won't hard seed be a source of contamination?

"Hard seed of alfalfa generally does not persist for more than one year in moist soils, much less after years of hay production," they respond. "To guard against hard seed carryover, seed growers take steps to eliminate residual alfalfa volunteers prior to planting. State seed certification standards already require that the alfalfa seed field's history include a two-year exclusion period before planting alfalfa for seed."

7. Much of the hay in my area is cut late with mature seed - we have good farmers but weather and equipment problems force late cuttings.

"This occasionally happens," Putnam and Undersander answer. "However, plants must remain in a field for four to six weeks after pollination of flowers for viable seed to form and longer for seed to shatter." Delayed cutting will cause little to no seed production in hayfields, and hay harvest should remove seed.

The last seven concerns have to do with **8)** growing organic hay; **9)** export markets; **10)** whether seed companies bias the research on RR alfalfa; **11)** possible effects it may have on insects, animals or the environment; **12)** whether farmers can or will follow stewardship protocols; **13)** weed resistance to Roundup and **14)** whether the risks of RR alfalfa outweigh the rewards.

"There is also a risk with NOT moving ahead with a technology," Under-sander and Putnam contend. RR alfalfa will control tough weeds, they write. "Further, if this breeding methodology is permanently banned, it would mean fewer genetic advancements for alfalfa in the future.

"It is important that alfalfa growers and the industry understand how to use this important new genetic tool, while at the same time, protecting those farmers who don't wish to adopt it."

Authors: Dan Putnam, University of California, and Dan Undersander, Univeristy of Wisconsin
January 2009

Understanding Roundup Ready Alfalfa

A number of concerns have been raised about the release of Roundup Ready (RR) alfalfa, the first biotech trait in alfalfa. Many of these concerns have been fueled by misinformation. In this article, we provide a scientific perspective on these concerns that we hope will inform.

Concern 1. Once you release this gene – you can't call it back.

Over 300,000 acres of RR alfalfa have been planted for hay over the past 2 to 3 years, with a limited amount planted for seed. The real question is whether you can continue to plant conventional alfalfa seed and the answer is a resounding 'yes' – all of the seed currently for sale is 'conventional' – and you only need to test it (or ask the seed company to test it) with inexpensive test strips to make sure it does not contain the gene if you don't want it. Conventional alfalfa seed will continue to be available after Roundup Ready alfalfa is released.

Concern 2. Won't contamination from neighboring fields result in all seed being Roundup Ready, eventually?

No. Seed production methods and isolation distances currently recommended by seed companies should keep adventitious presence at a very low level for seed. A gene will increase in a population only if the new gene gives the plant an advantage over other plants and the conditions creating the advantage are consistently present. Conversely, if plants are grown in an environment where the gene provides no advantage, the gene is more likely to remain in the population at very low levels or to be lost from the population. The formulas for computing these changes in gene frequency can be found in most books on population or quantitative genetics, such as Falconer and MacKay, 1996, Introduction to Quantitative Genetics, Longman Press. Thus non-GE seed will always be available.

Concern 3. Won't my neighbor's Roundup Ready hay fields contaminate my conventional or organic alfalfa hay production through pollen and gene flow?

No. There is almost zero probability of gene flow among hay fields. For this to happen all the following must occur:

- fields must flower at same time.
- pollinators must be present to move pollen (it does not blow in wind).
- plants must remain in field 4 to 6 weeks after flowering for viable seed production.
- seed must shatter, to fall to ground and establish on soil surface.
- seedlings must to overcome autotoxicity to germinate.
- seedlings must to overcome competition from existing plants.

Pollen moves among alfalfa plants only when carried by pollinators such as bees, and honey bees do not like to pollinate alfalfa. Alfalfa seed takes many weeks after flowering to mature sufficiently to germinate and longer to shatter and fall onto the ground. Alfalfa seed does not readily spread. Alfalfa does not germinate well on the soil surface. Germination will be further reduced by alfalfa autotoxicity from existing planting in the hay field (this is why interseeding alfalfa to thicken a stand generally fails). Germinating seeds must compete with established plants for water, nutrients and sunlight. Data has shown that interseeded plants generally die during the first growing season. Thus, if a grower takes care to plant conventional seed, it is very unlikely that the Roundup Ready gene will move to their hay fields. (See Gene Flow in Alfalfa: Biology, Mitigation, and Potential Impact on Production, Special Publication of the Council for Agricultural Science and Technology (CAST) at http://www.cast-science.org/displayProductDetails.asp?idProduct=157)

Concern 4. Will the seed companies be able to keep seed from being contaminated?

Yes, the greatest real potential for pollen flow and contamination is during seed production. The seed industry has agreed on a field tagging technique in areas where RR alfalfa seed will be grown so neighbors and other seed companies will know where RR seed is being produced. The bulk of non-GE alfalfa seed is produced for export by seed production companies and it is in their own best interest to control seed production to continue to produce the 30% or more of total production as non-biotech for export. This large volume of export seed production is much more significant economically than the less than 1% of total seed market for organic seed production. However, concerns and methodology for exported seed will allow organic seed production indefinitely, making non-biotech seed available to growers.

Concern 5. Won't feral alfalfa be a source of contamination?

Feral (wild growing) alfalfa can act as a bridge for moving genes from one seed field to another, and thus should be controlled to prevent gene flow in any area where seed production occurs, whether biotech or not. Feral alfalfa is primarily an issue in portions of Western states because little occurs elsewhere. Feral alfalfa will have low seed production for the reasons described in #3 plus damage from lygus bug and infection from seed-borne fungi when seed develops under damp conditions. Seed from any feral plants will contribute to new plants only over a very short term, but removing feral alfalfa from ditches and roads is a good idea for organic and export growers to prevent gene flow. If feral alfalfa is deemed a problem in a specific area, then it must be controlled as off types of alfalfa and other problem weeds are currently controlled using cultural and other herbicide methods.

Concern 6. Won't hard seed be a source of contamination?

Hard seed of alfalfa generally does not persist for more than one year in moist soils (Albrecht et al. 2008 Forage and Grazinglands), much less after years of hay production. To guard against hard seed carryover, seed growers take steps to eliminate residual alfalfa volunteers prior to planting. State Seed Certification Standards already require that the alfalfa seed field's history include a 2-year exclusion period before planting alfalfa for seed.

Concern 7. Much of hay in my area is cut late with mature seed – we have good farmers but weather, equipment problems force late cuttings.

Although late cuttings occasionally happen viable seed development is unlikely. However, plants must remain in field for 4 to 6 weeks after pollination of flowers for viable seed to form and longer for seed to shatter. Delaying harvest 1 to 2 weeks due to weather, equipment problems and other issues will cause little to no seed production in hay fields (see item #3). Furthermore, hay harvest should remove this small amount of seed so that it doesn't become a problem.

Concern 8. Organic producers may have difficulty growing organic hay.

No – there is no reason that organic growers can't continue to successfully grow organic hay. In fact the presence of Roundup Ready alfalfa hay in the marketplace may increase the value of organic hay, for buyers who are sensitive to biotech traits. Current demand for organic hay has been high, in spite of the introduction of Roundup Ready alfalfa. There are a number of growers who currently grow both Roundup Ready alfalfa and organic hay on the same farm without difficulty. Organic growers should 1) select conventional seed that is tested for the trait if their customers have set a standard of no adventitious presence, 2) take simple steps to protect their crop from gene flow and 3) identify hay lots after harvest. Feedstuffs can be tested to ensure low biotech levels desired for these markets. Organic growers currently are certified to show that their crops are not grown with pesticides or non-organic fertilizers, and similar steps can be taken to show that they do not use genetically engineered crops.

Concern 9. Couldn't we lose our entire export market?

No. While export growers and buyers are sensitive to the presence of biotech traits in crops, they have developed market-assurance methods to demonstrate that they are marketing non-biotech alfalfa hay, including testing to assure buyers of the non-biotech status of hay. Japan, Taiwan, and Korea (main U.S. hay market) already use biotech corn and soybeans and have accepted some RR alfalfa hay. The European Union has approved use of certain biotech varieties of corn and soybeans in food and feedstuffs. While significant in some growing regions in the US, exported hay represents less than 1 % of total alfalfa hay production.

Concern 10. Isn't the research biased by the seed companies that stand to gain most?

RR technology at has been evaluated at many universities. This research is independent of the concerned commercial parties. The goal is to independently test a technology for its viability and environmental safety for farmers and for the general public. These studies must be well-designed, accurate and can only be published only after review by anonymous individuals from other institutions selected for impartiality.

Concern 11. Won't the Roundup Ready gene in alfalfa have a negative effect on insects, diseases, other biota, or the environment?

There is currently no evidence that this gene would have a negative effect on insects or animals, or the environment. The Roundup Ready gene has been thoroughly tested as other crops were released (corn, soybeans, cotton) and no impact on any other biota has been found. No toxicology issues have been identified with roundup ready alfalfa fed to animals. In the past ten years, billions of tons of corn, soybeans, cotton and alfalfa have been produced with this gene, and there has been no documented harm to animals, humans or wildlife. In fact the use of Roundup would replace some more toxic pesticides that have been used and found in ground water (e.g. Velpar).

Concern 12. Farmers can't/won't follow stewardship protocols.

All technology requires stewardship by farmers (e.g. fertilizer use, pesticide use, irrigation). Farmers must be educated about stewardship needed and required to use appropriate stewardship for any technology. The possibility of gene flow is no different in scope than controlling pesticide drift, fertilizer contamination from conventional farms, or for that matter, the influence of weeds from organic fields that may contaminate neighbor's fields. Good farmers know how to do this.

Concern 13. Won't there be weed resistance to Roundup from use of RR alfalfa?

Weed resistance and weed shifts are issues with all herbicides. New management programs have always resulted in shifts in weed pressure. For example, no-till crop production has resulted in different weed problems than when crops were grown with conventional tillage. Resistance to glyphosate has occurred in row crop situations. Inclusion of alfalfa might actually slow increase of resistant populations of weeds because an additional mechanical control (frequent hay harvest) is being added to the weed management program. Techniques are readily available to avoid weed shifts or weed resistance using the Roundup Ready system as detailed in a recent article (Orloff et al., 2008).

Concern 14. Risk far outweighs reward/Do we really need this? Are we willing to take this kind of gamble?

There is also a risk with NOT moving ahead with a technology that has clear potential benefits to farmers and the environment. Currently, many animals are killed or hurt each year by weedy alfalfa fields – something that Roundup Ready technology could help address. Also, some of the conventional herbicides have been found in well water – something not true with glyphosate. Additionally, Roundup Ready alfalfa would allow farmers to control tough weeds for which no other good method of control exists (e.g. winter annuals such as chickweed, wild garlic, wild onion, perennials such as dandelion. difficult weeds such as nutsedge and dodder, and poisonous weeds such as groundsel).

Further, if this breeding methodology is permanently banned, it would mean fewer genetic advancements for alfalfa in the future. Some traits currently under development, such as a low lignin gene that could mean higher forage yield and fewer cuttings for farmers, a leaf retention gene to retain leaves through harvesting process, genes which confer pest resistance, or genes to increase bypass protein, would never be available to farmers. It is not reasonable or fair to farmers to restrict a technology from use in alfalfa that is available in other crops.

A series of articles on biotech alfalfa and coexistence of GE and conventional alfalfa seed and hay production is available at http://www.alfalfa.org/CSCoexistenceDocs.html and http://alfalfa.ucdavis.edu/+producing/biotech.aspx.

In summary, it is essential that alfalfa growers and the industry understand how to use this important new genetic tool, while at the same time, protecting those farmers who don't wish to adapt it. Research has proceeded with great deliberation in the development of Roundup Ready alfalfa and shown it to be a good tool that will benefit many farmers. Like every other tool, it must be used with care and appropriate stewardship. It is important for the industry to manage for coexistence of biotech-adapting and non biotech-adapting farmers, since other important biotech traits are being developed which might be much greater benefit to farmers and society.

Dr. Dan Putnam, University of California
Dr. Dan Undersander, University of Wisconsin

Appendix

J

Roundup Ready Alfalfa Harvesting Study, Study #3482 (Originally Submitted as Appendix 6 to Monsanto/FGI Comments to Draft EIS)

ROUNDUP READY ALFALFA HARVESTING STUDY

Study #3482

Prepared By:

Market Probe

St. Louis, Missouri

January 2010

METHODOLOGY

- To achieve the objectives set for this study, a total of 200 telephone interviews were completed with growers who had Roundup Ready alfalfa acres in production in 2009 and/or 2010. The interviews were distributed regionally:

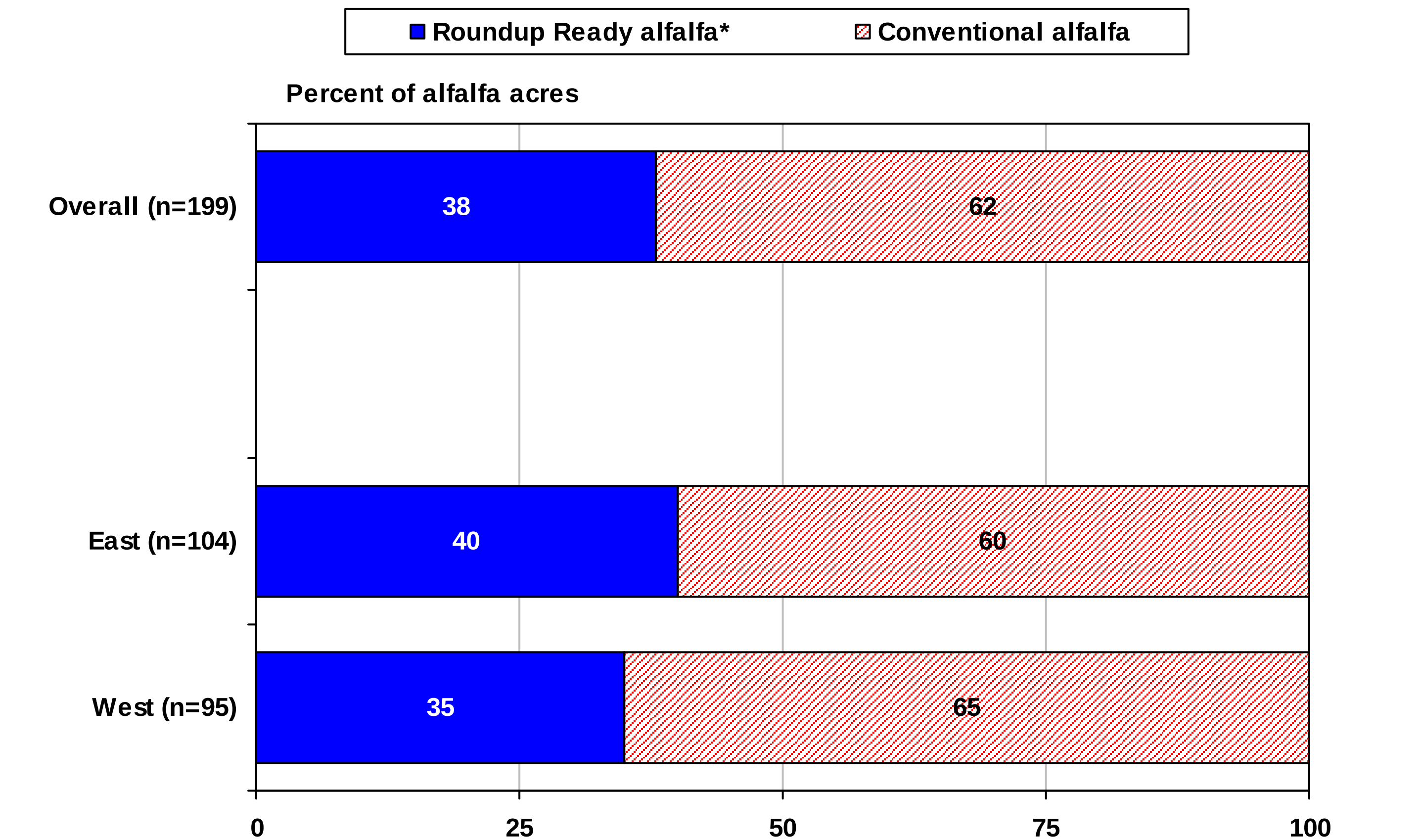
West:	WA/OR/ID/CA/NV/UT/AZ	N=95
East:	All other states, east of the Rockies	N=105

- Participants were screened on the following criteria:
  - Actively involved in farming
  - Primarily responsible for decisions concerning the management practices followed on alfalfa crop
  - Had 30+ acres of Roundup Ready alfalfa in production in 2009 or 2010
  - Not, nor anyone in household, working for a farm chemical manufacturer, distributor, or dealer
  - Not, nor anyone in household, working for a seed company, or as a farmer dealer
  - Not, nor anyone in household, raising alfalfa seed for a seed company

- A monetary honorarium was paid ($40-West and $20-East) to all participants. Interviews were conducted between January 18th and 25th, 2010.

2010 Roundup Ready Alfalfa Penetration

[Base=Respondents able to estimate]



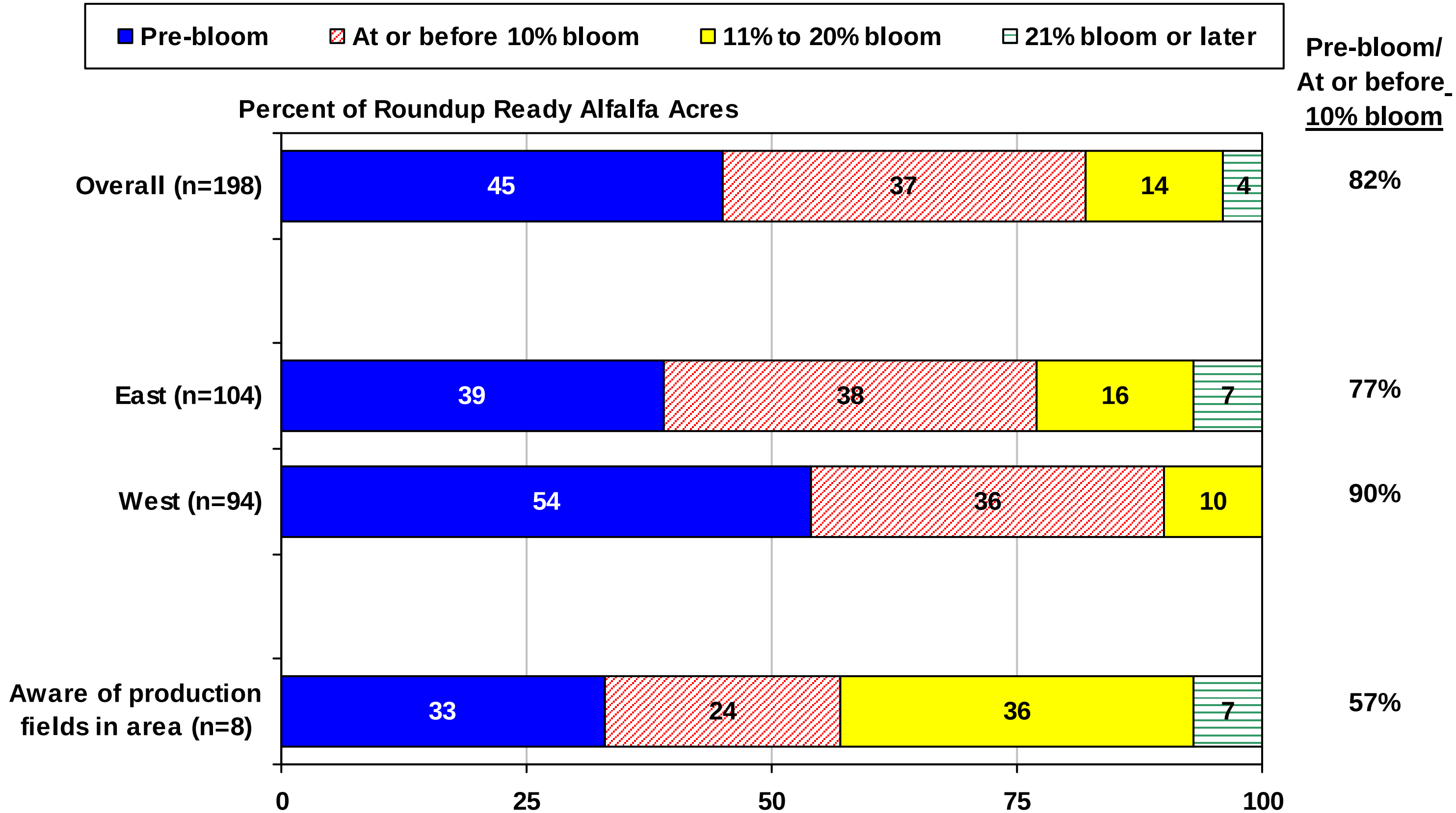
To be included in this study, growers were required to have Roundup Ready alfalfa acres in 2009 and/or 2010

Q.D How many acres of alfalfa, including both established and newly seeded, will you have this year in 2010?

Q.E And, how many, if any, of these [Q.D] acres are Roundup Ready alfalfa, and how many are conventional alfalfa?

Percent Of Roundup Ready Alfalfa Harvested At Specific Stage In 2009

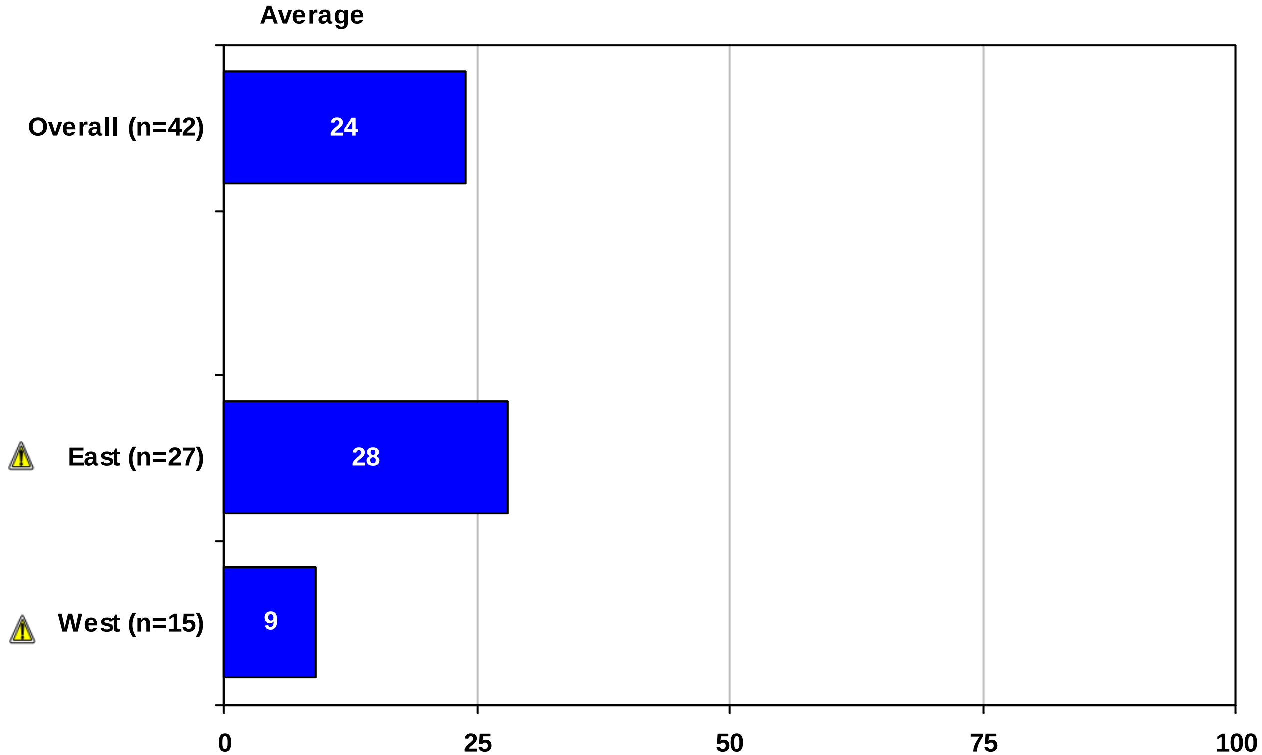
[Base=Respondents harvesting Roundup Ready alfalfa and able to estimate]



Q.3 In 2009, what percent of your total Roundup Ready alfalfa did you harvest:

Of the 18% of Occasions When Harvest Occurred After 10% Bloom, What Percent Were Due To Bad Weather?

[Base=Respondents harvesting at least some Roundup Ready alfalfa after 10% bloom, and able to estimate]



Q.4b What percent of the time was your decision to harvest Roundup Ready alfalfa after 10% bloom due to bad weather?

Appendix
K

Fitzpatrick, S. and G. Lowry. 2010. Alfalfa Seed Industry Innovations Enabling Coexistence. Proceedings of the 42nd North American Alfalfa Improvement Conference, Boise, Idaho, July 28-30, 2010

Alfalfa Seed Industry Innovations Enabling Coexistence

S. Fitzpatrick[*] and G. Lowry[**]

The alfalfa seed industry has recently implemented two complementary programs that together enable mutual coexistence between conventional and Roundup Ready alfalfa (RRA) seed producers. The 2010 Alfalfa Seed Stewardship Program (ASSP-2010) is an identity preserved process-based certificate offered by state seed certification agencies. It was developed by the Association of Official Seed Certifying Agencies (AOSCA) designed to serve GE-trait sensitive conventional seed producers (e.g., export). In 2008, the Best Management Practices for RRA Seed Production (BMPs) was adopted by the National Alfalfa & Forage Alliance. These BMPs are required coexistence protocols that apply only to RRA seed-producing companies (i.e., no new requirements are imposed upon external conventional seed producers). These market-driven, science-based programs were developed with the involvement of alfalfa industry stakeholders over a 5-year period (2005 to 2010) using all available market and gene flow data. An array of stakeholders were involved that represented diverse segments of the alfalfa seed and hay industries: scientists, seed certifiers, breeders, exporters, marketers, producers, growers and organic. These new programs are independent from and more stringent than AOSCA or OECD Seed Certification Programs. Forage Genetics and Pioneer Hi-Bred International (the only companies producing RRA seed), have collectively reported to inspectors that in 2009 greater than 97% of their conventional seed lots were produced without detection of the RRA trait (>500 lots tested with <0.00% RRA). If detected, AP was less than 0.5% (overall lot average <0.1%).

Seed Program	**No Program (e.g., common seed)**	**USDA National Organic Program Certification**	**Certified Seed**	**Roundup Ready Alfalfa (RRA) Seed**	**AOSCA AASP-2010 Identity Preserved, Certified Seed**
Market	U.S. domestic conventional (baseline)	Organic forage planting	U.S domestic conventional & RRA seed	U.S. domestic RRA seed	U.S. conventional seed for export
Purity Standard or Objective	n/a	No official purity standards; process-based requirements	≤1% off types	≤ 0.5% GE in *neighboring* conventional seed production	Non-detect GE
Spatial isolation from other seed field	n/a	Customized farm plan; not uniform mitigation standard	165 ft	900 ft to 3 mi at RRA seed field planting (pollinator specific)	≥5 miles
Program conforms to:	n/a	USDA-AMS National Organic Program	Federal Seed Act	Industry consensus and RRA seed co. contracts	AOSCA I. P. Program
Program monitored by:	n/a	Local Organic Certifying Agency	State Seed Certifying Agency	State Seed Certifying Agency	State Seed Certifying Agency
Program obligations fulfilled by:	n/a	Organic, conventional grower	Seed company and seed grower	RRA seed company and seed grower	GE-sensitive seed company and conventional seed grower
Growers using the program:	Conventional only	Conventional only	Both, conventional and RRA	All RRA, only	Conventional only

* Forage Genetics International, West Salem, WI

**Idaho Crop Improvement Association, Meridian, Idaho

RECEIVED
By APHIS BRS Document Control Officer at 3:13 pm, Aug 06, 2010

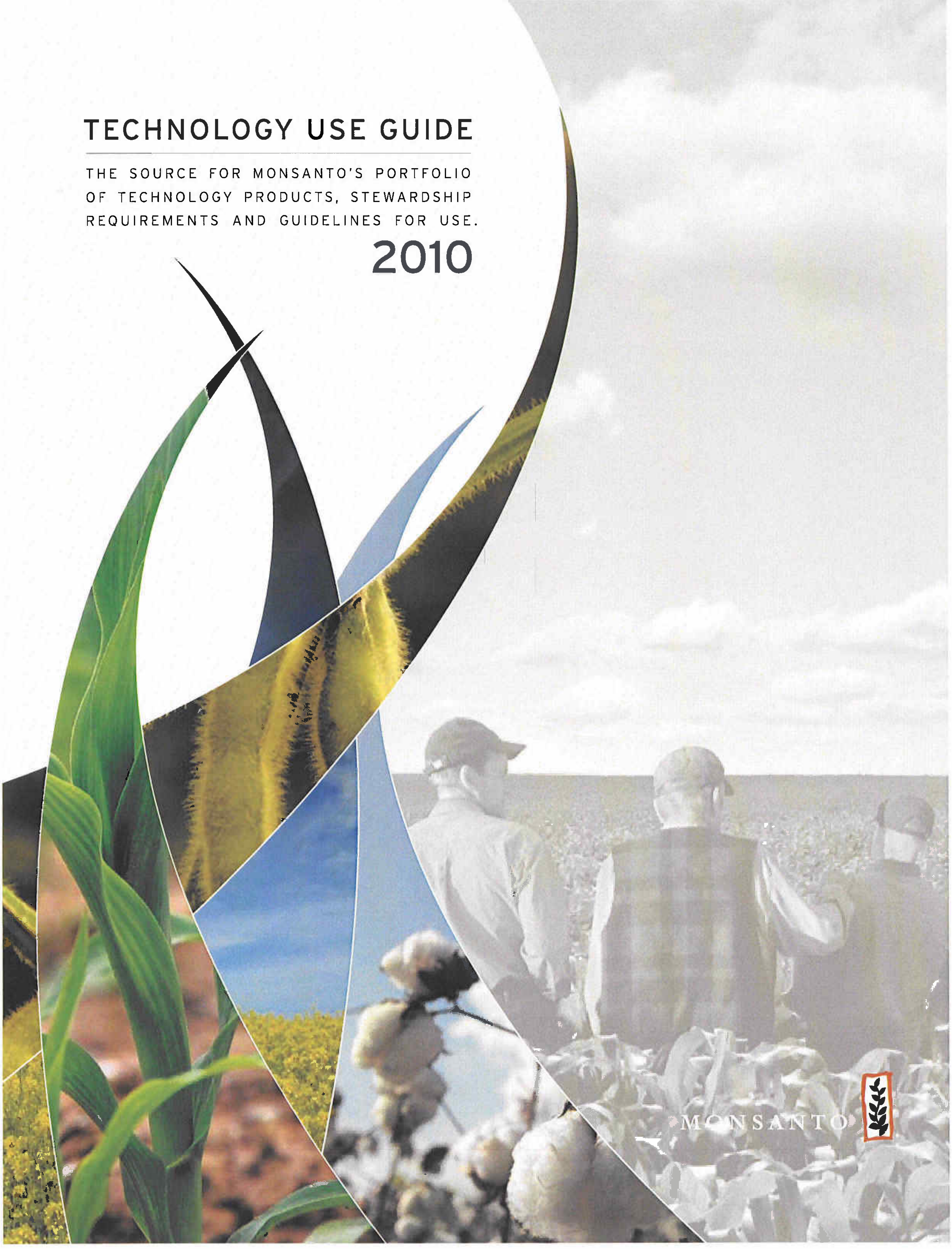
Appendix A

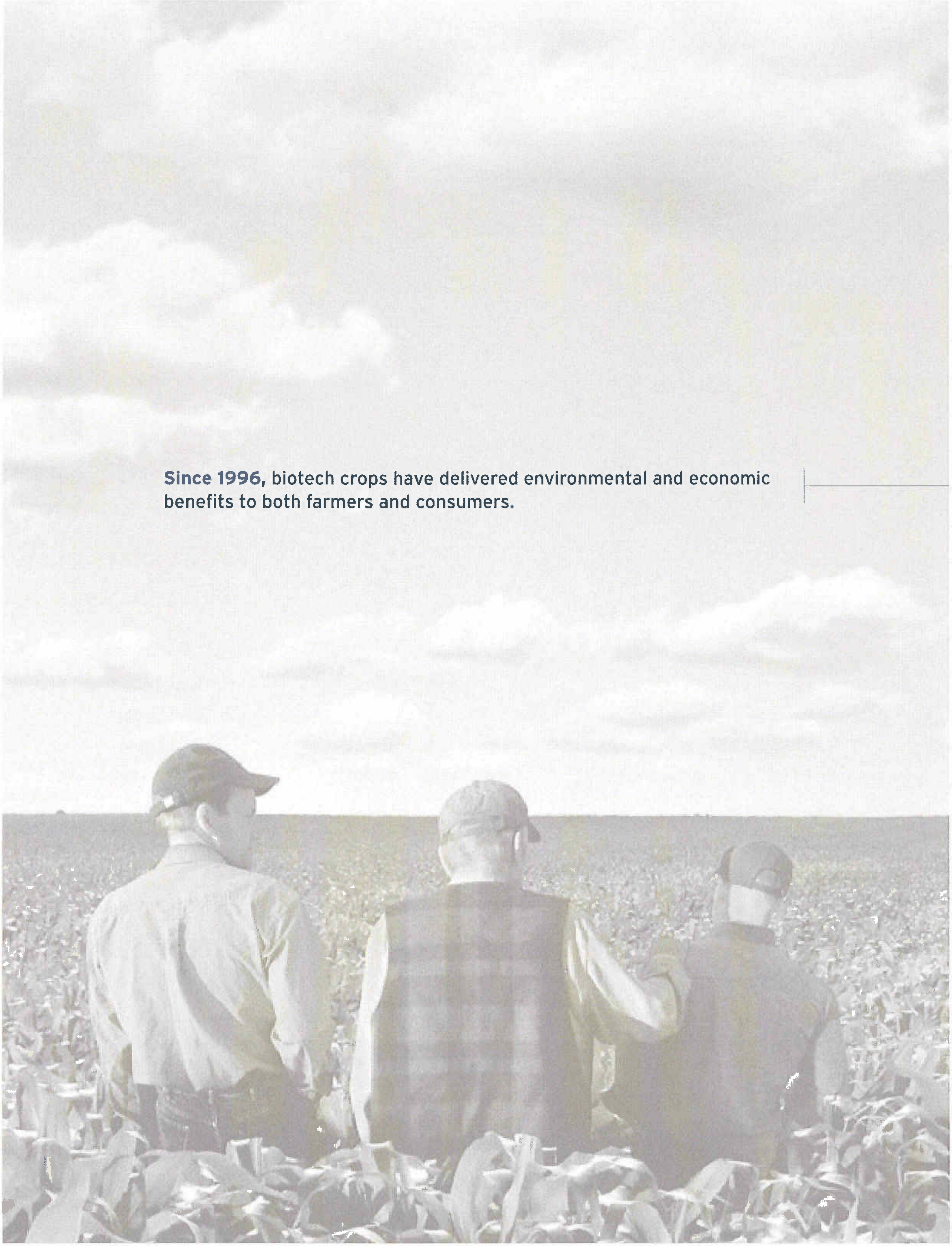
Monsanto Technology and Stewardship Agreement (MT/SA) and Accompanying Technology Use Guide (TUG)

TECHNOLOGY USE GUIDE

THE SOURCE FOR MONSANTO'S PORTFOLIO OF TECHNOLOGY PRODUCTS, STEWARDSHIP REQUIREMENTS AND GUIDELINES FOR USE.

2010





Since 1996, biotech crops have delivered environmental and economic benefits to both farmers and consumers.

$44 Increased **Billion**
farmers' net income

475 Saved **Million**
gallons of diesel fuel through reduced tillage or plowing

13.3 Grown by **Million**
farmers worldwide

0 reliably documented human or animal safety issues

Decreased
359,000
metric tons*
of pesticide applications

10 Eliminated **Million**
metric tons
of greenhouse gas emissions through fuel savings

Decreased
environmental impact quotient by
17.2% (EIQ)

Have been ingredients in an estimated
1,000,000,000,000
meals consumed

Source: www.biotech-gmo.com

*Pesticides registered by the U.S. EPA will not cause unreasonable adverse effects to man or the environment when used in accordance with label directions.

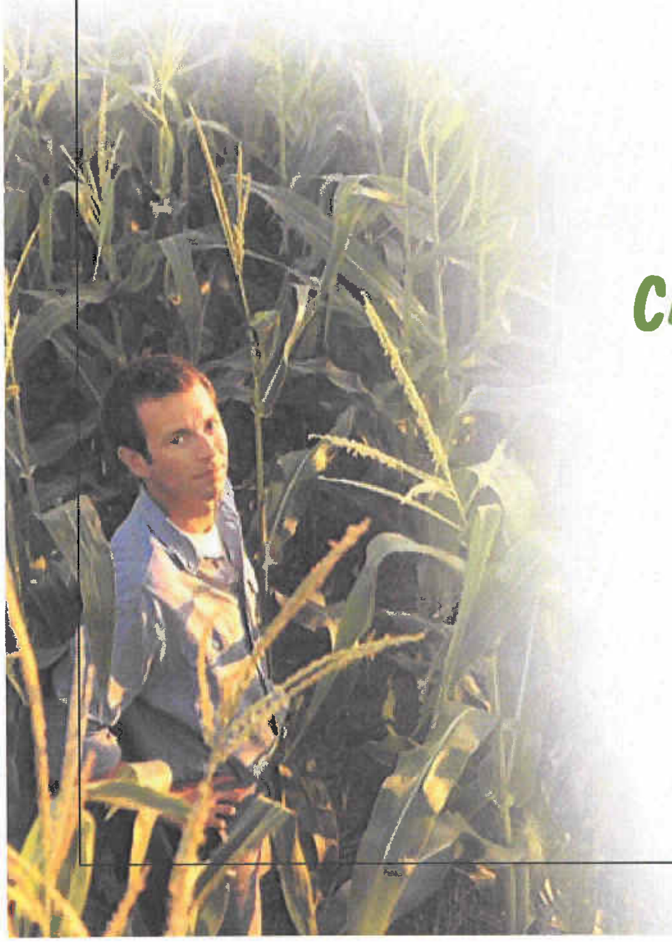
RE:NEW

YOUR ABILITY TO ENHANCE YOUR CROPS TODAY!

It's time to ReNEW your license

If you haven't renewed your Monsanto Technology/Stewardship Agreement (MTSA) in the past nine months, **take care of it today!**

Signing the MTSA ensures you'll have access to current and next-wave technologies. These innovations will enhance plant drought tolerance, cold tolerance, nitrogen use efficiency, yield and much more!



CALL

1-800-768-6387, Option 3

You'll then have the option to complete the process online or through conventional mail.

Paper MTSA's will continue to be accepted.

Introduction

This 2010 Technology Use Guide (TUG) provides a concise source of technical information about Monsanto's current portfolio of technology products and sets forth requirements and guidelines for the use of these products. As a user of Monsanto Technology, it is important that you are familiar with and follow certain management practices. Please read all of the information pertaining to the technology you will be using, including stewardship and related information. Growers must read the Insect Resistance Management (IRM)/Grower Guide prior to planting for important information on planting and IRM.

This technical guide is not a pesticide product label. It is intended to provide additional information and to highlight approved uses from the product labeling. Read and follow all precautions and use instructions in the label booklet and separately published supplemental labeling for the Roundup® agricultural herbicide product you are using.

Included in this guide is information on the following:

If you have any questions, contact your Authorized Retailer or Monsanto at 1-800-768-6387.

A Message About Stewardship - SEED AND TRAITS

Monsanto Company is committed to enhancing farmer productivity and profitability through the introduction of new agricultural biotechnology traits. These new technologies bring enhanced value and benefits to farmers, and farmers assume new responsibilities for proper management of these traits. Farmers planting seed with biotech traits agree to implement good stewardship practices, including, but not limited to:

- Reading, signing and complying with the Monsanto Technology/Stewardship Agreement (MTSA) and reading all annual license terms updates before purchase or use of any seed containing a trait.
- Reading and following the directions for use on all product labels.
- Following applicable stewardship practices as outlined in this TUG.
- Reading and following the IRM/Grower Guide prior to planting.
- Observing regional planting restrictions mandated by the U.S. Environmental Protection Agency (EPA).
- Complying with any additional stewardship requirements, such as grain or feed use agreements or geographical planting restrictions, that Monsanto deems appropriate or necessary to implement for proper stewardship or regulatory compliance.
- Following the Weed Resistance Management Guidelines to minimize the risk of resistance development.
- Complying with the applicable IRM practices for specific biotech traits as *mandated* by the EPA and set forth in this TUG.
- Utilizing all seed with biotech traits only for planting a single crop.
- Selling crops or material containing biotech traits only to grain handlers that confirm their acceptance, or using those products on farm.
- Not moving material containing biotech traits across boundaries into nations where import is not permitted.
- Not selling, promoting and/or distributing within a state where the product is not yet registered.

CROP OR MATERIAL HANDLING STEWARDSHIP STATEMENT

Monsanto Company is a member of Excellence Through Stewardship® (ETS). Monsanto products are commercialized in accordance with ETS Product Launch Stewardship Guidance, and in compliance with Monsanto's Policy for Commercialization of Biotechnology-Derived Plant Products in Commodity Crops. This product has been approved for import into key export markets with functioning regulatory systems. Any crop or material produced from this product can only be exported to, or used, processed or sold in countries where all necessary regulatory approvals have been granted. It is a violation of national and international law to move material containing biotech traits across boundaries into nations where import is not permitted. Growers should talk to their grain handler or product purchaser to confirm their buying position for this product. Excellence Through Stewardship® is a registered trademark of Biotechnology Industry Organization.

WHY IS STEWARDSHIP IMPORTANT?

Each component of stewardship offers benefits to farmers:

- Signing the MTSA provides farmers access to Monsanto's biotech trait seed technology.
- Following IRM guidelines guards against insect resistance to *Bacillus thuringiensis (B.t.)* technology and therefore enables the long-term viability of this technology, and meets EPA requirements.
- Proper weed management maintains the long-term effectiveness of glyphosate-based weed control solutions.
- Utilizing biotech seed only for planting a single-commercial crop helps preserve the effectiveness of biotech traits, while allowing investment for future biotech innovations which further improves farming technology and productivity.

Practicing these stewardship activities will enable biotechnology's positive agricultural contributions to continue.

Farmers' attitudes and adoption of sound stewardship principles, coupled with biotechnology benefits, provide for the sustainability of our land resources, biotechnology and farming as a preferred way of life.

SEED PATENT INFRINGEMENT

If Monsanto reasonably believes that a farmer has planted saved seed containing a Monsanto biotech trait, Monsanto will request invoices and records to confirm that fields in question have been planted with newly purchased seed. If this information is not provided within 30 days, Monsanto may inspect and test all of the farmer's fields to determine if saved seed has been planted. Any inspections will be coordinated with the farmer and performed at a reasonable time to best accommodate the farmer's schedule.

If you have questions about seed stewardship or become aware of individuals utilizing biotech traits in a manner other than as noted above, please call 1-800-768-6387. Letters reporting unacceptable or unauthorized use of biotech traits may be sent to:

Monsanto Trait Stewardship
800 N. Lindbergh Boulevard NC3C
St. Louis, MO 63167

For more information on Monsanto's practices related to seed patent infringement, please visit: www.monsanto.com/seedpatentprotection.

Provide Anonymous or Confidential reports as follows:

"Anonymous" reporting results when a person reports information to Monsanto in such a way that the identity of the person reporting the information cannot be identified. This kind of reporting includes telephone calls requesting anonymity and unsigned letters.

"Confidential" reporting results when a person reports information to Monsanto in such a way that the reporting person's identity is known to Monsanto. Every effort will be made to protect a person's identity, but it is important to understand that a court may order Monsanto to reveal the identity of people who are "known" to have supplied relevant information.

beyond the seed

You're buying more than just seed. You're getting value today and innovation for tomorrow.

COMMITMENT. INNOVATION. PERFORMANCE.

The Beyond the Seed Program was launched by the American Seed Trade Association (ASTA) to raise awareness and understanding of the value that goes beyond the seed. The future success of U.S. agriculture depends upon quality seed delivered by an industry commitment to bring innovation and performance through continued investment. For more information about seed technology, visit ASTA's Beyond the Seed Program at www.beyondtheseed.org.

Genuity™ Unites the Best Traits*

As a purchaser of Monsanto biotech trait products, your investment helps fuel the research and development engine that leads to the discovery and delivery of new technologies for agriculture. Current and future Genuity™ traits are designed to deliver high yield potential, maximize return on seed investments and consistently deliver future trait innovations.

CORN

Higher yields come from quality grain. Genuity™ VT Triple PRO™ was the next generation of corn technology available for the 2009 growing season. Genuity™ VT Triple PRO™ provides dual modes of action against above-ground pests such as corn earworm, European and southwestern corn borers, sugarcane borer, southern cornstalk borer and fall armyworm. Reduced kernel damage from corn earworm means the potential for reduced Aflatoxin contamination. Genuity™ VT Triple PRO™ dual modes-of-action also allows for a reduction in refuge acres required in southern cotton-growing regions while providing long-term effectiveness and consistency.

GENUITY™ SMARTSTAX™

Scheduled for launch in 2010, Genuity™ SmartStax™ is the most-advanced, all-in-one corn trait system that controls the broadest spectrum of above- and below-ground insects and weeds. Genuity™ SmartStax™ provides control of corn earworm, European corn borer, southwestern corn borer, sugarcane borer, fall armyworm, western bean cutworm, black cutworm, western corn rootworm, northern corn rootworm and Mexican corn rootworm. Genuity™ SmartStax™ contains Roundup Ready® 2 Technology and LibertyLink® herbicide tolerance. Genuity™ SmartStax™ also allows for a reduction in refuge acres in the corn belt from 20% down to 5% for above- and below-ground refuge. Genuity™ SmartStax™ is also approved for a 20% refuge in the cotton belt.

SOYBEAN

Genuity™ Roundup Ready 2 Yield® soybeans are taking yield to a higher level. They were developed to provide farmers with the same simple, dependable and flexible weed control and crop safety they've come to rely on with the first-generation Roundup Ready® soybean system, but with higher yield potential. This is possible because of advanced insertion and selection technologies.

COTTON

Genuity™ Roundup Ready® Flex and Genuity™ Bollgard II® offer the ultimate combination of peace of mind and flexibility. They contain unrivaled built-in worm control to stop the most leaf- and boll-feeding worm species, including bollworms, budworms, armyworms, loopers, saltmarsh caterpillars and cotton leaf perforators. Protecting just one additional boll per plant can result in significantly higher lint yield. The convenience and savings from fewer or no sprays for worms can make a big difference when it comes to the bottom line.

SPECIALTY

Genuity™ Roundup Ready® alfalfa: Bred from an innovative germplasm pool, it offers outstanding weed control, excellent crop safety and preservation of forage quality potential.

Genuity™ Roundup Ready® canola: Offers excellent control of broadleaf weeds and grasses, even in tough weather conditions. Also features excellent crop safety and broad application flexibility.

Genuity™ Roundup Ready® sugarbeets: Excellent in-plant tolerance to over-the-top applications of labeled Roundup agricultural herbicides. Offers outstanding weed control, excellent crop safety and preservation of yield potential.

*See pages 16 and 17 for additional traits.

NOTE: Farmers must read the IRM/Grower Guide prior to planting for information on planting and Insect Resistance Management.

Monsanto's New Generation of Technologies

As Monsanto continues to develop new generations of technologies, several of our newer technologies are migrating to the Genuity™ brand. These products and their new logos are presented below.

YieldGard VT™ Triple PRO → genuity™ VT Triple PRO

CORN

Roundup Ready 2 YIELD™ → genuity™ Roundup Ready 2 Yield

SOYBEANS

Roundup Ready FLEX COTTON → genuity™ Roundup Ready Flex

Bollgard II → genuity™ Bollgard II

Bollgard II with Roundup Ready Cotton → genuity™ Bollgard II + Roundup Ready COTTON

Bollgard II with Roundup Ready flex → genuity™ Roundup Ready Flex / Bollgard II

COTTON

Roundup Ready ALFALFA (Grow the Feed, Not the Weeds.) · Roundup Ready CANOLA · Roundup Ready SUGARBEETS → genuity™ Roundup Ready

SPECIALTY

Insect Resistance Management
Planting Refuges, Preserving Technology

An **EFFECTIVE** IRM program is a vital part of responsible product stewardship for insect-protected biotech products. Monsanto is committed to implementing an effective IRM program for all of its insect-protected *B.t.* technologies in all countries where they are commercialized, including promoting farmer awareness of these IRM programs. Monsanto works to develop and implement IRM programs that strike a balance between available knowledge and practicality, with farmer acceptance and implementation of the plan as critical components.

The U.S. EPA requires that Monsanto implement, and farmers who purchase insect-protected products follow, an IRM plan.* IRM programs for *B.t.* traits are based upon an assessment of the biology of the major target pests, farmer needs and practices, and appropriate pest management practices. These **mandatory regulatory programs** have been developed and updated through broad cooperation with farmer and consultant organizations, including the National Corn Growers Association and the National Cotton Council, extension specialists, academic scientists, and regulatory agencies.

*In some areas, a natural refuge option is available for Bollgard II. See the current IRM/Grower Guide for details.

The IRM programs for planting seeds containing *B.t.* traits contain several important elements. One key component of an IRM plan is a refuge. A refuge is simply a portion of the relevant crop (corn or cotton) that does not contain a *B.t.* technology for the control of the insect pests which are controlled by the planted technology(ies). The lack of exposure to the *B.t.* proteins means that there will be susceptible insects nearby to mate with any rare resistant insects that may emerge from *B.t.* products. Susceptibility to *B.t.* products is then passed on to offspring, preserving the long-term effectiveness of the technology.

Farmers who purchase seeds containing *B.t.* traits must plant an appropriately designed refuge. Refuge size, configuration, and management is described in detail in the sections on those products in the 2010 IRM/Grower Guide.

Failure to follow IRM requirements and to plant a proper refuge may result in the loss of a farmer's access to Monsanto technologies. Monsanto is committed to the preservation of *B.t.* technologies. Please do your part to preserve *B.t.* technologies by implementing the correct IRM plan on your farm.

MONITORING PROGRAM

The U.S. EPA requires Monsanto to take corrective measures in response to a finding of IRM non-compliance. Monsanto or an approved agent of Monsanto must monitor refuge management practices. The MTSA signed by a farmer requires that upon request by Monsanto or its approved agent, a farmer must provide the location of all fields planted with Monsanto technologies and the locations of all associated refuge areas as **required**, to cooperate fully with any field inspections, and allow Monsanto to inspect all fields and refuge areas to ensure an approved insect resistance program has been followed. All inspections will be performed at a reasonable time and arranged in advance with the farmer so that the farmer can be present if desired.

IRM GUIDELINES

Farmers must read the current IRM/Grower Guide prior to planting for information on planting and IRM. If you do not have a copy of the current IRM/Grower Guide, you may downloaded it at www.monsanto.com, or you may call 1-800-768-6387 to request a copy by mail.

Monsanto considers product stewardship to be a fundamental component of customer service and responsible business practices. As leaders in the development and stewardship of Roundup® agricultural herbicides and other products, Monsanto invests significantly in research to continuously improve the proper uses and stewardship of our proprietary herbicide brands.

This research, done in conjunction with academic scientists, extension specialists and crop consultants, includes an evaluation of the factors that can contribute to the development of weed resistance and how to properly manage weeds to delay the selection for weed resistance. Visit **www.weedtool.com** for practical, best practices-based information on reducing the risk for development of glyphosate-resistant weeds. Developed in cooperation with academic experts, the website provides options for managing the risk on a field-by-field basis.

Glyphosate is a Group 9 herbicide based on the mode of action classification system of the Weed Science Society of America. Any weed population may contain plants naturally resistant to Group 9 herbicides. The following general recommendations help manage the risk of weed resistance occurring.

WEED RESISTANCE MANAGEMENT PRACTICES:

- Scout your fields before and after herbicide application
- Start with a clean field, using either a burndown herbicide application or tillage
- Control weeds early when they are small
- Add other herbicides (e.g. a selective in-crop and/or a residual herbicide) and cultural practices (e.g. tillage or crop rotation) as part of your Roundup Ready® cropping system where appropriate
- Rotation to other Roundup Ready crops will add opportunities for introduction of other modes of action
- Use the right herbicide product at the right rate and the right time
- Control weed escapes and prevent weeds from setting seeds
- Clean equipment before moving from field to field to minimize spread of weed seed
- Use new commercial seed that is as free from weed seed as possible

Monsanto is committed to the proper use and long-term effectiveness of its proprietary herbicide brands through a four-part stewardship program: developing appropriate weed control recommendations, continuing research to refine and update recommendations, education on the importance of good weed management practices and responding to repeated weed control inquiries through a product performance evaluation program.

GLYPHOSATE-RESISTANT WEEDS

Monsanto actively investigates and studies weed control complaints and claims of weed resistance. When glyphosate-resistant weed biotypes have been confirmed, Monsanto alerts farmers and develops and provides farmers with recommended control measures, which may include additional herbicides, tank-mixes or cultural practices. Monsanto actively communicates all of this information to farmers through multiple channels, including the herbicide label, **www.weedscience.org**, supplemental labeling, this TUG, media and written communications, Monsanto's website, **www.weedresistancemanagement.com**, and farmer meetings.

Farmers must be aware of, and proactively manage for, glyphosate-resistant weeds in planning their weed control program. When a weed is known to be resistant to glyphosate, then a resistant population of that weed is by definition no longer controlled with labeled rates of glyphosate. Roundup® agricultural herbicide warranties will not cover the failure to control glyphosate-resistant weed populations.

Report any incidence of repeated non-performance on a particular weed to your local Monsanto representative, retailer or county extension agent.

Note: Always read and follow all pesticide label requirements.

ROUNDUP BRAND AGRICULTURAL OVER-THE-TOP HERBICIDE PRODUCTS

Read and follow all product labeling before using Roundup agricultural herbicides over the top of products with Roundup Ready Technology.

You may use another glyphosate herbicide, but only if it has federally approved label instructions for use over that specific Roundup Ready crop, and the product and the use label for that Roundup Ready crop has been approved by your specific state. Contact the product manufacturers, the local retailers or the local extension agents for confirmation that the products carry EPA and state approved labeling for this use. **MONSANTO DOES NOT MAKE ANY REPRESENTATIONS, WARRANTIES OR RECOMMENDATIONS CONCERNING THE USE OF GLYPHOSATE PRODUCTS SUPPLIED BY OTHER COMPANIES WHICH ARE LABELED FOR USE OVER ROUNDUP READY CROPS. MONSANTO SPECIFICALLY DENIES ALL RESPONSIBILITY AND DISCLAIMS ANY LIABILITY FOR ANY DAMAGE FROM THE USE OF THESE PRODUCTS IN ROUNDUP READY CROPS. ALL QUESTIONS AND COMPLAINTS CAUSED BY THE USE OF GLYPHOSATE PRODUCTS SUPPLIED BY OTHER COMPANIES SHOULD BE DIRECTED TO THE SUPPLIER OF THE PRODUCT IN QUESTION.**

MONSANTO BRANDS OF SELECTIVE OVER-THE-TOP HERBICIDE PRODUCTS

Herbicide products sold by Monsanto for use over the top of Roundup Ready crops for the 2010 crop season are as follows:

Roundup WeatherMAX® **Roundup PowerMAX®**

Read and follow all product labeling before using Roundup agricultural herbicides over the top of Roundup Ready traits. To learn more about applicable supplemental labels or fact sheets, call 1-800-768-6387.

Tank-mixtures of Roundup agricultural herbicides with insecticides, fungicides, micronutrients or foliar fertilizers are not recommended as they may result in reduced weed control, crop injury, reduced pest control or antagonism. Refer to the Roundup agricultural herbicide product label, supplemental labeling or fact sheets published separately by Monsanto for tank-mix recommendations.

Do not add additional surfactants and/or products containing surfactants to these Roundup agricultural herbicides unless otherwise directed by the label. Other glyphosate products labeled for use in Roundup Ready technologies may require the addition of surfactants, or other additives to optimize performance, that may increase the potential for crop injury. Monsanto will label and promote only fully tested brands that do not require surfactants and other additives for over-the-top applications to Roundup Ready Crops.

GLYPHOSATE ENDANGERED SPECIES INITIATIVE

Before making applications of glyphosate-based herbicide products, licensed farmers of crops containing Roundup Ready technology must access the website **www.pre-serve.org** to determine whether any mitigation requirements apply to the planned application to those crops, and must follow all applicable requirements. The mitigation measures described on the website are appropriate for all applications of glyphosate-based herbicides to all crop lands.

Farmers making only ground applications to crop land with a use rate of less than 3.5 lbs of glyphosate a.e./A are not required to access the website. If a farmer does not have web access, the seed dealer can access the website on behalf of the farmer to determine the applicable requirements, or the farmer can call 1-800-332-3111 for assistance.

RECOMMENDATIONS FOR MANAGING GLYPHOSATE-RESISTANT WEEDS IN ROUNDUP READY CROPS

In certain areas, populations of ryegrass, johnsongrass, marestail, common ragweed, giant ragweed, *Palmer Amaranth* and waterhemp are known to be resistant to glyphosate. For control recommendations for resistant biotypes of these weeds, refer to **www.weedresistancemanagement.com** or call 1-800-768-6387. When approved, supplemental labeling for specific herbicide products can also be viewed on **www.cdms.net** or **www.greenbook.net** or obtained by calling 1-800-768-6387.

Coexistence in agricultural production systems and supply chains is not new. Different agricultural systems have coexisted successfully for many years around the world. Standards and best practices were established decades ago and have continually evolved to deliver high purity seed and grain to support production, distribution and trade of products from different agricultural systems. For example, production of similar commodities such as field corn, sweet corn and popcorn has occurred successfully and in close proximity for many years. Another example is the successful coexistence of oilseed rape varieties with low erucic acid content for food use and high erucic acid content for industrial uses.

The introduction of biotech crops generated renewed discussion of coexistence focused on biotech production systems with conventional cropping systems and organic production. These discussions have primarily focused on the potential economic impact of the introduction of biotech products on other systems. The health and safety of biotech products are not an issue because their food, feed and environmental safety must be demonstrated before they enter the agricultural production system and supply chain.

The coexistence of conventional, organic and biotech crops has been the subject of several studies and reports. These reports conclude that coexistence among biotech and non-biotech crops is not only possible but is occurring. They recommend that coexistence strategies be developed on a case-by-case basis considering the diversity of products currently in the market and under development, the agronomic and biological differences in the crops themselves and variations in regional farming practices and infrastructures. Furthermore, coexistence strategies are driven by market needs and should be developed using current science-based industry standards and management practices. The strategies must be flexible, facilitating options and choice for the farmer and the food/feed supply chain, and must be capable of being modified as changes in markets and products warrant.

Successful coexistence of all agricultural systems is achievable and depends on cooperation, flexibility and mutual respect for each system. Agriculture has a history of innovation and change, and farmers have always adapted to new approaches or challenges by utilizing appropriate strategies, farm management practices and new technologies.

The responsibility for implementing practices to satisfy specific marketing standards or certification lies with that farmer who is growing a crop to satisfy a particular market. Only that farmer is instructed to employ the practices appropriate to assure the integrity of his/her crop. This is true whether the goal is high-oil corn, white/sweet corn or organically produced yellow corn for animal feed. In each case, the farmer is seeking to produce a crop that is supported by a market price and consequently that farmer assumes responsibility for satisfying reasonable market specifications. That said, the farmer needs to be aware of the planting intentions of his/her neighbor in order to gauge the need for management practices.

IDENTITY PRESERVED PRODUCTION

Some farmers may choose to preserve the identity of their crops to meet specific markets. Examples of Identity Preserved (I.P.) corn crops include production of seed corn, white, waxy or sweet corn, specialty oil or protein crops, food grade crops and any other crop that meets specialty needs, including organic and non-genetically enhanced specifications. Farmers of these crops assume the responsibility and receive the benefit for ensuring that their crop meets mutually agreed contract specifications.

Based on historical experience with a broad range of I.P. crops, the industry has developed generally accepted I.P. agricultural practices. These practices are intended to manage I.P. production to meet quality specifications, and are established for a broad range of I.P. needs. The accepted practice with I.P. crops is that each I.P. farmer has the responsibility to implement any necessary processes. These processes may include sourcing seed appropriate for I.P. specifications, field management practices such as adequate isolation distances, buffers between crops, border rows, planned differences in maturity between adjacent fields that might cross-pollinate and harvest and handling practices designed to prevent mixing and to maintain product quality. These extra steps associated with I.P. crop production are generally accompanied by incremental increases in cost of production and consequently of the goods sold.

General Instructions for Management of Pollen Flow and Mechanical Mixing

For all crop hybrids or varieties that they wish to identity preserve, or otherwise keep separated, farmers should take steps to prevent mechanical mixing. Farmers should make sure all seed storage areas, transportation vehicles and planter boxes are cleaned thoroughly both prior to and subsequent to the storage, transportation or planting of the crop. Farmers should also make sure all combines, harvesters and transportation vehicles used at harvest are cleaned thoroughly both prior to and subsequent to their use in connection with the harvest of the grain produced from the crop. Farmers should also make sure all harvested grain is stored in clean storage areas where the identity of the grain can be preserved.

Self-pollinated crops, such as soybeans, do not present a risk of mixing by cross-pollination. If the intent is to use or market the product of a self-pollinated crop separately from general commodity use, farmers should plant fields a sufficient distance away from other crops to prevent mechanical mixture.

Farmers planting cross-pollinated crops, such as corn or alfalfa, who desire to preserve the identity of these crops, or to minimize the potential for these crops to outcross with adjacent fields of the same crop kind, should use the same generally accepted practices to manage mixing that are used in any of the currently grown I.P. crops of similar crop kind.

It is generally recognized in the industry that a certain amount of incidental, trace level pollen movement occurs, and it is not possible to achieve 100% purity of seed or grain in any corn production system. A number of factors can influence the occurrence and extent of pollen movement. As stewards of technology, farmers are expected to consider these factors and talk with their neighbors about their cropping intentions.

Farmers should take into account the following factors that can affect the occurrence and extent of cross-pollination to or from other fields. Information that is more specific to the crop and region may be available from state extension offices.

- Cross-pollination is limited. Some plants, such as potatoes, are incapable of cross-pollinating, while others, like alfalfa, require cross-pollination to produce seed. Importantly, cross-pollination only occurs within the same crop kind, like corn to corn.
- The amount of pollen produced within the field can vary. The pollen produced by the crop within a given field, known as pollen load, is typically high enough to pollinate all of the plants in the field. Therefore, most of the pollen that may enter from other fields falls on plants that have already been pollinated with pollen that originated from plants within the field. In crops such as alfalfa, the hay cutting management schedule significantly limits or eliminates bloom, and thereby restricts the potential for pollen and/or viable seed formation.
- The existence and/or degree of overlap in the pollination period of crops in adjacent fields varies. This will vary depending on the maturity of crops, planting dates and the weather. For corn, the typical pollen shed period lasts from 5 to 10 days for a particular field. Therefore, viable pollen from neighboring fields must be present when silks are receptive in the recipient field during this brief period to produce any grain with traits introduced by the out-of-field pollen.
- Distance between fields of different varieties or hybrids of the same crop: The greater the distance between fields the less likely their pollen will remain viable and have an opportunity to mix and produce an outcross. For wind-pollinated crops, most cross-pollination occurs within the outermost few rows of the field. In fact, many white and waxy corn production contracts ask the farmer to remove the outer 12 rows (30 ft.) of the field in order to remove most of the impurities that could result from cross-pollination with nearby yellow dent corn. Furthermore, research has also shown that as fields become further separated, the incidence of wind-modulated cross-pollination drops rapidly. Essentially, the in-field pollen has an advantage over the pollen coming from other fields for receptive silks because of its volume and proximity to silks.
- The distance pollen moves. How far pollen can travel depends on many environmental factors, including weather during pollination, especially wind direction and velocity, temperature and humidity. For bee-pollinated crops, the farmer's choice of pollinator species and apiary management practice may reduce field-to-field pollination potential. All these factors will vary from season to season, and some factors from day to day and from location to location.
- For wind-pollinated crops, the orientation and width of the adjacent field in relation to the dominant wind direction. Fields oriented upwind during pollination will show dramatically lower cross-pollination for wind-pollinated crops, like corn, compared to fields located downwind.

Advanced breeding and biotechnology have had a major impact on farming production. From 1971 to 1995, average corn yields were increasing at a rate of 1.5 bushels per acre, per year. Since the advent of biotech in 1996, corn yields have increased at a rate of 2.6 bushels per acre, per year, for a total increase of 32 bushels per acre.*

Excellence Through Stewardship

Monsanto Company is a member of Excellence Through Stewardship® (ETS). Monsanto products are commercialized in accordance with ETS Product Launch Stewardship Guidance, and in compliance with Monsanto's Policy for Commercialization of Biotechnology-Derived Plant Products in Commodity Crops. This product has been approved for import into key export markets with functioning regulatory systems. Any crop or material produced from this product can only be exported to, or used, processed or sold in countries where all necessary regulatory approvals have been granted. It is a violation of national and international law to move material containing biotech traits across boundaries into nations where import is not permitted. Growers should talk to their grain handler or product purchaser to confirm their buying position for this product. Excellence Through Stewardship® is a registered trademark of Biotechnology Industry Organization.

IRM GUIDELINES

For specific refuge requirements for *B.t.* corn and cotton, see the current IRM/Grower Guide, sent with this TUG. If you have not received a copy of this Guide, it can be downloaded at **www.monsanto.com**, or call 1-800-768-6387 to request a copy be mailed to you.

Before opening a bag of seed, be sure to read and understand the stewardship requirements, **including applicable refuge requirements for insect resistance management,** for the biotechnology traits expressed in the seed as set forth in the Monsanto Technology Agreement that you sign. By opening and using a bag of seed, you are reaffirming your obligation to comply with those stewardship requirements.

* USDA Yields were calculated using 3 year rolling averages (32 Yield is 2.6 bu/ac *12 years). 2008 Yield is from Doane Ag Services forecast in April 8, 2008 Quarterly Crop Outlook.

Genuity™ Trait Products and YieldGard® Corn Technologies Product Descriptions

GENUITY™ SMARTSTAX™

Scheduled to launch in 2010, Genuity™ SmartStax™ is the most advanced, all-in-one corn trait system that controls the broadest spectrum of above- and below-ground insects and weeds. Genuity™ SmartStax™ hybrids will contain *B.t.* proteins that represent three separate modes of action for control of lepidopteron, above-ground insect pests, as well as combined modes of action for control of coleopteran, below-ground insect pests. Providing multiple *B.t.* proteins for control will dramatically decrease the probability that insects will become resistant to the traits, resulting in enhanced durability of transgenic insect control via *B.t.* genes. Based on this multiple gene approach, Genuity™ SmartStax™ is approved for reduced refuge in the corn belt from 20% down to 5% for both above- and below-ground pests. The cotton belt refuge for Genuity SmartStax™ is also reduced, from 50% down to 20%.

GENUITY™ VT TRIPLE PRO™

(Formerly YieldGard VT Triple PRO™) — Genuity™ VT Triple PRO™ is available in selected southern corn- and cotton-growing areas. It includes broad-spectrum insect control against corn earworm, European and southwestern corn borers, sugarcane borer, southern cornstalk borer, fall armyworm, western corn rootworm, northern corn rootworm and Mexican corn rootworm. Its advanced control of ear pests can result in higher grain quality and higher-yielding crop potential. The dual mode-of-action of Genuity™ VT Triple PRO™ allows for lower corn borer refuge acres in southern cotton-growing areas compared to other registered *B.t.*-traited products. It includes the same Roundup Ready® 2 Technology as Monsanto's previous product, YieldGard VT Triple. Seed containing Genuity™ VT Triple PRO™ technology is treated with seed-applied insecticide.*

YIELDGARD VT TRIPLE®

YieldGard VT Triple technology combines YieldGard Corn Borer and YieldGard VT Rootworm/RR2® technology into a single plant. YieldGard VT Triple corn hybrids control European and southwestern corn borer, sugarcane borer, southern cornstalk borer, western corn rootworm, northern corn rootworm and Mexican corn rootworm. YieldGard VT Triple technology suppresses corn earworm, fall armyworm and stalk borer. By providing in-plant protection against the above insect pests, the genetic yield potential of YieldGard VT Triple corn hybrids is preserved. YieldGard VT Triple corn hybrids also include Roundup Ready 2 Technology. This trait allows a farmer to experience the benefits of utilizing Roundup agricultural herbicides in a weed control system that provides the broadest weed control spectrum available, better application flexibility, and superior crop safety. Seed containing YieldGard VT Triple technology is treated with seed-applied insecticide.*

GENUITY™ VT DOUBLE PRO™

Genuity™ VT Double PRO™ is a new corn technology scheduled for launch in 2010. It includes broad-spectrum insect control against corn earworm, European and southwestern corn borers, sugarcane borer, southern cornstalk borer and fall armyworm. The dual mode-of-action of Genuity™ VT Double PRO™ allows for lower corn borer refuge acres compared to other registered *B.t.*-traited products. Seed containing Genuity™ VT Double PRO™ technology is treated with seed-applied insecticide.*

*A seed-applied insecticide can protect seed, roots and seedlings from insects such as black cutworm, wireworm, white grubs, seed corn maggots, chinch bug and early flea beetles.

YieldGard VT Rootworm/RR2

YIELDGARD VT ROOTWORM/RR2®

YieldGard VT Rootworm/RR2 technology is the current YieldGard stacked-trait product for control of western corn rootworm, northern corn rootworm and Mexican corn rootworm. Protecting the root of the corn plant from feeding by corn rootworm larvae decreases lodging and protects the genetic yield potential of YieldGard VT Rootworm/RR2 corn hybrids. The Roundup Ready 2 Technology allows a farmer to experience the benefits of utilizing Roundup agricultural herbicides in a weed control system that provides the broadest weed control spectrum, better application flexibility and superior crop safety. Seed containing YieldGard VT Rootworm/RR2 technology is treated with seed-applied insecticide.*

YIELDGARD® CORN BORER

YieldGard Corn Borer corn hybrids contain an insecticidal protein from *B.t.* that protects corn plants from European corn borer, southwestern corn borer, sugarcane borer and southern cornstalk borer resulting in full yield potential.

Maximum Insect Protection

YIELDGARD PLUS

YieldGard Plus corn technology combines YieldGard Corn Borer and YieldGard Rootworm technology into a single plan.

YIELDGARD ROOTWORM

YieldGard Rootworm corn hybrids contain an insecticidal protein from *B.t.* that protects corn roots from larval feeding by western, northern and Mexican corn rootworm.

YIELDGARD® CORN BORER WITH ROUNDUP READY® CORN 2

YieldGard Corn Borer with Roundup Ready Corn 2 offers farmers all the benefits of both traits combined in one crop. These hybrids exhibit the same insect protection qualities as YieldGard Corn Borer and, like Roundup Ready Corn 2, are tolerant to over-the-top applications of Roundup® agricultural herbicides.

Maximum Insect Protection

YIELDGARD PLUS WITH ROUNDUP READY CORN 2

YieldGard Plus with Roundup Ready Corn 2 offers farmers all the benefits of all three traits combined in one crop. These hybrids exhibit the same insect protection qualities of YieldGard Corn Borer and YieldGard Rootworm and, like Roundup Ready Corn 2, are tolerant to over-the-top applications of Roundup® agricultural herbicides. Seed containing YieldGard Plus technology is treated with seed-applied insecticide.*

YIELDGARD ROOTWORM WITH ROUNDUP READY CORN 2

YieldGard Rootworm with Roundup Ready Corn 2 offers farmers all the same insect protection qualities as YieldGard Rootworm and, like Roundup Ready Corn 2, is tolerant to over-the-top applications of Roundup agricultural herbicides.

*A seed-applied insecticide can protect seed, roots and seedlings from insects such as black cutworm, wireworm, white grubs, seed corn maggots, chinch bug and early flea beetles.

ROUNDUP READY® Technology in Corn

WEED CONTROL RECOMMENDATIONS

Roundup Ready® Corn 2 (RR2) and corn with Roundup Ready® 2 Technology are equivalent in their tolerance to Roundup agricultural herbicides. Products with Roundup Ready Technology contain in-plant tolerance to Roundup agricultural herbicides.

The Roundup Ready® Technology system's flexibility, broad-spectrum weed control and proven crop safety offer farmers weed control programs that allow them to use the system in the way that provides the greatest benefit. Farmers can select the program that best fits the way they farm. Options include the use of a residual herbicide with a Roundup® agricultural herbicide, tank-mixing other herbicides with Roundup agricultural herbicides where appropriate and a total postemergence program.

AGRONOMIC PRINCIPLES

Corn yield is very sensitive to early-season weed competition. Weed control systems must provide farmers the opportunity to control weeds before they become competitive. The Roundup Ready Technology system provides a mechanism to control weeds at planting and once they emerge. Farmers are provided excellent crop safety and full yield potential, with applications made from planting through 48" of corn height. Drop nozzles must be used between 30" and 48" of corn height. Failure to control weeds with the right rate, at the right time and with the right product, can lead to increased weed competition, weed escapes and the potential for decreased yields. Use other approved herbicide products with Roundup agricultural herbicides if appropriate for the weed spectrum.

<table>
<tr><th>PROGRAM</th><th>INSTRUCTIONS AND USE RATES*</th><th>ADDITIONAL INFORMATION</th></tr>
<tr>
<td>For use where residual herbicides are typically used for early-season weed control:

Residual Herbicide Plus Roundup WeatherMAX®</td>
<td>Use the proper Roundup Ready RATE™ of Bullet®, Degree®, Degree Xtra®, Harness®, Harness Xtra, Harness Xtra 5.6L, Micro-Tech™, or Lariat® (no post) as defined in the table below and the individual product labels, either pre or postemergence to the crop.**

Follow with Roundup WeatherMAX at 16 to 22 oz/A post sequentially after preemergence application or tank-mixed in-crop with the residual. Applications should be made before weeds exceed 4" in height.

Roundup Ready RATEs***
<table>
<tr><td>Harness</td><td>1.5</td><td>Pints</td></tr>
<tr><td>Degree</td><td>3.0</td><td>Pints</td></tr>
<tr><td>Harness Xtra</td><td>1.2</td><td>Quarts</td></tr>
<tr><td>Harness Xtra 5.6L</td><td>1.5</td><td>Quarts</td></tr>
<tr><td>Degree Xtra</td><td>2.0</td><td>Quarts</td></tr>
<tr><td>Micro-Tech</td><td>2.0</td><td>Quarts</td></tr>
<tr><td>Lariat</td><td>2.0</td><td>Quarts</td></tr>
<tr><td>Bullet</td><td>2.0</td><td>Quarts</td></tr>
</table>
</td>
<td>Use full labeled rate of residual when application is 14 days or more prior to planting or when tough grasses are present, e.g., barnyardgrass, shattercane, seedling johnsongrass, sandbur.

Use a minimum of 2.5 pt/A of Harness on woolly cupgrass and wild proso millet.

Products containing atrazine will provide improved control of cocklebur, giant ragweed, Palmer Amaranth and morningglory.

Tank-mix products such as 2,4-D, dicamba or Status® herbicide with Roundup WeatherMAX for control of glyphosate-resistant marestail (horseweed), Palmer Amaranth and other difficult-to-control weeds.

Use 22 to 32 oz/A of Roundup WeatherMAX* when morningglory or perennial weeds are present or when broadleaf weeds are 4" in height or taller.</td>
</tr>
<tr>
<td>For use where total postemergence programs are effective and sustainable:

Roundup WeatherMAX Sequential</td>
<td>Apply Roundup WeatherMAX at 16 to 22 oz/A before weeds exceed 4" in height and follow with a second application at 16 to 22 oz/A for an additional flush of weeds before they exceed 4" in height.</td>
<td>Use 22 to 32 oz/A of Roundup WeatherMAX when morningglory or perennial weeds are present.

Tank-mix products such as 2,4-D, dicamba or Status herbicide with Roundup WeatherMAX for control of glyphosate-resistant marestail (horseweed), Palmer Amaranth and other difficult-to-control weeds.</td>
</tr>
<tr>
<td>Maximum Use Rates For Roundup WeatherMAX</td>
<td>Products with Roundup Ready 2 Technology In-crop:
• 32 oz/A per single application
• Total: 64 oz/A from emergence through 48" height of corn, drop nozzles must be used from 30" to 48" corn.</td>
<td>Products with Roundup Ready 2 Technology Total Season:
The combined total of preplant, in-crop and preharvest applications of Roundup WeatherMAX can not exceed 5.3 qt/A. The combined total of in-crop and preharvest applications can not exceed 66 oz/A.</td>
</tr>
</table>

*If using another Roundup agricultural herbicide, you must refer to the label booklet or Roundup Ready Corn 2 Technology supplemental label for that brand to determine appropriate use rates. If using Roundup PowerMAX®, application rates are the same as for Roundup WeatherMAX. If using another residual herbicide, follow the labeled use rate instructions applicable to Roundup Ready Corn 2. Follow all pesticide label requirements.

**Atrazine may also be used as a residual herbicide in the Roundup Ready Corn 2 System.

***You may apply up to the full residual herbicide labeled rate for corn.

WEED RESISTANCE MANAGEMENT FOR CORN WITH ROUNDUP READY TECHNOLOGY

Follow all pesticide label requirements and the guidelines below to minimize the risk of developing glyphosate-resistant weed populations in a Roundup Ready Technology system.

- Start clean with a burndown herbicide or tillage. Early-season weed control is critical to yield.
- Apply pre-emergence residual herbicides such as Harness Xtra, Degree Xtra or other residual herbicides at the recommended rate.
- Or apply a pre-emergence residual herbicide at the recommended rate tank-mixed with Roundup WeatherMAX® at a minimum of 22 oz/A in-crop before weeds exceed 4" in height.
- Follow with a postemergence in-crop application of Roundup WeatherMAX at a minimum of 22 oz/A for additional weed flushes before they exceed 4" in height.
- Roundup WeatherMAX may be tank-mixed with other herbicides for postemergence weed control.
- Report repeated non-performance to Monsanto or your local retailer.

RECOMMENDATIONS FOR MANAGING GLYPHOSATE-RESISTANT WEEDS IN PRODUCTS WITH ROUNDUP READY TECHNOLOGY

WEEDS	INSTRUCTIONS AND USE RATES*
Glyphosate-Resistant Marestail (Horseweed)	Start clean with a burndown program or tillage. -Tank-mix Roundup agricultural herbicides with 2,4-D, or dicamba, according to the label directions. In-crop, tank-mix 22 ounces per acre of Roundup WeatherMAX with Clarity® (8 to 16 fluid ounces per acre) or 2,4-D (0.5 to 1.0 lb active ingredient per acre) from corn emergence to the 5-leaf stage of corn growth (approximately 8" tall). Or tank-mix 22 ounces per acre of Roundup WeatherMAX with 5 ounces per acre of Status® herbicide when the corn is 4" to 36" tall (V2 to V10). Marestail should not exceed 6" in height at the time of in-crop application.
Glyphosate-Resistant *Amaranthus* Species **- *Palmer Amaranth*** **- Waterhemp**	Start clean with a burndown program or tillage. Use a residual herbicide such as Harness Xtra, Harness Xtra 5.6L, Degree Xtra or other residual herbicide either preemergence or in-crop for control of *Amaranthus* species. In-crop, tank-mix Roundup WeatherMAX with other herbicides such as 2,4-D, dicamba (Clarity or Banvel®) or Status herbicide to control emerged weeds. Applications of Status herbicide should be made when the corn is between 4" and 36" tall (V2 to V10). Follow all label directions. *Amaranthus* species should not exceed 3" in height at the time of in-crop application.
Glyphosate-Resistant *Ambrosia* Species **- Giant Ragweed** **- Common Ragweed**	Start clean with a burndown program or tillage. Use a residual herbicide such as Harness Xtra, Harness Xtra 5.6L, Degree Xtra or other residual herbicide either preemergence or in-crop for control of *Ambrosia* species. In-crop, tank-mix Roundup WeatherMAX with other herbicides such as 2,4-D, dicamba (Clarity or Banvel) or Status herbicide to control emerged weeds. Applications of Status herbicide should be made when the corn is between 4" and 36" tall (V2 to V10). Follow all label directions. *Ambrosia* species should not exceed 3" in height at the time of in-crop application.
Glyphosate-Resistant Johnsongrass	Start clean with a burndown program or tillage. Use a residual herbicide such as Harness Xtra, Harness Xtra 5.6L, Degree Xtra or other residual herbicide containing atrazine preemergence to reduce the competition from seedling johnsongrass prior to the emergence of corn. In-crop, tank-mix Roundup WeatherMAX with a herbicide such as Accent®, Equip™ or Option® for control of emerged weeds including seedling and rhizome johnsongrass. Follow all label directions of tank-mix partners, especially those related to weed size.

In certain areas, Italian ryegrass is known to be resistant to glyphosate. For control recommendations, refer to **www.weedresistancemanagement.com** or call 1-800-768-6387. When approved, supplemental labeling for specific herbicide products can also be viewed on **www.cdms.net** or **www.greenbook.net.**

*Follow all pesticide label requirements.

Genuity™ Bollgard II® and Bollgard® Cotton Descriptions

GENUITY™ BOLLGARD II® COTTON

Genuity™ Bollgard II® cotton contains two distinct insecticidal proteins from *Bacillus thuringiensis (B.t.)* that increase the efficacy and spectrum of control and reduce the chance that resistance will develop to the *B.t.* insecticidal proteins, relative to Bollgard® cotton. Genuity™ Bollgard II® cotton normally provides excellent, season-long control of tobacco budworm, pink bollworm and cotton bollworm. Genuity™ Bollgard II® cotton provides good protection against fall armyworm, beet armyworm, cabbage and soybean loopers and other secondary leaf- or fruit-feeding caterpillar pests of cotton. Applications of insecticides to control these insects are substantially reduced with Genuity™ Bollgard II® cotton.

BOLLGARD® COTTON

Bollgard cotton contains a single insecticidal protein from *B.t.* that provides good control against three major lepidopteran insect pests of cotton. Specifically, Bollgard cotton provides excellent, season-long control of tobacco budworm and pink bollworm, and suppression of cotton bollworm. When the above-mentioned insect larvae feed on Bollgard cotton plants, the *B.t.* protein protects the plants from damage by reducing larval survival. Under high infestation, application of insecticides may be necessary to protect Bollgard cotton.

BOLLGARD PHASE OUT

The U.S. Environmental Protection Agency has mandated the following terms and conditions:*

- Bollgard® cotton may be sold through September 30, 2009. After that date, all sales of Bollgard cotton are prohibited.
- All Bollgard cotton seed must be planted by midnight of July 1, 2010 (the expiration date of the Bollgard cotton registration). After July 1, 2010, planting of Bollgard cotton seed is prohibited. Any Bollgard cotton seed not planted on or before July 1, 2010, must be returned to either the retailer or to Monsanto. No refunds are to be issued on Bollgard cotton seeds bought for planting in 2010 and returned by growers.
- An adequate amount of refuge seed must be purchased for planting an appropriate refuge for Bollgard cotton. Purchase of refuge seed with the Bollgard cotton seed is mandatory, and such seed must be purchased by growers in advance of their receipt of Bollgard cotton seed. Any seed purchased for use as a refuge is non-refundable, unless the proportional amount of Bollgard cotton seed that the refuge seed would have supported is returned at the same time.
- Any order for replacement or additional Bollgard cotton seed for the 2010 planting season, that does not conform to the requirements stated above must be filled with Genuity™ Bollgard II® cotton seed (or other products with current registrations).
- On-farm IRM assessments will be conducted during the planting season.
- In 2010, Bollgard cotton may only be planted in: Alabama, Arkansas, Florida (North of Florida Route 60), Georgia, Kentucky, Louisiana, Maryland, Missouri, Mississippi, North Carolina, South Carolina, Tennessee, Texas (excluding the ten prohibited Texas panhandle counties of: Dallam, Sherman, Hansford, Ochiltree, Lipscomb, Hartley, Moore, Hutchinson, Roberts, and Carson) and Virginia.

*It is a violation of federal law to sell or distribute an unregistered pesticide.

NOTE: Sale or commercial planting of Bollgard®cotton is prohibited in certain states, including: Arizona, California, Colorado, Kansas, New Mexico and Oklahoma.

Sale or planting of Bollgard is prohibited in the Texas counties of: Carson, Dallam, Hansford, Hartley, Hutchinson, Lipscomb, Moore, Ochiltree, Roberts, and Sherman.

Sale or commercial planting of both Genuity™ Bollgard II® and Bollgard is prohibited in Hawaii, Puerto Rico, the U.S. Virgin Islands, and in Florida south of Route 60 (near Tampa).

The *B.t. delta endotoxin* protein expressed in this cotton targets certain cotton insect pests. Routine applications of insecticides to control certain insects are usually unnecessary when cotton containing the *B.t. delta endotoxin* protein is planted. However, if insecticide applications are necessary to control certain cotton insect pests, follow all label requirements.

Genuity™ Bollgard II® and Bollgard® Cotton

INSECT RESISTANCE MANAGEMENT (IRM)

Lepidopteran cotton pests have demonstrated the ability to develop resistance to many chemical insecticides. As a pre-emptive measure, Genuity™ Bollgard II® and Bollgard® cotton must be managed in ways that will retard insect resistance development. These practices are designed to ensure that some lepidopteran populations are not exposed to the *B.t.* proteins so they can maintain susceptibility in select populations. In order to achieve this, refuge cotton that does not contain *B.t.* proteins must be planted.

GENUITY™ BOLLGARD II - DUAL EFFECTIVE DOSE

Resistance management is critical to the long-term viability of our technology and the benefits realized by our farmer customers. 2010 is a transition year for Monsanto *B.t.* cotton products as we shift all U.S. cotton acres toward the two-gene insect control product, Genuity™ Bollgard II® cotton. The move to multiple-gene products, including Genuity™ Bollgard II®, offers dual effective modes of action against target insect pests, increasing the longevity of the technology.

INTEGRATED PEST MANAGEMENT (IPM)

Integrated Pest Management (IPM) is an effective and environmentally sensitive approach to pest management that relies on a combination of common-sense practices. IPM programs use current, comprehensive information on the life cycles of pests and their interaction with the environment. This information is used to manage pests in a manner that is least harmful to people, property and the environment.

Prevention

Using the best agronomic management practices in conjunction with the appropriate cotton varieties will yield the greatest benefits.

Use varieties, seeding rates and planting technologies appropriate for each specific geographical area. As much as possible, manage the crop to avoid plant stress.

- Employ appropriate scouting techniques and treatment decisions to preserve beneficial insects that can provide additional insect pest control.
- Manage for appropriate maturity and harvest schedules. destroy stalks immediately after harvest to avoid regrowth and minimize selection for resistance in late-season infestations.
- Use soil management practices that encourage destruction of over-wintering pupae.

Monitor and Identify

Fields should be carefully monitored for all pests, including cotton bollworms, to determine the need for remedial insecticide treatments. For target pests, scouting techniques and supplemental treatment decisions should take into account the fact that larvae must hatch and feed before they can be affected by the *B.t.* protein(s) in either Genuity™ Bollgard II® or Bollgard cotton. Fields should be scouted regularly, following periods of heavy or sustained egg lay, especially during bloom, to determine if significant larval survival has occurred. Scouting should include a modified whole-plant inspection, including terminals, squares, blooms, bloom tags and small bolls. Larvae larger than 1/4 inch (3- to 4-days old) are generally recognized as survivors that may not be controlled by Genuity™ Bollgard II® or Bollgard cotton.

Read the IRM/Grower Guide prior to planting for information on planting and Insect Resistance Management. If you do not have a copy of this Guide, you may download it at www.monsanto.com, or call 1-800-768-6387 to request a copy by mail.

Control

Monsanto recommends the use of appropriate remedial insecticide treatments to ensure desired levels of control if any cotton insect pest reaches locally established thresholds in Genuity™ Bollgard II® or Bollgard cotton.

Although Genuity™ Bollgard II® and Bollgard cotton will sustain less damage from some of the most troublesome lepidopteran pests, they will not provide protection against non-lepidopteran species. These insects should be monitored and treated with insecticides when necessary, using recommended thresholds. Whenever possible, select insecticides that are least harmful to beneficial insects.

NOTE: In 2010, sale or commercial planting of Bollgard® cotton is prohibited in the following states: Arizona, California, Colorado, Kansas, New Mexico and Oklahoma.

In 2010, sale or planting of Bollgard® is prohibited in the Texas counties of: Carson, Dallam, Hansford, Hartley, Hutchison, Lipscomb, Moore, Ochiltree, Roberts, and Sherman.

In 2010, sale or commercial planting of both Genuity™ Bollgard II® and Bollgard® is prohibited in Hawaii, Puerto Rico, and the U.S. Virgin Islands, or in Florida south of Route 60 (near Tampa).

Roundup Ready® Cotton, Genuity™ Bollgard II® with Roundup Ready® Cotton and Bollgard with Roundup Ready Cotton

ROUNDUP READY COTTON

Roundup Ready® cotton varieties contain in-plant tolerance to Roundup® agricultural herbicides, enabling farmers to make in-crop applications of Roundup WeatherMAX® or Roundup PowerMAX® according to label requirements.

GENUITY™ BOLLGARD II WITH ROUNDUP READY COTTON AND BOLLGARD WITH ROUNDUP READY COTTON

Genuity™ Bollgard II® with Roundup Ready® cotton and Bollgard with Roundup Ready varieties offer farmers the benefits of both insect protection and glyphosate tolerance combined in one crop. These varieties exhibit the same insect protection qualities as Genuity™ Bollgard II® and Bollgard cotton and enable farmers to make in-crop applications of Roundup WeatherMAX or Roundup PowerMAX according to label requirements.

MARKET OPTIONS

Gin by-products of cotton containing Monsanto's biotech traits, including cottonseed for feed uses, are fully approved for export to Canada, Japan, Mexico and South Korea. Cottonseed containing Monsanto traits may not be exported for the purpose of planting without a license from Monsanto.

It is a violation of national and international law to move material containing biotech traits across boundaries into nations where import is not permitted.

RECOMMENDED MANAGEMENT PRACTICES

Managing Roundup Ready cotton, Bollgard with Roundup Ready cotton and Genuity™ Bollgard II® with Roundup Ready® cotton requires that a farmer follow the recommended management practices associated with cotton containing each individual trait. Farmers of Bollgard with Roundup Ready cotton and Genuity™ Bollgard II® with Roundup Ready® cotton varieties must follow the same guidelines for establishing required refuge options, practicing IRM and managing target and non-target pests as described for Bollgard and Genuity™ Bollgard II® cotton in the IRM/Grower Guide.

APPLICATION OF ROUNDUP WEATHERMAX® AND ROUNDUP POWERMAX®

Roundup Ready cotton is genetically improved to provide tolerance to glyphosate, the active ingredient in Roundup agricultural herbicides. Roundup Ready cotton can receive over-the-top applications of Roundup agricultural herbicides only through the four-leaf stage. With the introduction of Genuity™ Roundup Ready® Flex cotton, there is the potential for both Roundup Ready cotton and Genuity™ Roundup Ready® Flex cotton to be used on a farmer's farm. This creates concern for the crop safety of Roundup Ready cotton. Monsanto recommends that farmers:

- Maintain accurate records of which technologies have been planted and where they have been planted.
- Communicate the field plan with other members of their work force to ensure proper applications for each technology.
- Clearly mark fields to indicate which technology has been planted.

TRACK IT. COUNT IT.
More than Four, Post-Direct.

WEED RESISTANCE MANAGEMENT GUIDELINES

Follow all pesticide label requirements and these guidelines to minimize the risk of developing glyphosate-resistant weed populations in a Roundup Ready cotton system:

- Scout fields before and after each burndown and in-crop application.
- Start clean with a burndown herbicide program or tillage.
- Use the right herbicide product at the right rate and right time.
- Add soil residual herbicide(s) and cultural practices as part of a Roundup Ready weed control program.
- In-crop, apply Roundup WeatherMAX at a minimum of 22 oz/A when weeds are less than 6" in height.
- Tank-mix other approved herbicides with Roundup WeatherMAX if necessary for postemergence weed control.
- Clean equipment before moving from field to field to minimize the spread of weed seed (as well as nematodes, insects and other cotton pests).
- Should repeated non-performance occur, report to Monsanto or your local retailer.

WEED CONTROL RECOMMENDATIONS

Weed control in cotton is essential to help maximize both fiber yield and quality potential. Cotton is very sensitive to early-season weed competition, which can result in unacceptable stands and/or reduced yield potential. The Roundup Ready® cotton system provides farmers with the right tools to control weeds before they become competitive.

PROGRAM	INSTRUCTIONS AND USE RATES*	ADDITIONAL INFORMATION
Preplant Burndown	Always start clean by planting into a weed-free field using either tillage or a burndown application. In no-till and reduced-till systems, apply a preplant burndown application of Roundup WeatherMAX®** at 22 to 44 oz/A in a tank-mix with dicamba or 2,4-D. See the dicamba and 2,4-D product label for rates and time intervals required between application and cotton planting. State restrictions may apply.	Early-season weed competition can result in unacceptable stands and/or reduced yield potential. This tank-mix is recommended for control and management of glyphosate-resistant marestail (*Conyza sp.*) or other tough-to-control weeds. Burndown application should be made far enough in advance of planting to control existing weeds.
Residual Herbicides	Apply residual herbicide(s) as part of a Roundup Ready cotton weed control program. Use the recommended label rate and timing of the residual herbicide applied. Refer to individual product labels for list of residual herbicides that may be used.	The residual herbicide(s) may be applied as either a preemergence (including preplant incorporated), postemergence, and/or layby application as allowed on the label of the specific product being used.
Over-The-Top through Fourth Leaf	Apply Roundup WeatherMAX over the top from crop emergence through the fourth true-leaf (node) stage (until the fifth true leaf reaches the size of a quarter). Two applications can be made during this period at a maximum rate of 22 oz/A per application. Refer to the "Annual Weeds Rate Table" in the Roundup WeatherMAX label for rate recommendations for specific annual weeds.	In-crop over-the-top applications must be at least 10 days apart and the cotton must have at least two nodes of incremental growth between applications. Care should be taken to record growth stage at first application. In situations where the potential for weed infestations is high (including perennial weeds), make the first application early enough to allow a second application before cotton exceeds the fourth true-leaf stage. Over-the-top applications after the fourth true-leaf stage can result in boll loss, delayed maturity, and/or yield loss.
Selective Equipment	After the fourth true-leaf stage through layby, Roundup WeatherMAX may be applied using precision post-directed or hooded sprayers which direct the spray to the base of the cotton plant. Two post-directed applications can be made during this period at a maximum rate of 22 oz/A per application.	Place nozzles in a low horizontal position to permit spray pattern to overlap in the row while contact of spray solution with cotton leaves should be avoided to the maximum extent possible. Excessive foliar contact can result in boll loss, delayed maturity, and/or yield loss. There must be two nodes of growth and at least 10 days between applications.
Preharvest Over-The-Top Applications	Before harvest and after cotton reaches 20% boll-crack, if needed, apply up to 44 oz/A of Roundup WeatherMAX. This treatment is effective in controlling late-season perennial weeds and can improve harvest efficiency.	Applications must be made at least 7 days prior to harvest. Roundup agricultural herbicides are not effective for preharvest cotton regrowth in Roundup Ready cotton. Do not apply Roundup agricultural herbicides preharvest to crops grown for seed under contract at an authorized cotton seed company.

Roundup Ready cotton has excellent vegetative tolerance to Roundup WeatherMAX allowing early-season over-the-top applications. Incomplete reproductive tolerance requires that applications after the 4-leaf (node) stage be properly post-directed.

ATTENTION: Use of Roundup agricultural herbicides in accordance with label directions is expected to result in normal growth of Roundup Ready cotton, however, various environmental conditions, agronomic practices, and other factors make it impossible to eliminate all risks associated with the product, even when applications are made in conformance with the label specifications. In some cases, these factors can result in boll loss, delayed maturity, and/or yield loss.

*Follow all pesticide label requirements.

**If using another Roundup agricultural herbicide, you must refer to the label booklet or Roundup Ready cotton supplemental label for that brand to determine appropriate use rates. If using Roundup PowerMAX®, application rates are the same as for Roundup WeatherMAX.

RECOMMENDATIONS FOR MANAGING GLYPHOSATE-RESISTANT WEEDS

WEEDS	INSTRUCTIONS AND USE RATES*
Glyphosate-Resistant Marestail (Horseweed)	Start clean with a burndown herbicide program or tillage. -Tank-mix Roundup agricultural herbicides with dicamba or 2,4-D (consult label for plant back timing). If you have dense stands of marestail, use a preplant residual herbicide at the recommended rate and timing, such as diuron (Direx®) or flumioxazin (Valor®). Use Roundup WeatherMAX in-crop, as needed, at a minimum of 22 oz/A to control other weeds. In-crop, if applying post-directed to glyphosate-resistant marestail, Roundup WeatherMAX can be tank-mixed with other herbicides, such as diuron or MSMA. Marestail should be less than 6" in height at the time of in-crop application.
Glyphosate-Resistant *Amaranthus* Species **- *Palmer Amaranth*** **- Waterhemp**	Start clean with a burndown herbicide program or tillage. Apply a preemergence residual herbicide such as pendimethalin (Prowl®) plus fluometuron or fomesafen (Reflex®) or flumioxazin (Valor) for control of *Amaranthus* species. In-crop, tank-mix Roundup WeatherMAX at 22 oz/A with metolachlor or other labeled chloracetamide herbicide before *Amaranthus* species emerges. Use Roundup WeatherMAX in-crop, as needed, at a minimum of 22 oz/A to control other weeds. A post-directed application of Roundup WeatherMAX tank-mixed with MSMA and a residual such as diuron (Direx) or flumioxazin (Valor) should be made to control *Amaranthus* species 3" or smaller in height and prevent additional flushes.
Glyphosate-Resistant *Ambrosia* Species **- Giant Ragweed** **- Common Ragweed**	Start clean with a burndown herbicide program or tillage. Apply a preemergence residual herbicide such as pendimethalin (Prowl) plus fluometuron or fomesafen (Reflex)for control of *Ambrosia* species. In-crop, tank-mix Roundup WeatherMAX at 22 oz/A with metolachlor before *Ambrosia* species emerges. Use Roundup WeatherMAX in-crop, as needed, at a minimum of 22 oz/A to control other weeds. A post-directed application of Roundup WeatherMAX tank-mixed with MSMA and a residual such as diuron (Direx) or flumioxazin (Valor) should be made to control *Ambrosia* species 3" or smaller in height and prevent additional flushes.
Glyphosate-Resistant Johnsongrass	Start clean with a burndown herbicide or tillage. Preplant incorporate a residual herbicide such as pendimethalin or trifluralin for control or suppression of seedling johnsongrass. Apply Roundup WeatherMAX in a tank-mix with herbicides such as SelectMAX®, Assure® II or Poast Plus for the control of emerged weeds including seedling and rhizome johnsongrass. Follow all label directions of tank-mix partners, especially those related to weed size.

In certain areas, Italian ryegrass is known to be resistant to glyphosate. For control recommendations, refer to **www.weedresistancemanagement.com** or call 1-800-768-6387. When approved, supplemental labeling for specific herbicide products can also be viewed on **www.cdms.net** or **www.greenbook.net.**

*Follow all pesticide label requirements.

Genuity™ Roundup Ready® Flex Cotton and Genuity™ Bollgard II® with Roundup Ready® Flex Cotton

GENUITY™ ROUNDUP READY® FLEX COTTON

Genuity™ Roundup Ready® Flex cotton varieties possess improved reproductive tolerance to Roundup® agricultural herbicides. This technology gives farmers the opportunity to make over-the-top broadcast applications of labeled Roundup agricultural herbicides from crop emergence up to seven (7) days prior to harvest.

GENUITY™ BOLLGARD II® WITH ROUNDUP READY® FLEX COTTON

Genuity™ Bollgard II® with Roundup Ready® Flex varieties offer farmers the benefits of both insect protection and glyphosate tolerance combined in one crop. These varieties exhibit the same insect protection qualities as Genuity™ Bollgard II® and are tolerant to over-the-top applications of Roundup WeatherMAX® and Roundup PowerMAX®.

MARKET OPTIONS

Genuity™ Roundup Ready® Flex cotton and Genuity™ Bollgard II® with Roundup Ready Flex cotton have regulatory clearance in the United States, but do not have import approval in all export markets. Processed fractions from these products, including linters, oil, meal, cottonseed and gin trash, must not be exported without all necessary approvals in the importing country. It is a violation of national and international law to move material containing biotech traits across boundaries into nations where import is not permitted.

RECOMMENDED MANAGEMENT PRACTICES

Managing Genuity™ Roundup Ready® Flex cotton and Genuity™ Bollgard II® with Roundup Ready® Flex cotton requires a farmer to follow the recommended management practices associated with cotton containing each individual trait. Farmers of Genuity™ Bollgard II® with Roundup Ready® Flex cotton must follow the same guidelines for establishing required refuge options, practicing IRM and managing target and non-target pests as described for Genuity™ Bollgard II® cotton in the IRM/Grower Guide.

WEED RESISTANCE MANAGEMENT GUIDELINES

Follow all label requirements and the guidelines below to minimize the risk of developing weed resistance in a Genuity™ Roundup Ready® Flex cotton system:

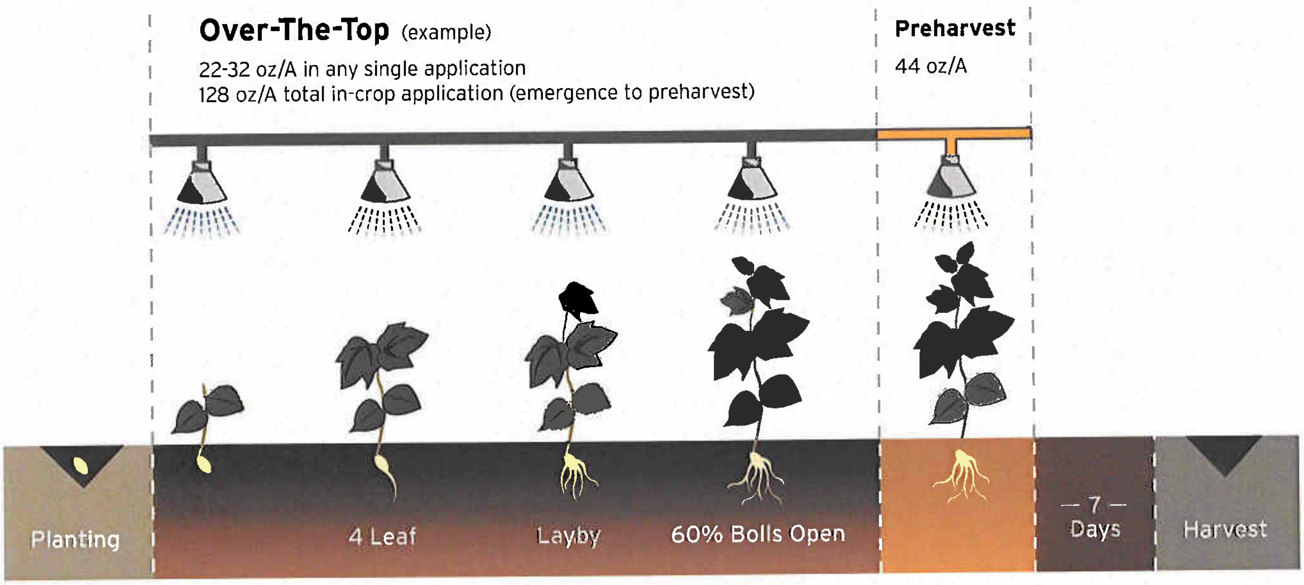
- Scout fields before and after each burndown and in-crop application.
- Start clean with a burndown herbicide program or tillage.
- Use the right herbicide product at the right rate and right time.
- Add soil residual herbicide(s) and cultural practices as part of a Genuity™ Roundup Ready® Flex cotton weed control program.
- In-crop, apply Roundup WeatherMAX at a minimum of 22 oz/A when weeds are 3" to 6" in height.
- Tank-mix other approved herbicides with Roundup WeatherMAX if necessary for postemergence weed control.
- Should repeated non-performance occur, report to Monsanto or your local retailer.
- Clean equipment before moving from field to field to minimize the spread of weed seed (as well as nematodes, insects and other cotton pests).

APPLICATION OF ROUNDUP WEATHERMAX® AND ROUNDUP POWERMAX®

- May be applied over-the-top and/or in-crop, from crop emergence up to 7 days prior to harvest.
- A maximum rate of 32 oz/A per application may be applied using ground application equipment while the maximum is 22 oz/A per application by air.
- There are no growth or timing restrictions for sequential applications.
- Four (4) quarts/A is the total in-crop volume allowed from emergence to 60% open bolls.
- A maximum total volume of 44 oz/A may be applied between layby and 60% open bolls.
- Post-directed equipment may be used to achieve more thorough spray coverage of weeds or if herbicides not labeled for over-the-top application will be tank-mixed with Roundup WeatherMAX or Roundup PowerMAX.

PREHARVEST APPLICATIONS

- Up to 44 oz/A may be applied after cotton reaches 60% open bolls and before harvest, if needed.
- Applications must be made at least 7 days prior to harvest.



CROP SAFETY OF OVER-THE-TOP GLYPHOSATE APPLICATIONS

Monsanto has determined that a combination of components in glyphosate formulations have the potential to cause leaf injury when applied during later stages of crop growth. Roundup WeatherMAX and Roundup PowerMAX are the only Roundup agricultural herbicides labeled and approved for new labeled uses over the top of Genuity™ Roundup Ready® Flex cotton.

Leaf injury may occur if the products are not used according to the product label, used at higher than recommended rates or if overlap of spray occurs in the field. **Farmers must confirm that any glyphosate formulation to be used on Genuity™ Roundup Ready® Flex cotton has been labeled for use on Genuity™ Roundup Ready® Flex cotton and should confirm that it has been tested to demonstrate crop safety.**

WEED CONTROL RECOMMENDATIONS

Weed control in cotton is essential to maximize both fiber yield and quality potential. Cotton is very sensitive to early-season weed competition, which can result in unacceptable stands and/or reduced yield potential. The Genuity™ Roundup Ready® Flex cotton system, with improved reproductive tolerance to Roundup® agricultural herbicides, provides farmers with the right tools to control weeds.

PROGRAM	INSTRUCTIONS AND USE RATES*	ADDITIONAL INFORMATION
Preplant Burndown	Always start clean by planting into a weed-free field using either tillage or a burndown application. In no-till and reduced-till systems, apply a preplant burndown application of Roundup WeatherMAX®** at 22 to 44 oz/A in a tank-mix with dicamba or 2,4-D. See the dicamba and 2,4-D product label for rates and time intervals required between application and cotton planting. State restrictions may apply.	Early-season weed competition can result in unacceptable stands and/or reduced yield potential. This tank-mix is recommended for control and management of glyphosate-resistant marestail (*Conyza sp.*) or other tough-to-control weeds. Burndown application should be made far enough in advance of planting to control existing weeds.
Residual Herbicides	Apply approved residual herbicide(s) as part of a Genuity™ Roundup Ready® Flex cotton weed control program. Use the recommended label rate and timing of the residual herbicide applied. Refer to individual product labels for list of residual herbicides that may be used.	The residual herbicide(s) may be applied as either a preemergence (including preplant incorporated), postemergence, and/or layby application as allowed on the label of the specific product being used.
In-Crop Weed Control	Target the first application of Roundup WeatherMAX on 1-2 leaf cotton when weeds are small. Apply a minimum of 22 oz/A of Roundup WeatherMAX in-crop. The need for sequential applications of Roundup WeatherMAX will depend upon the occurrence of subsequent weed flushes. Refer to the "Annual Weeds Rate Table" in the Roundup WeatherMAX label booklet for rate recommendations for specific annual weeds.	Early-season weed competition can reduce yield potential in cotton. Select timing of application based on the most difficult to control weed species in your field. Post-direct or hooded sprayers can be used to achieve more thorough spray coverage on weeds.
Preharvest Over-The-Top Applications	Before harvest and after cotton reaches 60% open bolls, if needed, apply up to 44 oz/A of Roundup WeatherMAX. This treatment is effective in controlling late-season perennial weeds.	Applications must be made at least 7 days prior to harvest. Roundup agricultural herbicides are not effective for preharvest cotton regrowth in Genuity™ Roundup Ready® Flex cotton.

*Follow all pesticide label requirements.

**The maximum volume of Roundup WeatherMAX and Roundup PowerMAX® that may be used in a single season is 5.3 quarts per acre.

RECOMMENDATIONS FOR MANAGING GLYPHOSATE-RESISTANT WEEDS

WEEDS	INSTRUCTIONS AND USE RATES*
Glyphosate-Resistant Marestail (Horseweed)	Start clean with a burndown herbicide program or tillage. -Tank-mix Roundup agricultural herbicides with dicamba or 2,4-D (consult label for plant back timing). If you have dense stands of marestail, use a preplant residual herbicide at the recommended rate and timing, such as diuron (Direx®) or flumioxazin (Valor®). Use Roundup WeatherMAX in-crop, as needed, at a minimum of 22 oz/A to control other weeds. In-crop, if applying post-directed to glyphosate-resistant marestail, Roundup WeatherMAX can be tank-mixed with other herbicides, such as diuron or MSMA. Marestail should not exceed 6" in height at the time of in-crop application.
Glyphosate-Resistant *Amaranthus* Species **- *Palmer Amaranth*** **- Waterhemp**	Start clean with a burndown herbicide program or tillage. Apply a preemergence residual herbicide such as pendimethalin (Prowl®) plus fluometuron or fomesafen (Reflex®) or flumioxazin (Valor) for control of *Amaranthus* species. In-crop, tank-mix Roundup WeatherMAX at 22 oz/A with metolachlor or other labeled chloracetamide herbicide before *Amaranthus* species emerges. Use Roundup WeatherMAX in-crop, as needed, at a minimum of 22 oz/A to control other weeds. A post-directed application of Roundup WeatherMAX tank-mixed with MSMA and a residual such as diuron (Direx) or flumioxazin (Valor) should be made to control *Amaranthus* species 3" or smaller in height and prevent additional flushes.
Glyphosate-Resistant *Ambrosia* Species **- Giant Ragweed** **- Common Ragweed**	Start clean with a burndown herbicide program or tillage. Apply a preemergence residual herbicide such as pendimethalin (Prowl) plus fluometuron or fomesafen (Reflex) for control of *Ambrosia* species. In-crop, tank-mix Roundup WeatherMAX at 22 oz/A with metolachlor before *Ambrosia* species emerges. Use Roundup WeatherMAX in-crop, as needed, at a minimum of 22 oz/A to control other weeds. A post-directed application of Roundup WeatherMAX tank-mixed with MSMA and a residual such as diuron (Direx) or flumioxazin (Valor) should be made to control *Ambrosia* species 3" or smaller in height and prevent additional flushes.
Glyphosate-Resistant Johnsongrass	Start clean with a burndown herbicide or tillage. Preplant incorporate a residual herbicide such as pendimethalin or trifluralin for control or suppression of seedling johnsongrass. Apply Roundup WeatherMAX in a tank-mix with herbicides such as SelectMAX®, Assure® II or Poast Plus for the control of emerged weeds including seedling and rhizome johnsongrass. Follow all label directions of tank-mix partners, especially those related to weed size.

In certain areas, Italian ryegrass is known to be resistant to glyphosate. For control recommendations, refer to **www.weedresistancemanagement.com** or call 1-800-768-6387. When approved, supplemental labeling for specific herbicide products can also be viewed on **www.cdms.net** or **www.greenbook.net.**

*Follow all pesticide label requirements.

Genuity™ Roundup Ready 2 Yield® and Roundup Ready® soybean varieties contain in-plant tolerance to Roundup® agricultural herbicides. This means you can spray Roundup agricultural herbicides in-crop from emergence through flowering.

Spray labeled Roundup agricultural herbicides over the top from emergence (cracking) through flowering (R2 stage soybeans) for unsurpassed weed control, proven crop safety and maximum yield potential. R2 stage soybeans end when a pod 5 millimeters (3/16") long at one of the four uppermost nodes appears on the main stem along with a fully developed leaf (R3 stage).

WEED CONTROL RECOMMENDATIONS

Starting clean with a weed-free field, and making timely post-emergence in-crop applications, is critical to obtaining excellent weed control and maximum yield potential. The Roundup Ready soybean system provides the flexibility to use the herbicide tools necessary to control weeds at planting and in-crop. Failure to control weeds with the right rate, at the right time and with the right product, can lead to increased weed competition and the potential for decreased yield.

PROGRAM	INSTRUCTIONS AND USE RATES*	ADDITIONAL INFORMATION
Preplant Burndown	To start clean in no-till systems, apply a burndown application of Roundup WeatherMAX®** at 22 to 44 oz/A before planting. See the label for appropriate rates by weed species. For control and management of glyphosate-resistant marestail (*Conyza sp.*) or other difficult-to-control weeds present at burndown, apply 22 oz/A of Roundup WeatherMAX in a tank-mix with 1 to 2 pt/A 2,4-D. Make applications 7 to 30 days before planting and before marestail reaches 6" in height.	Always start with a weed-free field. In no-till and reduced-till systems, apply a Roundup WeatherMAX* burndown application to control existing weeds before planting. Adding 2,4-D in the burndown can significantly reduce broadleaf weed pressure at post-emergence timing. Read the 2,4-D product label for time intervals required between application and soybean planting.
Residual Herbicide Plus Roundup WeatherMAX	Use the recommended label rate of a soil-applied residual herbicide applied preemergence to soybeans as defined in the individual product's labeling. The residual product may be tank-mixed with Roundup WeatherMAX at burndown. Refer to individual product labels for list of residual herbicides that may be used. Follow with 22 oz/A Roundup WeatherMAX in-crop when weeds are 2" to 8" tall. Refer to the "Annual Weeds Rate Table" in the Roundup WeatherMAX label for rate recommendations for specific annual weeds. Crop rotation following Genuity™ Roundup Ready 2 Yield® and Roundup Ready soybeans is strongly encouraged. Use of a residual herbicide is encouraged especially if the cropping system is a continuous Roundup Ready system.	A residual program is encouraged when agronomic conditions favor the practice. Reducing Roundup WeatherMAX rate when tank-mixing with a residual or use of premixes utilizing a reduced rate of glyphosate (such as Extreme®) is not recommended. If the in-crop application is delayed and weeds are larger, apply a higher rate of Roundup WeatherMAX.
Roundup WeatherMAX	Apply a minimum of 22 oz/A of Roundup WeatherMAX** in-crop when weeds are 2" to 8" tall. Refer to the "Annual Weeds Rate Table" in the Roundup WeatherMAX label for rate recommendations for specific annual weeds. Choose the rate to control the most difficult-to-control weed in your field. A sequential application of this product may be required to control new flushes of weeds in the Roundup Ready soybean crop. If a sequential application is necessary, apply 16 to 22 oz/A of Roundup WeatherMAX** when weeds are 3" to 6" tall.	In-crop application of Roundup WeatherMAX provides control of labeled weeds. For best results, apply 3 to 4 weeks after planting or when weeds are less than 8" tall. If initial application is delayed and weeds are larger, apply a higher labeled rate of Roundup WeatherMAX.

*Follow all pesticide label requirements.

**If using another Roundup agricultural herbicide, you must refer to the label booklet or Genuity™ Roundup Ready 2 Yield® soybean or Roundup Ready soybean supplemental label for that brand to determine appropriate use rates. If using Roundup PowerMAX, application rates are the same as for Roundup WeatherMAX.

PROGRAM	INSTRUCTIONS AND USE RATES*	ADDITIONAL INFORMATION
Glyphosate-Tolerant Volunteer Corn	Tank-mix Roundup WeatherMAX® with 6 to 12 oz/A of Select Max™ and apply to 4" to 36" glyphosate-tolerant volunteer corn.	Choose your Roundup WeatherMAX rate based on the weed species and size listed in the "Annual Weeds Rate Table" of the Roundup WeatherMAX Label.
Maximum Use Rates for Roundup WeatherMAX	**In-Crop:** • 44 oz/A per single application • 44 oz/A during flowering • 64 oz/A emergence through flowering (R2 stage soybeans) **Preharvest:** • 22 oz/A application	**Total Season:** The combined total of preplant, in-crop and preharvest applications of Roundup WeatherMAX can not exceed 5.3 qt/A. The combined total of in-crop and preharvest applications can not exceed 64 oz/A.

*Follow all pesticide label requirements.

Herbicide products sold by Monsanto for use over the top of soybeans with Genuity™ Roundup Ready 2 Yield® Technology for the 2010 crop season are as follows:

- Roundup WeatherMAX
- Roundup PowerMAX

WEED CONTROL RECOMMENDATIONS

KEY WEEDS	INSTRUCTIONS AND USE RATES*	ADDITIONAL INFORMATION
Weeds that Tend to Have Multiple Emergence Events	Where dense stands of weed species such as common lambsquarters, tall and common waterhemp, *Palmer Amaranth*, redroot pigweed, common ragweed, and giant ragweed are expected, the following agronomic practices are recommended: • Start clean with tillage or burndown in no-till and reduced till systems. Include 2,4-D in the burndown. • Plant soybeans in narrow rows (<20"). • Use a pre-plant residual herbicide. • Use the right rate of Roundup WeatherMAX at the right time (proper weed size).	Weeds such as lambsquarters, waterhemp, pigweed, and giant ragweed tend to emerge throughout the season. Sequential Roundup WeatherMAX applications or the addition of a soil residual herbicide may be required for control of subsequent weed flushes.
Difficult-to-Control Weeds	Black nightshade, velvetleaf, waterhemp, morningglory, lambsquarters, Florida pusley, giant ragweed, Pennsylvania smartweed, groundcherry, hemp sesbania and spurred anoda are difficult-to-control weeds. Please refer to the Roundup agricultural herbicide label for specific rates and weed sizes for control of these weeds.	These weed species require special attention be paid to Roundup WeatherMAX rate and application timing (proper weed size) to obtain excellent weed control. A sequential application may be required if a new weed flush occurs, especially in soybeans planted in wide rows (>20").
Perennial Weeds	An in-crop application of 22 to 44 oz/A of Roundup WeatherMAX** will provide suppression and/or control of nutsedge and perennial weeds like Canada thistle, field bindweed, hemp dogbane, horsenettle, johnsongrass, milkweed, quackgrass, etc.	For additional information on perennial weeds, see the "Perennial Weeds Rate Table" in the label booklet for Roundup WeatherMAX. For best control, allow perennials to achieve at least 6" or more of growth before spraying.

*Follow all pesticide label requirements.

**If using another Roundup agricultural herbicide, you must refer to the label booklet or Roundup Ready Soybean or Genuity™ Roundup Ready 2 Yield® Soybean supplemental label for that brand to determine appropriate use rates. If using Roundup PowerMAX, application rates are the same as for Roundup WeatherMAX.

WEED RESISTANCE MANAGEMENT GUIDELINES

Follow all pesticide label requirements and the guidelines below to minimize the risk of developing glyphosate-resistant weed populations in a Roundup Ready Soybean System:

- Crop rotation is strongly encouraged.
- Scout fields before and after each burndown and in-crop application.

- Start clean with a burndown herbicide or tillage.
  - Tank-mix with 2,4-D to control glyphosate-resistant marestail or other tough-to-control broadleaf weeds.
- Use the recommended label rate of a soil-applied residual herbicide such as INTRRO®, Valor®, Valor XLT® or Gangster®.
- In-crop, apply Roundup WeatherMAX at a minimum of 22 oz/A before weeds exceed 8" in height.
- If an additional flush of weeds occurs, a sequential application of Roundup WeatherMAX at 22 oz/A may be needed before weeds exceed 6" in height.
- Refer to individual product labels for a list of recommended tank-mix partners.
- Clean equipment before moving from field to field to minimize the spread of weed seed.
- Report repeated non-performance to Monsanto or your local retailer.

RECOMMENDATIONS FOR MANAGING GLYPHOSATE-RESISTANT WEEDS

WEEDS	INSTRUCTIONS AND USE RATES*
Glyphosate-Resistant Marestail (Horseweed)	**Preplant:** Apply a tank-mixture of 22 oz/A Roundup WeatherMAX® with 1 pt/A 2,4-D before marestail exceeds 6" in height. See the 2,4-D product label for time intervals required between application and planting. **In-crop:** It is strongly encouraged that marestail should be controlled prior to planting using recommended preplant burndown treatments. In-crop, apply a tank-mixture of 22 oz/A Roundup WeatherMAX with 0.3 oz/A FirstRate®. This treatment should be used as a salvage treatment only for a marestail infestation that was not controlled preplant. Application should be made between full emergence of the first trifoliate leaf and 50% flowering stage of soybeans. At the time of treatment, marestail should not exceed 6" in height.
Glyphosate-Resistant *Amaranthus* Species **- *Palmer Amaranth*** **- Waterhemp**	**Preplant:** Apply a tank-mix of 22 oz/A Roundup WeatherMAX with a preemergence residual herbicide such as alachlor (INTRRO®), flumioxazin (Valor®) or another residual herbicide for preemergence control of *Amaranthus* species. 2,4-D may be added to the tank-mix to help control emerged *Amaranthus* species and other broadleaf weeds preplant only. Follow label instructions regarding application timing relative to soybean planting. **In-crop:** It is strongly encouraged that a preemergence residual product be used to control *Amaranthus* species prior to emergence. If there is emerged *Amaranthus* in-crop, apply a tank-mixture of 22 oz/A Roundup WeatherMAX with a postemergence product with activity on *Amaranthus* such as lactofen (Cobra®), fomesafen (Flexstar®) or cloransulam (FirstRate). Applications should be made on emerged *Amaranthus* that does not exceed 3" in height. Read and follow all product label instructions. It is likely that visual soybean injury will occur with these tank-mixtures.
Glyphosate-Resistant *Ambrosia* Species **- Giant Ragweed** **- Common Ragweed**	**Preplant:** Apply a tank-mix of 22 oz/A Roundup WeatherMAX with a preemergence residual herbicide such as cloransulam (FirstRate) or cloransulam + flumioxazin (Ganster®) or another residual herbicide for preemergence control of *Ambrosia* species. 2,4-D may be added to the tank-mix to help control emerged *Ambrosia* species and other broadleaf weeds preplant only. Follow label instructions regarding application timing relative to soybean planting. **In-crop:** It is strongly encouraged that a preemergence residual product be used to control *Ambrosia* species prior to emergence. If there is emerged *Ambrosia* in-crop, apply a tank-mixture of 22 oz/A Roundup WeatherMAX with a postemergence product with activity on *Ambrosia* such as lactofen (Cobra) or fomesafen (Flexstar). Applications should be made on emerged *Ambrosia* that does not exceed 3" in height. Read and follow all product label instructions. It is likely that visual soybean injury will occur with these tank-mixtures.
Glyphosate-Resistant Johnsongrass	Start clean with a burndown herbicide or tillage. Preplant incorporate a residual herbicide such as pendimethalin or trifluralin for control or suppression of seedling johnsongrass. Apply Roundup WeatherMAX in a tank-mix with herbicides such as SelectMAX®, Assure® II or Poast Plus for the control of emerged weeds including seedling and rhizome johnsongrass. Follow all label directions of tank-mix partners, especially those related to weed size.

In certain areas, Italian ryegrass is known to be resistant to glyphosate. For control recommendations, refer to **www.weedresistancemanagement.com** or call 1-800-768-6387. When approved, supplemental labeling for specific herbicide products can also be viewed on **www.cdms.net** or **www.greenbook.net.**

*Follow all pesticide label requirements.


CANOLA


ALFALFA


SUGARBEET

ATTENTION: Pursuant to a Court Order issued on May 3, 2007, Genuity™ Roundup Ready® alfalfa seed **CAN NOT be commercially sold or planted** until further administrative regulatory actions are completed. For more information, and the latest updates on Genuity™ Roundup Ready® alfalfa, go to www.roundupreadyalfalfa.com.

Genuity™ Roundup Ready® alfalfa varieties have in-plant tolerance to Roundup® agricultural herbicides, enabling farmers to apply labeled Roundup agricultural herbicides up to 5 days before cutting for unsurpassed weed control, excellent crop safety and preservation of forage quality potential.

Hay and Forage Management Practices

Genuity™ Roundup Ready® alfalfa must be managed for high quality hay/forage production, including timely cutting to promote high forage quality (i.e. before 10% bloom) and to prevent seed development. In geographies where conventional alfalfa seed production is intermingled with forage production and the agronomic conditions (climate and water/irrigation availability) are such that forage alfalfa is allowed to stand and flower late in the season, Genuity™ Roundup Ready® alfalfa must be harvested at or before 10% bloom to minimize potential pollen flow from hay to common or conventional alfalfa seed production. Farmers who are unwilling to or who can not make this commitment to stewardship should not continue to grow Genuity™ Roundup Ready® alfalfa.

Genuity™ Roundup Ready® alfalfa varieties have excellent tolerance to over-the-top applications of labeled Roundup agricultural herbicides. An in-crop weed control program using Roundup WeatherMAX® or Roundup PowerMAX® will provide excellent weed control in most situations. A residual herbicide labeled for use in alfalfa may also be applied postemergence in alfalfa. Contact a Monsanto Representative, local crop advisor or extension specialist to determine the best option for your situation.

Stand Takeout and Volunteer Management

Crop rotations can be divided into two main groups, alfalfa rotated to: 1) grass crops (e.g. corn and cereal crops); and 2) broadleaf crops. More herbicide alternatives exist for management of volunteer alfalfa in grass crops. The recommended steps for controlling volunteer Genuity™ Roundup Ready® alfalfa are:

- Diligent Stand Takeout
- Start Clean
- Plan for Success
- Timely Execution

DILIGENT STAND TAKEOUT

Use appropriate, commercially available herbicide treatments alone for reduced tillage systems or in combination with tillage to terminate the Genuity™ Roundup Ready® alfalfa stand. Refer to your regional technical bulletin for specific stand takeout recommendations. **NOTE:** Roundup® agricultural herbicides are **not** effective for terminating Genuity™ Roundup Ready® alfalfa stands.

START CLEAN

If necessary, utilize tillage and/or additional herbicide application(s) after stand takeout, and before planting of the subsequent rotational crop to manage any newly emerged or surviving alfalfa.

PLAN FOR SUCCESS

Rotate the crops with known and available mechanical or herbicidal methods for managing volunteer alfalfa, keeping in mind that Roundup agricultural herbicides will not terminate Genuity™ Roundup Ready® alfalfa stands.

- Rotations to certain broadleaf crops are not advisable if the farmer is not willing to implement recommended stand termination practices.
- In the event that no known mechanical or herbicidal methods are available to manage volunteer alfalfa in the desired rotational crop, it is suggested that a crop with established volunteer alfalfa management practices be introduced into the rotation.

TIMELY EXECUTION

Implement in-crop mechanical or herbicide treatments for managing alfalfa volunteers in a timely manner; that is, before the volunteers become too large to control or begin to compete with the rotational crop.

Planting Requirements

Genuity™ Roundup Ready® alfalfa is not permitted to be planted in any wildlife feed plots.

Stewardship

All Genuity™ Roundup Ready® alfalfa farmers shall sign the Monsanto Technology/Stewardship Agreement (MTSA) limited-use license application which provides the terms and conditions for the authorized use of the product. Due to special circumstances, alfalfa farmers in the Imperial Valley of California will also sign an Imperial Valley Use Agreement (IVUA) with specific stewardship commitments. The MTSA or IVUA must be completed before purchase or use of seed.

Both the MTSA or IVUA explicitly prohibit all forms of commercial seed harvest on the stand. Every alfalfa farmer producing seed of Genuity™ Roundup Ready® alfalfa must possess an additional, separate and distinct seed farmer contract to produce Genuity™ Roundup Ready® alfalfa seed. Genuity™ Roundup Ready® alfalfa seed may not be planted outside of the United States, or for the production of seed or sprouts.

Any product produced from a Genuity™ Roundup Ready® alfalfa crop or seed, including hay and hay products, must be labeled and may only be used, exported to, processed or sold in countries where regulatory approvals have been granted. It is a violation of national and international laws to move material containing biotech traits across boundaries into nations where import is not permitted.

Pursuant to a Court Order issued on May 3, 2007, Genuity™ Roundup Ready® alfalfa farmers must adhere to the requirements set out in the December 18, 2007 USDA Administrative Order **(http://www.aphis.usda.gov/brs/pdf/RRA_A8_final.pdf)** until the USDA completes its regulatory process.

These requirements include, but are not limited to:

- Pollinators shall not be added to Genuity™ Roundup Ready® alfalfa fields grown only for hay production.
- Farm equipment used in Genuity™ Roundup Ready® alfalfa production shall be properly cleaned after use.
- Genuity™ Roundup Ready® alfalfa shall be handled and clearly identified to minimize commingling after harvest.

For additional information visit the USDA website: **http://www.aphis.usda.gov/biotechnology/alfalfa_history.shtml**

For more information and the latest updates on Genuity™ Roundup Ready® alfalfa, go to **http://www.roundupreadyalfalfa.com**

To meet sales reporting requirements, the seed supplier is required to identify and list all Genuity™ Roundup Ready® alfalfa field locations. Therefore, all farmers MUST PROVIDE their seed supplier with the GPS coordinates of all their Genuity™ Roundup Ready® alfalfa fields.

WEED RESISTANCE MANAGEMENT GUIDELINES

Follow all pesticide label requirements and the guidelines below to minimize the risk of developing glyphosate-resistant weed populations in a Genuity™ Roundup Ready® alfalfa system:

- Scout fields before and after each herbicide application.
- Use the right herbicide product at the right rate and at the right time.
- To control flushes of weeds in established alfalfa, make applications of Roundup WeatherMAX® or Roundup PowerMAX® herbicide at 22 to 44 oz/A before weeds exceed 6" in height, up to 5 days before cutting.
- Use other approved herbicide products tank-mixed or in sequence with Roundup agricultural herbicide if appropriate for the weed spectrum present as part of a Genuity™ Roundup Ready® alfalfa weed control program.
- Report repeated non-performance to Monsanto or your local retailer.

WEED CONTROL RECOMMENDATIONS

In established stands, to preserve the quality potential of forage and hay, applications should be made after weeds have emerged but before alfalfa re-growth interferes with application spray coverage of the target weeds.

PROGRAM	INSTRUCTIONS AND USE RATES*	ADDITIONAL INFORMATION
Established Stands	After the first harvest of a newly established stand, up to 44 oz/A of Roundup WeatherMAX®** herbicide per cutting may be applied up to 5 days before each subsequent cutting. The combined total per year for all in-crop applications in established stands must not exceed 132 oz/A (4.1 qt/A) of Roundup WeatherMAX.	Applications between cuttings may be applied as a single application or in multiple applications (e.g. 2 applications of 22 oz/A). Sequential applications should be at least 7 days apart.
Weeds Controlled	For specific application rates and instructions for control of various annual and perennial weeds, refer to the Roundup WeatherMAX** herbicide label booklet. Some weeds with multiple germination times or suppressed (stunted) weeds may require a second application of Roundup WeatherMAX** herbicide for complete control. For some perennial weeds, repeated applications may be required to eliminate crop competition throughout the growing season.	In addition to those weeds listed in the Roundup WeatherMAX* label booklets, this product will suppress or control the parasitic weed, dodder (*Cuscuta spp.*) in Genuity™ Roundup Ready® alfalfa. Repeat applications may be necessary for complete control. For tough-to-control weeds or weeds not controlled by Roundup® agricultural herbicides use labeled rates of other approved herbicides, alone or in tank-mixtures, with Roundup agricultural herbicides.
Maximum Use Rates	**In-Crop:** • 44 oz/A per single application. • Established Stand Total: 44 oz/A per cutting up to 5 days before harvest.	**Total Per Year:** The combined total per year for all in-crop applications in established stands must not exceed 132 oz/A (4.1 qt/A) of Roundup WeatherMAX.

*Follow all pesticide label requirements.

**If using another Roundup agricultural herbicide, you must refer to the label booklet or separately published Genuity™ Roundup Ready® alfalfa supplemental label for that brand to determine appropriate use rates. If using Roundup PowerMAX, application rates are the same as for Roundup WeatherMAX.

Genuity™ Roundup Ready® spring canola hybrids contain in-plant tolerance to Roundup agricultural herbicides, enabling farmers to apply Roundup® agricultural herbicides over the top of Genuity™ Roundup Ready® spring canola anytime from emergence through the 6-leaf stage of development.

The introduction of the Roundup Ready® trait into leading spring canola hybrids and varieties gives farmers the opportunity for unsurpassed weed control, proven crop safety and maximum profit potential. With Genuity™ Roundup Ready® spring canola, farmers have the weed management tool necessary to improve spring canola profitability, while providing a viable rotational crop to help break pest and disease cycles in cereal-growing areas.

WEED RESISTANCE MANAGEMENT GUIDELINES

Follow all pesticide label requirements and the guidelines below to minimize the risk of developing glyphosate-resistant weed populations in a Genuity™ Roundup Ready® spring canola system:

- Scout fields before and after each burndown and in-crop application.
- Start clean with a burndown herbicide or tillage.
- In-crop, apply Roundup WeatherMAX® herbicide before weeds exceed 3" in height.
- A sequential application of Roundup WeatherMAX herbicide may be needed.
- Clean equipment before moving from field to field to minimize the spread of weed seed.
- Report repeated non-performance to Monsanto or your local retailer.

WEED CONTROL RECOMMENDATIONS (SPRING-SEEDED)

PROGRAM	INSTRUCTIONS AND USE RATES*	ADDITIONAL INFORMATION
Two-Pass Program– For Annual and Perennial Weed Control	For broad-spectrum control of annual and perennial weeds, use an initial application of 11 oz/A of Roundup WeatherMAX**, in 5 to 10 gal/A water volume. No surfactant is required. Make a second application of 11 oz/A of Roundup WeatherMAX** no less than 10 days after initial application up to the 6-leaf stage (prebolting). Do not exceed 11 oz/A per application.	Spray when canola is at the 0- to 6-leaf stage of growth. To maximize yield potential, spray Genuity™ Roundup Ready® spring canola at the 1- to 3-leaf stage to eliminate competing weeds. Short-term yellowing may occur with later applications, with little effect on crop growth, maturity, or yield. Wait a minimum of 10 days between applications. Two applications of Roundup WeatherMAX will: • Control late flushes of annual weeds such as foxtail, pigweed, and wild mustard. • Provide season-long suppression of Canada thistle, quackgrass, and perennial sow thistle. • Provide better yields by eliminating competition from both annuals and hard-to-control perennials.
Single Application– For Annual Weed Control	For broad-spectrum control of annual and easy-to-control perennial weeds, make a single application of 16 oz/A of Roundup WeatherMAX.**	For best results, spray Genuity™ Roundup Ready® spring canola at the 2- to 3-leaf stage. Can be applied up to 6-leaf stage; yellowing may occur with later application with little effect on crop growth, maturity, or yield. No additional over-the-top applications can be made.
Maximum Use Rate For Roundup WeatherMAX	Two over-the-top applications: Do not exceed 11 oz/A per application. Single over-the-top applications: Do not exceed 16 oz/A. No additional application can be made.	

*Follow all pesticide label requirements.

**If using another Roundup agricultural herbicide, you must refer to the label booklet or separately published Genuity™ Roundup Ready® canola supplemental label for that brand to determine appropriate use rates. If using Roundup PowerMAX, application rates are the same as for Roundup WeatherMAX.

Genuity™ Roundup Ready® winter canola varieties have been developed for seeding in the fall and harvesting the following spring/summer.

Genuity™ Roundup Ready® winter canola varieties contain in-plant tolerance to Roundup® agricultural herbicides, enabling farmers to apply Roundup agricultural herbicides over the top of Genuity™ Roundup Ready® winter canola from crop emergence to the pre-bolting stage. The introduction of the Roundup Ready trait into winter canola varieties gives farmers the opportunity of unsurpassed weed control, crop safety and maximum yield potential. Genuity™ Roundup Ready® winter canola offers farmers an important option as a rotational crop in traditional monoculture winter wheat production areas. Introducing crop rotation is an important factor in reducing pest cycles, including weed and disease problems.

WEED RESISTANCE MANAGEMENT GUIDELINES

Follow the same guidelines as stated for spring canola.

WEED CONTROL RECOMMENDATIONS (WINTER-SEEDED)

PROGRAM	INSTRUCTIONS AND USE RATES*	ADDITIONAL INFORMATION
Sequential Applications	The two-pass program gives the greatest flexibility in controlling late emerging weeds. For broad-spectrum weed control, apply 11 to 22 oz/A of Roundup WeatherMAX** herbicide to 2-leaf or larger Genuity™ Roundup Ready® winter canola in the fall. Use 5 to 10 gallons/A water volume. Do not add surfactants. Apply a second application of Roundup WeatherMAX** at 11 to 22 oz/A at a minimum interval of 60 days after the first application and before bolting in the spring. Do not exceed 22 oz/A per application.	Spray when Genuity™ Roundup Ready® winter canola is at the 2-3 leaf stage of growth. Early applications can eliminate competing weeds and improve yield potential. Two applications of Roundup WeatherMAX will provide control of early emerging annual weeds and winter emerging weeds such as downy brome, cheat and jointed goatgrass.
Single Application	For broad-spectrum control of annual and easy-to-control perennial weeds, make a single application of 16 to 22 oz/A of Roundup WeatherMAX**, preferably in the fall.	For best results, spray Genuity™ Roundup Ready® winter canola at the 2-3 leaf stage and when weeds are small and actively growing. Applications must be made prior to bolting. Use the higher rate in the range when weed densities are high, when weeds have over wintered or when weeds become large and well established.
Maximum Use Rate for Roundup WeatherMAX	Any single over-the-top application of Roundup WeatherMAX** should not exceed 22 oz/A. No more than two over-the-top applications may be made from crop emergence to canopy closure prior to bolting in the spring.	Applications of greater than 16 fluid ounces/A prior to the 6-leaf stage may result in temporary yellowing and/or growth reduction.

*Follow all pesticide label requirements.

**If using another Roundup brand herbicide, you must refer to the label booklet or Genuity™ Roundup Ready® winter canola supplemental label for that brand to determine appropriate use rates. If using Roundup PowerMAX, application rates are the same as for Roundup WeatherMAX.

GRAZING

It is recommended that Genuity™ Roundup Ready® winter canola not be grazed. While Genuity™ Roundup Ready® winter canola may provide farmers additional opportunity as a forage for grazing livestock, at the present time insufficient information exists to allow safe and proper grazing recommendations. Preliminary data suggest that excessive grazing can significantly reduce yield, and that careful nitrate management is critical in managing Genuity™ Roundup Ready® winter canola as a forage to limit the risk of livestock nitrate poisoning. State universities are assessing the potential and the instructions for grazing Genuity™ Roundup Ready® winter canola and they will provide grazing management guidelines when their research is completed.

Genuity™ Roundup Ready® sugarbeet varieties have in-plant tolerance to Roundup® agricultural herbicides, enabling farmers to apply labeled Roundup agricultural herbicides from planting through 30 days prior to harvest for unsurpassed weed control, excellent crop safety and preservation of yield potential.

MANAGEMENT PRACTICES

Sugarbeets are extremely sensitive to weed competition for light, nutrients and soil moisture. Research on sugarbeet weed control suggests that sugarbeets need to be kept weed-free for the first eight weeks of growth to protect yield potential. Therefore, weeds must be controlled when they are small and before they compete with Genuity™ Roundup Ready® sugarbeets (exceed crop height), that is from less than 2" up to 4" in height, to preserve sugarbeet yield potential. *More than one in-crop herbicide application will be required* to control weed infestations to protect yield potential as Roundup agricultural herbicides have no soil residual activity. Bolting sugarbeets must be rogued or topped in Genuity™ Roundup Ready® sugarbeet fields.

Genuity™ Roundup Ready® sugarbeet varieties have excellent tolerance to over-the-top applications of labeled Roundup agricultural herbicides. A postemergence weed control program using Roundup WeatherMAX® or Roundup PowerMAX® will provide excellent weed control in most situations. A residual herbicide labeled for use in sugarbeets may also be applied preemergence, preplant or postemergence in Genuity™ Roundup Ready® sugarbeets. Contact a Monsanto Representative, local crop advisor or extension specialist to determine the best option for your situation.

WEED RESISTANCE MANAGEMENT FOR GENUITY™ ROUNDUP READY® SUGARBEETS

Follow all pesticide label requirements and the guidelines below to minimize the risk of developing glyphosate-resistant weed populations in a Genuity™ Roundup Ready® sugarbeet system:

- Start clean with tillage and follow-up with a burndown herbicide, such as Roundup WeatherMAX, if needed prior to planting.
- Early-season weed control is critical to protect sugarbeet yield potential. Apply the first in-crop application of Roundup WeatherMAX at a minimum of 22 oz/A while weeds are less than 2" in height.
- Follow with additional postemergence in-crop application of Roundup WeatherMAX at a minimum of 22 oz/A for additional weed flushes before weeds exceed 4" in height.
- Add spray grade ammonium sulfate at a rate of 17 lbs/100 gallons of spray solution with Roundup® agricultural herbicides to maximize product performance.
- Use mechanical weed control/cultivation and/or residual herbicides where appropriate in your Genuity™ Roundup Ready® sugarbeets.
- Use additional herbicide modes of action/residual herbicides and/or mechanical weed control in other Roundup Ready crops you rotate with Genuity™ Roundup Ready® sugarbeets.
- Report repeated non-performance of Roundup agricultural herbicides to Monsanto or your local retailer.

AGRONOMIC PRINCIPLES IN SUGARBEETS

Sugarbeets are very sensitive to early-season weed competition. It is important to select the appropriate herbicide product, application rate and timing to minimize weed competition to protect yields. The Genuity™ Roundup Ready® sugarbeet system provides a mechanism to control weeds at planting and once Genuity™ Roundup Ready® sugarbeets emerge. Failure to control weeds with the right rate, at the right time and with the right product, can lead to increased weed competition, weed escapes and the potential for decreased yields. Tank-mixtures of Roundup agricultural herbicides with fungicides, insecticides, micronutrients or foliar fertilizers are not recommended as they may result in crop injury and reduced pest control or antagonism.

PLANTING REQUIREMENTS

Genuity™ Roundup Ready® sugarbeets are not permitted to be planted in any wildlife feed plots.

STEWARDSHIP

All Genuity™ Roundup Ready® sugarbeet farmers shall sign the Monsanto Technology/Stewardship Agreement (MTSA) limited-use license application which provides the terms and conditions for the authorized use of the product. The MTSA must be signed and approved prior to purchase or use of seed.

WEED CONTROL RECOMMENDATIONS

PROGRAM	INSTRUCTIONS AND USE RATES*	ADDITIONAL INFORMATION
Preplant Burndown	After preplant tillage or bedding operations have been completed, a preplant burndown application of Roundup WeatherMAX®** at 22 to 44 oz/A may be applied to control weeds that have germinated after tillage and prior to planting. See the label for appropriate rates by weed species and weed size.	Always utilize tillage to start with a weed-free field.
Over-The-Top Applications up to eight-leaf Genuity™ Roundup Ready® Sugarbeets	Up to two applications of Roundup agricultural herbicides may be made prior to the 8-leaf stage of Genuity™ Roundup Ready® sugarbeets. The first application of 22 to 32 oz/A of Roundup WeatherMAX** should be made when weeds are less than 2" in height to protect yield potential. Make an additional application of 22 to 32 oz/A of Roundup WeatherMAX before weeds exceed 4" in height. Maximum in-crop Roundup WeatherMAX prior to 8-leaf stage must not exceed 56 oz/A.	Sugarbeets are sensitive to weed competition and can lose yield rapidly if weeds are not controlled early. More than one in-crop Roundup WeatherMAX application will be required to control weed infestations to protect yield potential as Roundup agricultural herbicides have no soil residual activity. Add ammonium sulfate at a rate of 17 lbs/100 gallons of spray solution with Roundup agricultural herbicides to maximize product performance. Tank-mixtures of Roundup agricultural herbicides with fungicides, insecticides, micronutrients or foliar fertilizers are not recommended. Sequential applications should be at least 10 days apart.
Over-The-Top Applications to greater than eight-leaf Genuity™ Roundup Ready® Sugarbeets	Up to two additional applications of 22 oz/A of Roundup WeatherMAX can be made after the eight-leaf stage up to 30 days prior to harvest. Maximum in-crop Roundup WeatherMAX from 8-leaf stage up until 30 days prior to harvest must not exceed 44 oz/A.	Add ammonium sulfate at a rate of 17 lbs/100 gallons of spray solution with Roundup agricultural herbicides to maximize product performance. Tank-mixtures of Roundup agricultural herbicides with fungicides, insecticides, micronutrients or foliar fertilizers are not recommended. Sequential applications should be at least 10 days apart.
Maximum Use Rates	**In-Crop:** • Two applications of Roundup WeatherMAX prior to the 8-leaf stage of Genuity™ Roundup Ready® sugarbeets - 32 oz/A per single application up to the 8-leaf stage. - Combined maximum of 56 oz/A in-crop prior to the 8-leaf stage • Two applications of Roundup WeatherMAX after the 8-leaf stage up to 30 days prior to harvest - 22 oz/A per single application after the 8-leaf stage. - Combined maximum of 44 oz/A in-crop after the 8-leaf stage until 30 days prior to harvest	**Total Per Year:** The combined total per year for all Roundup WeatherMAX applications including pre-plant must not exceed 5.3 qt/A. Total in-crop application must not exceed 3 qt/A. Add ammonium sulfate at a rate of 17 lbs/100 gallons of spray solution with Roundup agricultural herbicides to maximize product performance. Tank-mixtures of Roundup agricultural herbicides with fungicides, insecticides, micronutrients or foliar fertilizers are not recommended.

*Follow all pesticide label requirements.

**If using another Roundup agricultural herbicide, you must refer to the label booklet or separately published Genuity™ Roundup Ready® sugarbeets supplemental label for that brand to determine appropriate use rates. If using Roundup PowerMAX, application rates are the same as for Roundup WeatherMAX.

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- Saves the equivalent of 585 mature trees
- Reduces solid waste by 35,308 pounds
- Reduces waste water by 213,390 gallons
- Reduces greenhouse gas emissions by 199,989.75 pounds

Before opening a bag of seed, be sure to read, understand and accept the stewardship requirements, **including applicable refuge requirements for insect resistance management,** for the biotechnology traits expressed in the seed as set forth in the Monsanto Technology Agreement that you sign. By opening and using a bag of seed, you are reaffirming your obligation to comply with the most recent stewardship requirements.

Roundup Ready® Alfalfa seed is currently not for sale or distribution. The movement and use of Roundup Ready® Alfalfa forage is subject to a USDA administrative Order available at http://www.aphis.usda.gov/brs/pdf/RRA_A8_final.pdf.

This stewardship statement applies to all products listed herein except Genuity™ VT Double PRO™, Genuity™ VT Triple PRO™ and Genuity™ SmartStax™. See restrictions related to Genuity™ Double PRO™, Genuity™ VT Triple PRO™ and Genuity™ SmartStax™ below:

Monsanto Company is a member of Excellence Through Stewardship® (ETS). Monsanto products are commercialized in accordance with ETS Product Launch Stewardship Guidance, and in compliance with Monsanto's Policy for Commercialization of Biotechnology-Derived Plant Products in Commodity Crops. This product has been approved for import into key export markets with functioning regulatory systems. Any crop or material produced from this product can only be exported to, or used, processed or sold in countries where all necessary regulatory approvals have been granted. It is a violation of national and international law to move material containing biotech traits across boundaries into nations where import is not permitted. Growers should talk to their grain handler or product purchaser to confirm their buying position for this product. Excellence Through Stewardship® is a registered trademark of Biotechnology Industry Organization.

IMPORTANT: Grain Marketing and Seed Availability: Genuity™ VT Double PRO™ has received the necessary approvals in the United States, however, as of October 22, 2009, approvals have not been received in certain major corn export markets. **Genuity™ VT Double PRO™** will not be launched and seed will not be available until after import approvals are received in appropriate major corn export markets. ***B.t.* products, including Genuity™ VT Double PRO™** may not yet be registered in all states. Check with your Monsanto representative for the registration status in your state.

IMPORTANT: Grain Marketing and Seed Availability: Genuity™ VT Triple PRO™ has received the necessary approvals in the United States however, as of October 22, 2009, approval has not been received in all major corn export markets. Monsanto anticipates that all such approvals will be in place for the 2010 growing season. If all approvals are not in place, **Genuity™ VT Triple PRO™** seed will only be available as part of a commercial demonstration program that includes grain marketing stewardship requirements. It is a violation of national and international law to move material containing biotech traits across boundaries into nations where import is not permitted. Consult with your seed representative for current regulatory and stewardship information status.

IMPORTANT: Grain Marketing and Seed Availability: Genuity™ SmartStax™ has received the necessary approvals in the United States, however, as of October 22, 2009, approvals have not been received in certain major corn export markets. **Genuity™ SmartStax™** will not be launched and seed will not be available until after import approvals are received in appropriate major corn export markets. ***B.t.* products, including Genuity™ SmartStax™** may not yet be registered in all states. Check with your Monsanto representative for the registration status in your state.

Cottonseed containing Monsanto traits may not be exported for the purpose of planting without a license from Monsanto.

Individual results may vary, and performance may vary from location to location and from year to year. This result may not be an indicator of results you may obtain as local growing, soil and weather conditions may vary. Growers should evaluate data from multiple locations and years whenever possible.

Growers may utilize the natural refuge option for varieties containing the Bollgard II® trait in the following states: AL, AR, FL, GA, KS, KY, LA, MD, MS, MO, NC, OK, SC, TN, VA, and most of Texas (excluding the Texas counties of Brewster, Crane, Crockett, Culberson, El Paso, Hudspeth, Jeff Davis, Loving, Pecos, Presidio, Reeves, Terrell, Val Verde, Ward and Winkler). The natural refuge option does not apply to **Bollgard II** cotton grown in areas where pink bollworm is a pest, including CA, AZ, NM, and the above listed Texas counties. It also remains the case that **Bollgard®** and **Bollgard II** cotton cannot be planted south of Highway 60 in Florida, and that **Bollgard** cotton cannot be planted in certain other counties in the Texas panhandle. Refer to the Technology Use Guide and IRM/Grower Guide for additional information regarding Bollgard II, Bollgard, natural refuge and EPA-mandated geographical restrictions on the planting of *B.t.* cotton.

ALWAYS READ AND FOLLOW PESTICIDE LABEL DIRECTIONS. Roundup Ready® crops contain genes that confer tolerance to glyphosate, the active ingredient in Roundup® brand agricultural herbicides. Roundup® brand agricultural herbicides will kill crops that are not tolerant to glyphosate. Degree® and Harness® are not registered in all states. Degree® and Harness® may be subject to use restrictions in some states. Bullet®, Degree Xtra®, Harness®, INTRRO®, Lariat®, and Micro-Tech™ are restricted use pesticides and are not registered in all states. The distribution, sale, or use of an unregistered pesticide is a violation of federal and/or state law and is strictly prohibited. Check with your local Monsanto dealer or representative for the product registration status in your state.

Tank mixtures: The applicable labeling for each product must be in the possession of the user at the time of application. Follow applicable use instructions, including application rates, precautions and restrictions of each product used in the tank mixture. Monsanto has not tested all tank mix product formulations for compatibility or performance other than specifically listed by brand name. Always predetermine the compatibility of tank mixtures by mixing small proportional quantities in advance.

Appendix B

National and Tier III Production Data and State Maps with County-Level Detail for the Eleven Tier III States with Seed Production Greater Than 100,000 lbs

Counties Within Eleven States with Seed Production greater than 100,000 lbs in 2007 (County List)

State	County	Seed Production Reported, 2007	Alfalfa For Forage Production	Seed - Acres Hvstd.	Seed - Operations	Seed - In Pounds		Alf. Hay - Acres	Alf. Hay - Operations	Alf. Hay - Tons	Hay % Operations Excluded	Hay % Operations Included
ARIZONA	COCONINO							0	4	141		
ARIZONA	GILA							0	1	0		
ARIZONA	GREENLEE			0	0	0		1,126	19	6,767		
ARIZONA	LAPAZ	No	Yes, With Limits and GPS Reporting					60,290	52	451,583		
ARIZONA	MOHAVE							10,374	15	58,068		
ARIZONA	PIMA							1,888	23	19,303		
ARIZONA	SANTA CRUZ							0	2	0		
			Subtotals	0	0	0	0	73,678	116	535,862	12%	
ARIZONA	APACHE			0	2	0		0	146	4,372		
ARIZONA	COCHISE			0	1	0		19,621	65	142,696		
ARIZONA	GRAHAM			304	6	112,960		1,973	61	0		
ARIZONA	MARICOPA	Yes	No new RRA forage production	776	17	182,099		75,394	175	612,404		
ARIZONA	NAVAJO			0	2	0		2,694	48	7,561		
ARIZONA	PINAL			0	6	859,873		54,495	175	420,575		
ARIZONA	YAVAPAI			0	3	30,000		0	28	2,981		
ARIZONA	YUMA			1,723	16	708,212		25,789	129	228,082		
Subtotal			Subtotals	2,803	53	1,893,144	0	179,966	827	1,418,671		88%
			State Total	2,803	53	1,893,144	0	253,644	943	1,954,533		
CALIFORNIA	ALAMEDA	No	Yes, With Limits and GPS Reporting					0	4	2,770		
CALIFORNIA	ALPINE							0	1	0		
CALIFORNIA	AMADOR							1,613	4	9,692		
CALIFORNIA	BUTTE			0	0	0		1,349	20	7,782		
CALIFORNIA	CALAVERAS							0	1	0		
CALIFORNIA	COLUSA							14,900	49	104,403		
CALIFORNIA	CONTRA COSTA							3,696	15	22,423		
CALIFORNIA	GLENN							13,851	109	90,271		
CALIFORNIA	INYO							3,273	12	16,177		
CALIFORNIA	LAKE							58	8	347		
CALIFORNIA	LOS ANGELES			0	0	0		7,693	30	59,240		
CALIFORNIA	MARIN							0	0	0		
CALIFORNIA	MARIPOSA							0	0	0		

Counties Within Eleven States with Seed Production greater than 100,000 lbs in 2007 (County List)

State	County	Seed Production Reported, 2007	Alfalfa For Forage Production	Seed - Acres Hvstd.	Seed - Operations	Seed - In Pounds		Alf. Hay - Acres	Alf. Hay - Operations	Alf. Hay - Tons	Hay % Operations Excluded	Hay % Operations Included
CALIFORNIA	MENDOCINO							1,218	7	5,325		
CALIFORNIA	MERCED			0	0	0		82,731	304	622,298		
CALIFORNIA	MONO							7,525	17	40,666		
CALIFORNIA	MONTEREY							428	12	2,633		
CALIFORNIA	NAPA							125	6	436		
CALIFORNIA	NEVADA							0	3	0		
CALIFORNIA	ORANGE							0	1	0		
CALIFORNIA	PLACER							170	4	0		
CALIFORNIA	PLUMAS							5,118	10	16,888		
CALIFORNIA	SAN BENITO							489	4	3,161		
CALIFORNIA	SAN BERNARDINO			0	0	0		9,345	43	66,349		
CALIFORNIA	SAN DIEGO							183	10	660		
CALIFORNIA	SAN JOAQUIN			0	0	0		56,969	225	394,624		
CALIFORNIA	SAN LUIS OBISPO							0	20	25,519		
CALIFORNIA	SAN MATEO							0	1	0		
CALIFORNIA	SANTA BARBARA							841	21	6,123		
CALIFORNIA	SANTA CLARA							1,213	8	7,268		
CALIFORNIA	SHASTA							4,894	54	21,418		
CALIFORNIA	SIERRA							1,064	11	3,594		
CALIFORNIA	SISKIYOU			0	0	0		59,216	194	267,718		
CALIFORNIA	SOLANO							28,129	69	197,659		
CALIFORNIA	SONOMA			0	0	0		925	11	4,119		
CALIFORNIA	STANISLAUS			0	0	0		28,836	259	220,581		
CALIFORNIA	SUTTER			0	0	0		6,388	39	40,765		
CALIFORNIA	TEHAMA							5,289	44	31,465		
CALIFORNIA	TRINITY							0	6	0		
CALIFORNIA	TULARE			0	0	0		76,413	306	624,055		
CALIFORNIA	TUOLUMNE							0	0	0		
CALIFORNIA	VENTURA							1,001	7	6,682		
CALIFORNIA	YUBA							850	9	4,267		
			Subtotals	0	0	0	0	425,793	1,958	2,927,378	55%	
CALIFORNIA	FRESNO	Yes	No new RRA forage production	3,287	20	2,603,178		69,290	250	528,024		

Counties Within Eleven States with Seed Production greater than 100,000 lbs in 2007 (County List)

State	County	Seed Production Reported, 2007	Alfalfa For Forage Production	Seed - Acres Hvstd.	Seed - Operations	Seed - In Pounds		Alf. Hay - Acres	Alf. Hay - Operations	Alf. Hay - Tons	Hay % Operations Excluded	Hay % Operations Included
CALIFORNIA	HUMBOLDT			0	1	0		997	16	4,487		
CALIFORNIA	IMPERIAL			25,848	64	11,411,921		127,406	199	976,999		
CALIFORNIA	KERN			367	7	253,000		85,756	274	704,029		
CALIFORNIA	KINGS			5,779	5	4,295,319		63,840	243	485,411		
CALIFORNIA	LASSEN			377	4	190,000		19,752	119	85,017		
CALIFORNIA	MADERA			0	2	0		29,759	78	220,963		
CALIFORNIA	MODOC			65	5	41,000		45,890	159	217,036		
CALIFORNIA	RIVERSIDE			0	1	0		47,418	104	422,220		
CALIFORNIA	SACRAMENTO			0	2	0		9,960	65	75,678		
CALIFORNIA	YOLO			0	3	86,240		57,001	122	405,914		
			Subtotals	35,723	114	18,880,658	0	557,069	1,629	4,125,778		45%
			State Total	35,723	114	18,880,658	0	982,862	3,587	7,053,156		
IDAHO	ADAMS	No	Yes, With Limits and GPS Reporting					6,953	84	11,390		
IDAHO	BANNOCK							20,926	258	55,839		
IDAHO	BEAR LAKE							22,934	219	42,805		
IDAHO	BENEWAH							1,093	16	1,938		
IDAHO	BINGHAM			0	0	0		56,101	477	267,008		
IDAHO	BLAINE							22,083	101	78,802		
IDAHO	BOISE							1,471	25	0		
IDAHO	BONNER							4,298	90	7,340		
IDAHO	BONNEVILLE							41,382	348	160,554		
IDAHO	BOUNDARY			0	0	0		9,988	134	25,562		
IDAHO	BUTTE							31,843	110	123,505		
IDAHO	CAMAS							44,382	52	44,559		
IDAHO	CARIBOU							21,060	131	54,535		
IDAHO	CLARK							0	22	0		
IDAHO	CLEARWATER							1,544	16	2,634		
IDAHO	CUSTER							23,590	126	66,103		
IDAHO	FREMONT							17,469	184	55,889		
IDAHO	IDAHO							14,264	183	23,380		
IDAHO	JEFFERSON			0	0	0		80,999	432	389,645		

Counties Within Eleven States with Seed Production greater than 100,000 lbs in 2007 (County List)

State	County	Seed Production Reported, 2007	Alfalfa For Forage Production	Seed - Acres Hvstd.	Seed - Operations	Seed - In Pounds		Alf. Hay - Acres	Alf. Hay - Operations	Alf. Hay - Tons	Hay % Operations Excluded	Hay % Operations Included
IDAHO	KOOTENAI							5,362	100	11,974		
IDAHO	LATAH							4,156	90	8,391		
IDAHO	LEMHI							21,478	116	52,354		
IDAHO	LEWIS							4,469	57	9,744		
IDAHO	LINCOLN							23,248	145	104,300		
IDAHO	MADISON							15,114	183	58,374		
IDAHO	NEZ PERCE							0	91	10,414		
IDAHO	POWER							9,961	89	32,946		
IDAHO	SHOSHONE							0	3	0		
IDAHO	TETON							12,617	110	24,422		
IDAHO	VALLEY							1,304	22	3,585		
			Subtotals	0	0	0	0	520,089	4,014	1,727,992	46%	
IDAHO	ADA	Yes	No new RRA forage production	0	8	609,015		20,972	461	88,529		
IDAHO	CANYON			7,018	31	5,940,842		40,654	867	230,714		
IDAHO	CASSIA			0	1	0		53,422	267	284,796		
IDAHO	ELMORE			0	1	0		38,569	162	167,200		
IDAHO	FRANKLIN			0	2	0		33,233	320	110,584		
IDAHO	GEM			233	7	129,588		10,747	241	43,580		
IDAHO	GOODING			0	1	0		33,174	289	169,518		
IDAHO	JEROME			707	5	577,532		42,265	286	233,523		
IDAHO	MINIDOKA			0	1	0		29,381	269	168,412		
IDAHO	ONEIDA			0	6	430,150		28,802	178	97,341		
IDAHO	OWYHEE			1,179	11	877,054		48,409	307	281,034		
IDAHO	PAYETTE			496	9	267,467		15,850	290	75,673		
IDAHO	TWIN FALLS			258	5	151,500		68,924	596	395,914		
IDAHO	WASHINGTON			130	4	68,418		29,866	270	87,337		
			Subtotals	10,021	92	9,051,566	0	494,268	4,803	2,434,155		54%
			State Total	10,021	92	9,051,566		1,014,357	8,817	4,162,147		
MONTANA	CASCADE	No	Yes, With Limits and GPS Reporting					65,292	401	116,943		
MONTANA	DANIELS							19,602	95	26,311		
MONTANA	DEER LODGE							4,150	21	13,459		

Counties Within Eleven States with Seed Production greater than 100,000 lbs in 2007 (County List)

State	County	Seed Production Reported, 2007	Alfalfa For Forage Production	Seed - Acres Hvstd.	Seed - Operations	Seed - In Pounds		Alf. Hay - Acres	Alf. Hay - Operations	Alf. Hay - Tons	Hay % Operations Excluded	Hay % Operations Included
MONTANA	FERGUS							158,137	520	264,997		
MONTANA	GARFIELD			0	0	0		30,927	121	35,604		
MONTANA	GLACIER							28,397	151	45,795		
MONTANA	GOLDEN VALLEY							21,207	64	31,268		
MONTANA	GRANITE							8,720	50	26,982		
MONTANA	HILL							13,796	99	24,359		
MONTANA	JUDITH BASIN							79,911	181	142,981		
MONTANA	LAKE							33,618	379	89,981		
MONTANA	LEWIS AND CLARK							31,028	282	88,048		
MONTANA	LIBERTY							6,982	43	11,875		
MONTANA	MADISON							47,830	215	160,160		
MONTANA	MEAGHER							18,583	54	48,779		
MONTANA	MINERAL							1,332	25	2,323		
MONTANA	MISSOULA							9,158	157	23,051		
MONTANA	MUSSELSHELL			0	0	0		26,499	104	44,026		
MONTANA	PARK			0	0	0		38,637	205	117,514		
MONTANA	PONDERA							27,044	188	52,042		
MONTANA	POWELL							17,602	79	52,203		
MONTANA	RAVALLI							15,037	333	52,990		
MONTANA	ROOSEVELT							52,241	205	92,044		
MONTANA	SHERIDAN							19,749	125	34,294		
MONTANA	SILVER BOW							3,585	19	7,060		
MONTANA	SWEET GRASS							38,484	136	72,294		
MONTANA	TETON							42,172	240	108,722		
MONTANA	TOOLE							8,782	59	11,299		
MONTANA	VALLEY			0	0	0		51,908	257	112,848		
MONTANA	WHEATLAND							22,600	70	33,514		
MONTANA	WIBAUX			0	0	0		19,272	77	32,690		
			Subtotals	0	0	0	0	962,282	4,955	1,976,456	51%	
MONTANA	BEAVERHEAD	Yes	No new RRA forage production	0	1	0		42,828	145	141,961		
MONTANA	BIG HORN			619	7	341,502		70,177	293	181,466		
MONTANA	BLAINE			0	3	230,000		53,439	254	135,988		

Counties Within Eleven States with Seed Production greater than 100,000 lbs in 2007 (County List)

State	County	Seed Production Reported, 2007	Alfalfa For Forage Production	Seed - Acres Hvstd.	Seed - Operations	Seed - In Pounds		Alf. Hay - Acres	Alf. Hay - Operations	Alf. Hay - Tons	Hay % Operations Excluded	Hay % Operations Included
MONTANA	BROADWATER			0	1	0		20,608	115	80,074		
MONTANA	CARBON			0	12	1,253,336		34,963	309	87,750		
MONTANA	CARTER			560	3	76,000		68,447	185	103,119		
MONTANA	CHOUTEAU			0	1	0		25,519	149	42,578		
MONTANA	CUSTER			0	5	53,921		41,624	198	91,104		
MONTANA	DAWSON			0	1	0		29,735	206	54,018		
MONTANA	FALLON			105	3	22,341		73,050	165	83,380		
MONTANA	FLATHEAD			0	2	0		18,783	315	50,486		
MONTANA	GALLATIN			0	1	0		54,242	372	150,592		
MONTANA	JEFFERSON			0	2	0		13,747	83	41,164		
MONTANA	LINCOLN			0	1	0		3,341	70	5,873		
MONTANA	MCCONE			0	1	0		20,625	111	33,913		
MONTANA	PETROLEUM			0	1	0		26,304	53	49,588		
MONTANA	PHILLIPS			0	2	0		40,426	211	82,203		
MONTANA	POWDER RIVER			2,187	17	410,112		68,080	190	121,469		
MONTANA	PRAIRIE			0	2	0		14,352	88	28,379		
MONTANA	RICHLAND			0	1	0		44,729	227	92,452		
MONTANA	ROSEBUD			749	8	200,108		35,367	166	88,426		
MONTANA	SANDERS			0	1	0		13,685	129	28,181		
MONTANA	STILLWATER			0	1	0		43,459	222	59,995		
MONTANA	TREASURE			0	1	0		7,278	38	26,923		
MONTANA	YELLOWSTONE			0	2	0		41,666	462	98,907		
			Subtotals	4,220	80	2,587,320	0	906,474	4,756	1,959,989		49%
			State Total	4,220	80	2,587,320	0	1,868,756	9,711	3,936,445		
NEVADA	CARSON CITY	No	Yes, With Limits and GPS Reporting					0	2	0		
NEVADA	CLARK							1,742	28	0		
NEVADA	DOUGLAS							0	55	41,706		
NEVADA	ELKO							12,076	80	42,599		
NEVADA	ESMERALDA							12,114	13	58,110		
NEVADA	EUREKA							22,340	49	106,164		
NEVADA	LANDER							23,245	44	92,820		

Counties Within Eleven States with Seed Production greater than 100,000 lbs in 2007 (County List)

State	County	Seed Production Reported, 2007	Alfalfa For Forage Production	Seed - Acres Hvstd.	Seed - Operations	Seed - In Pounds		Alf. Hay - Acres	Alf. Hay - Operations	Alf. Hay - Tons	Hay % Operations Excluded	Hay % Operations Included
NEVADA	LYON							43,451	139	218,529		
NEVADA	MINERAL			0				0	4	0		
NEVADA	NYE							9,787	41	42,319		
NEVADA	STOREY							0	1	0		
NEVADA	WASHOE							4,134	101	14,842		
			Subtotals	0	0	0	0	128,889	557	617,089	49%	
NEVADA	CHURCHILL			162	5	129,000		25,955	294	122,839		
NEVADA	HUMBOLDT			4,206	6	3,024,793		51,041	101	215,768		
NEVADA	LINCOLN	Yes	No new RRA forage production	0	2	0		11,039	47	53,193		
NEVADA	PERSHING			1,960	4	1,067,308		30,625	74	145,593		
NEVADA	WHITE PINE			0	2	0		12,056	55	42,735		
			Subtotals	6,328	19	4,221,101	0	130,716	571	580,128		51%
			State Total	6328	19	4221101		259605	1128	1197217		
OKLAHOMA	ADAIR	No	Yes, With Limits and GPS Reporting					190	7	561		
OKLAHOMA	ATOKA							524	10	1,078		
OKLAHOMA	BEAVER							3,786	34	20,502		
OKLAHOMA	BECKHAM			-	-	-		5,527	76	16,930		
OKLAHOMA	BLAINE							6,525	89	20,137		
OKLAHOMA	BRYAN							4,071	31	11,658		
OKLAHOMA	CADDO							7,456	116	20,444		
OKLAHOMA	CANADIAN			-	-	-		14,541	165	46,215		
OKLAHOMA	CARTER							1,339	19	3,707		
OKLAHOMA	CHEROKEE							302	6	670		
OKLAHOMA	CHOCTAW							1,634	13	2,996		
OKLAHOMA	CIMARRON							5,390	16	26,933		
OKLAHOMA	CLEVELAND							3,482	46	10,993		
OKLAHOMA	COAL							260	9	656		
OKLAHOMA	COMANCHE							5,384	58	11,161		
OKLAHOMA	CRAIG							1,066	21	2,312		
OKLAHOMA	CUSTER							9,835	121	48,291		
OKLAHOMA	DELAWARE							352	18	1,001		

Counties Within Eleven States with Seed Production greater than 100,000 lbs in 2007 (County List)

State	County	Seed Production Reported, 2007	Alfalfa For Forage Production	Seed - Acres Hvstd.	Seed - Operations	Seed - In Pounds		Alf. Hay - Acres	Alf. Hay - Operations	Alf. Hay - Tons	Hay % Operations Excluded	Hay % Operations Included
OKLAHOMA	DEWEY							3,325	39	13,615		
OKLAHOMA	ELLIS							4,878	31	25,770		
OKLAHOMA	GARFIELD							7,838	108	24,312		
OKLAHOMA	GARVIN			-	-	-		17,535	133	68,099		
OKLAHOMA	GREER			-	-	-		4,437	39	14,481		
OKLAHOMA	HARMON							2,416	27	8,171		
OKLAHOMA	HASKELL							2,442	13	10,935		
OKLAHOMA	HUGHES							1,166	25	3,106		
OKLAHOMA	JACKSON			-	-	-		4,420	59	14,916		
OKLAHOMA	JEFFERSON							303	4	938		
OKLAHOMA	JOHNSTON							-	2	-		
OKLAHOMA	KINGFISHER			-	-	-		12,149	102	39,621		
OKLAHOMA	LATIMER							290	3	-		
OKLAHOMA	LEFLORE							1,973	22	3,165		
OKLAHOMA	LINCOLN			-	-	-		1,509	43	4,672		
OKLAHOMA	LOGAN			-	-	-		3,878	69	10,497		
OKLAHOMA	MAJOR			-	-	-		8,079	90	25,063		
OKLAHOMA	MARSHALL							-	4	160		
OKLAHOMA	MAYES							1,157	33	3,599		
OKLAHOMA	MCCLAIN							10,022	100	34,842		
OKLAHOMA	MCCURTAIN							2,094	40	5,364		
OKLAHOMA	MCINTOSH							519	16	1,293		
OKLAHOMA	MURRAY							2,254	18	7,483		
OKLAHOMA	NOBLE							5,315	92	13,656		
OKLAHOMA	NOWATA							996	25	3,499		
OKLAHOMA	OKFUSKEE							317	6	1,141		
OKLAHOMA	OKLAHOMA			-	-	-		5,565	75	17,875		
OKLAHOMA	OSAGE							2,902	55	8,210		
OKLAHOMA	OTTAWA							680	17	1,300		
OKLAHOMA	PAWNEE							1,667	38	6,427		
OKLAHOMA	PAYNE			-	-	-		2,560	47	9,524		
OKLAHOMA	PITTSBURG							681	12	1,642		

Counties Within Eleven States with Seed Production greater than 100,000 lbs in 2007 (County List)

State	County	Seed Production Reported, 2007	Alfalfa For Forage Production	Seed - Acres Hvstd.	Seed - Operations	Seed - In Pounds		Alf. Hay - Acres	Alf. Hay - Operations	Alf. Hay - Tons	Hay % Operations Excluded	Hay % Operations Included
OKLAHOMA	PONTOTOC							409	14	1,080		
OKLAHOMA	POTTAWATOMIE			-	-	-		2,510	61	5,679		
OKLAHOMA	PUSHMATAHA							497	6	1,186		
OKLAHOMA	ROGER MILLS							6,267	48	29,205		
OKLAHOMA	ROGERS							606	24	2,585		
OKLAHOMA	SEMINOLE							850	13	2,458		
OKLAHOMA	SEQUOYAH							968	18	2,183		
OKLAHOMA	TULSA							1,016	24	2,829		
OKLAHOMA	WASHINGTON							203	8	546		
OKLAHOMA	WOODS			-	-	-		13,060	106	40,906		
OKLAHOMA	WOODWARD							2,879	64	11,551		
			Subtotals	0	0	0		214,296	2,628	729,829	70%	
OKLAHOMA	ALFALFA			96	3	1,696		21,702	178	68,863		
OKLAHOMA	COTTON			-	2	-		813	14	1,665		
OKLAHOMA	CREEK			-	1	-		1,853	24	3,908		
OKLAHOMA	GRADY			275	5	4,350		22,971	220	70,671		
OKLAHOMA	GRANT			-	1	-		13,621	138	36,665		
OKLAHOMA	HARPER			-	2	-		3,421	38	11,823		
OKLAHOMA	KAY			-	2	-		6,991	119	19,145		
OKLAHOMA	KIOWA	Yes	No new RRA forage production	-	3	-		6,226	84	18,238		
OKLAHOMA	LOVE			-	1	-		328	11	901		
OKLAHOMA	MUSKOGEE			-	2	-		1,735	27	4,242		
OKLAHOMA	OKMULGEE			-	2	-		298	9	1,038		
OKLAHOMA	STEPHENS			-	1	-		2,222	26	6,829		
OKLAHOMA	TEXAS			-	1	-		6,611	32	31,588		
OKLAHOMA	TILLMAN			-	1	-		18,134	94	75,361		
OKLAHOMA	WAGONER			-	1	-		878	17	1,703		
OKLAHOMA	WASHITA			-	1	-		12,700	122	48,894		30%
			Subtotals	371	29	6,046		120,504	1,153	401,534		
			State Total	371	29	6046		334800	3781	1131363		
OREGON	BAKER	No	Yes, With Limits and GPS Reporting					22,057	215	80,919		

Appendix B

Counties Within Eleven States with Seed Production greater than 100,000 lbs in 2007 (County List)

State	County	Seed Production Reported, 2007	Alfalfa For Forage Production	Seed - Acres Hvstd.	Seed - Operations	Seed - In Pounds		Alf. Hay - Acres	Alf. Hay - Operations	Alf. Hay - Tons	Hay % Operations Excluded	Hay % Operations Included
OREGON	BENTON							390	9	2,620		
OREGON	CLACKAMAS							1,371	42	4,679		
OREGON	CLATSOP							185	5	513		
OREGON	COLUMBIA							345	12	0		
OREGON	COOS							268	8	616		
OREGON	CROOK							17,975	149	76,640		
OREGON	DESCHUTES							8,165	126	27,089		
OREGON	DOUGLAS							1,928	34	11,140		
OREGON	GRANT							8,796	80	17,985		
OREGON	HARNEY							45,514	178	150,512		
OREGON	JEFFERSON							15,175	146	65,594		
OREGON	JOSEPHINE							463	25	1,904		
OREGON	KLAMATH							61,859	335	271,713		
OREGON	LAKE							64,174	171	268,148		
OREGON	LANE			0	0	0		737	22	3,009		
OREGON	LINCOLN							130	3	0		
OREGON	LINN							829	23	3,122		
OREGON	MARION			0	0	0		1,740	69	6,219		
OREGON	MORROW							18,269	57	92,461		
OREGON	MULTNOMAH							238	12	640		
OREGON	POLK							342	19	1,402		
OREGON	SHERMAN							421	14	1,303		
OREGON	TILLAMOOK							326	3	0		
OREGON	UNION							26,633	314	80,843		
OREGON	WALLOWA							19,777	147	69,497		
OREGON	WHEELER							4,006	42	10,743		
OREGON	YAMHILL							1,781	51	5,747		
			Subtotals	0	0	0	0	323,894	2,311	1,255,058	65%	
OREGON	GILLIAM	Yes	No new RRA forage production	0	1	0		2,312	14	10,643		
OREGON	HOOD RIVER			0	1	0		236	14	452		
OREGON	JACKSON			0	1	0		4,127	104	14,850		
OREGON	MALHEUR			3,565	25	2,317,740		58,166	707	294,335		

Counties Within Eleven States with Seed Production greater than 100,000 lbs in 2007 (County List)

State	County	Seed Production Reported, 2007	Alfalfa For Forage Production	Seed - Acres Hvstd.	Seed - Operations	Seed - In Pounds		Alf. Hay - Acres	Alf. Hay - Operations	Alf. Hay - Tons	Hay % Operations Excluded	Hay % Operations Included
OREGON	UMATILLA			0	2	0		34,341	312	175,636		
OREGON	WASCO			0	1	0		4,451	70	18,402		
OREGON	WASHINGTON			0	1	0		1,285	37	5,550		
			Subtotals	3,565	32	2,317,740	0	104,918	1,258	519,868		35%
			Total	3,565	32	2,317,740		428,812	3,569	1,774,926		
SOUTH DAKOTA	AURORA	No	Yes, With Limits and GPS Reporting	0	0	0		17,065	159	52,198		
SOUTH DAKOTA	BEADLE			0	0	0		38,312	315	126,217		
SOUTH DAKOTA	BON HOMME							28,997	352	100,562		
SOUTH DAKOTA	BRULE			0	0	0		23,814	178	66,440		
SOUTH DAKOTA	BUFFALO							10,296	38	21,181		
SOUTH DAKOTA	BUTTE			0	0	0		46,953	299	119,239		
SOUTH DAKOTA	CHARLES MIX							42,202	358	122,162		
SOUTH DAKOTA	CLARK							23,158	208	70,286		
SOUTH DAKOTA	CLAY							17,946	140	66,019		
SOUTH DAKOTA	CODINGTON			0	0	0		22,632	244	72,022		
SOUTH DAKOTA	CUSTER							8,523	86	10,981		
SOUTH DAKOTA	DAVISON			0	0	0		19,504	209	60,524		
SOUTH DAKOTA	DAY			0	0	0		16,978	239	47,623		
SOUTH DAKOTA	DEUEL							15,882	224	57,396		
SOUTH DAKOTA	DOUGLAS							16,158	198	59,366		
SOUTH DAKOTA	EDMUNDS			0	0	0		27,401	164	66,818		
SOUTH DAKOTA	FALL RIVER			0	0	0		8,596	72	9,968		
SOUTH DAKOTA	FAULK							33,758	149	82,460		
SOUTH DAKOTA	GRANT							18,919	222	58,049		
SOUTH DAKOTA	HAAKON			0	0	0		44,691	146	35,926		
SOUTH DAKOTA	HAMLIN			0	0	0		10,296	153	36,251		
SOUTH DAKOTA	HAND							46,311	218	120,449		
SOUTH DAKOTA	HANSON							9,084	110	28,164		
SOUTH DAKOTA	HARDING							56,869	131	56,085		
SOUTH DAKOTA	HYDE							24,976	96	52,674		
SOUTH DAKOTA	JERAULD							20,034	110	61,931		

Counties Within Eleven States with Seed Production greater than 100,000 lbs in 2007 (County List)

State	County	Seed Production Reported, 2007	Alfalfa For Forage Production	Seed - Acres Hvstd.	Seed - Operations	Seed - In Pounds		Alf. Hay - Acres	Alf. Hay - Operations	Alf. Hay - Tons	Hay % Operations Excluded	Hay % Operations Included
SOUTH DAKOTA	JONES			0	0	0		25,627	82	38,332		
SOUTH DAKOTA	LAKE							10,956	200	36,862		
SOUTH DAKOTA	LAWRENCE							17,738	108	43,706		
SOUTH DAKOTA	LINCOLN							6,988	205	26,174		
SOUTH DAKOTA	MCCOOK							11,207	207	39,346		
SOUTH DAKOTA	MCPHERSON							46,056	180	117,492		
SOUTH DAKOTA	MINER							14,753	162	40,614		
SOUTH DAKOTA	MINNEHAHA			0	0	0		21,271	413	85,718		
SOUTH DAKOTA	MOODY							10,304	163	42,074		
SOUTH DAKOTA	PERKINS			0	0	0		101,477	260	138,351		
SOUTH DAKOTA	POTTER							12,155	68	26,927		
SOUTH DAKOTA	ROBERTS			0	0	0		21,618	268	68,944		
SOUTH DAKOTA	SANBORN			0	0	0		24,493	158	78,542		
SOUTH DAKOTA	SPINK			0	0	0		28,985	241	103,565		
SOUTH DAKOTA	STANLEY							10,430	55	12,373		
SOUTH DAKOTA	TODD			0	0	0		55,694	124	102,834		
SOUTH DAKOTA	UNION							7,753	143	33,192		
SOUTH DAKOTA	WALWORTH							20,749	105	46,700		
SOUTH DAKOTA	YANKTON							29,048	309	111,003		
SOUTH DAKOTA	ZIEBACH							34,754	101	33,260		
			Subtotals	0	0	0	0	1,161,411	8,370	2,887,000	66%	
SOUTH DAKOTA	BENNETT	Yes	No new RRA forage production	759	5	100,000		30,980	131	45,279		
SOUTH DAKOTA	BROOKINGS			0	2	0		19,123	299	65,750		
SOUTH DAKOTA	BROWN			0	1	0		32,865	315	100,125		
SOUTH DAKOTA	CAMPBELL			0	2	0		24,821	130	66,849		
SOUTH DAKOTA	CORSON			0	1	0		89,144	206	124,029		
SOUTH DAKOTA	DEWEY			2,113	9	50,000		65,514	186	92,402		
SOUTH DAKOTA	GREGORY			0	1	0		64,016	330	153,946		
SOUTH DAKOTA	HUGHES			0	1	0		9,816	97	17,901		
SOUTH DAKOTA	HUTCHINSON			0	1	0		23,966	300	90,463		
SOUTH DAKOTA	JACKSON			0	1	0		51,461	161	51,950		
SOUTH DAKOTA	KINGSBURY			0	1	0		22,344	218	71,982		

Counties Within Eleven States with Seed Production greater than 100,000 lbs in 2007 (County List)

State	County	Seed Production Reported, 2007	Alfalfa For Forage Production	Seed - Acres Hvstd.	Seed - Operations	Seed - In Pounds		Alf. Hay - Acres	Alf. Hay - Operations	Alf. Hay - Tons	Hay % Operations Excluded	Hay % Operations Included
SOUTH DAKOTA	LYMAN			0	1	0		21,977	111	39,503		
SOUTH DAKOTA	MARSHALL			324	4	23,782		23,530	187	64,281		
SOUTH DAKOTA	MEADE			0	5	30,500		150,760	489	181,724		
SOUTH DAKOTA	MELLETTE			0	2	0		43,478	146	59,893		
SOUTH DAKOTA	PENNINGTON			0	2	0		55,621	290	54,028		
SOUTH DAKOTA	SHANNON			0	1	0		9,094	39	10,968		
SOUTH DAKOTA	SULLY			0	2	0		6,121	39	14,082		
SOUTH DAKOTA	TRIPP			175	3	0		76,438	343	172,293		
SOUTH DAKOTA	TURNER			0	2	0		14,119	266	49,890		
			Subtotals	3,371	47	204,282	0	835,188	4,283	1,527,338		34%
			Total	3,371	47	204,282	0	1,996,599	12,653	4,414,338		
UTAH	BEAVER							19,908	120	102,373		
UTAH	CARBON			0	0	0		5,786	142	16,774		
UTAH	DAGGETT							3,761	20	9,850		
UTAH	DAVIS			0	0	0		3,715	155	18,078		
UTAH	EMERY			0	0	0		17,488	351	49,048		
UTAH	GARFIELD							9,738	156	26,741		
UTAH	GRAND							2,945	45	13,868		
UTAH	IRON							45,230	238	226,627		
UTAH	KANE							1,443	50	4,885		
UTAH	MORGAN	No	Yes, With Limits and GPS Reporting	0	0	0		9,406	165	24,368		
UTAH	PIUTE			0	0	0		8,870	73	24,732		
UTAH	RICH							9,270	78	22,164		
UTAH	SALT LAKE			0	0	0		3,324	153	12,577		
UTAH	SAN JUAN							5,300	64	9,792		
UTAH	SEVIER							25,878	394	109,322		
UTAH	SUMMIT			0	0	0		7,361	214	17,962		
UTAH	TOOELE							5,951	144	21,645		
UTAH	WASATCH			0	0	0		7,189	227	23,045		
UTAH	WASHINGTON			0	0	0		5,031	153	23,003		
UTAH	WAYNE							11,732	157	45,074		

Counties Within Eleven States with Seed Production greater than 100,000 lbs in 2007 (County List)

State	County	Seed Production Reported, 2007	Alfalfa For Forage Production	Seed - Acres Hvstd.	Seed - Operations	Seed - In Pounds		Alf. Hay - Acres	Alf. Hay - Operations	Alf. Hay - Tons	Hay % Operations Excluded	Hay % Operations Included
			Subtotals	0	0	0	0	209,326	3,099	801,928	40%	
UTAH	BOX ELDER			0	21	1,091,907		49,161	533	190,085		
UTAH	CACHE			580	6	311,706		50,741	636	193,480		
UTAH	DUCHESNE			60	3	30,000		33,357	423	110,596		
UTAH	JUAB			0	1	0		15,445	158	64,677		
UTAH	MILLARD	Yes	No new RRA forage production	1,118	16	426,700		72,244	421	343,717		
UTAH	SANPETE			0	1	0		35,994	475	139,572		
UTAH	UINTAH			0	2	0		36,019	497	125,099		
UTAH	UTAH			0	2	0		30,197	996	139,095		
UTAH	WEBER			0	2	0		16,086	542	63,969		
			Subtotals	1,758	54	1,860,313	0	339,244	4,681	1,370,290		60%
			Total	1,758	54	1,860,313		548,570	7,780	2,172,218		
WASHINGTON	ASOTIN	No	Yes, With Limits and GPS Reporting					673	10	0		
WASHINGTON	CHELAN							1,561	44	0		
WASHINGTON	CLALLAM							1,633	40	4,025		
WASHINGTON	CLARK							431	12	1,356		
WASHINGTON	COLUMBIA							1,284	29	3,462		
WASHINGTON	COWLITZ							0	1	0		
WASHINGTON	DOUGLAS			0	0	0		1,624	44	6,336		
WASHINGTON	GARFIELD							394	12	0		
WASHINGTON	GRAYS HARBOR							108	6	121		
WASHINGTON	ISLAND							1,612	20	3,186		
WASHINGTON	JEFFERSON							77	5	105		
WASHINGTON	KING							0	0	0		
WASHINGTON	KITSAP							0	2	0		
WASHINGTON	LEWIS							638	18	2,079		
WASHINGTON	PACIFIC							0	2	0		
WASHINGTON	PEND OREILLE							1,603	36	0		
WASHINGTON	PIERCE							105	7	399		
WASHINGTON	SAN JUAN							0	2	0		
WASHINGTON	SKAGIT							254	8	843		

Appendix B

Counties Within Eleven States with Seed Production greater than 100,000 lbs in 2007 (County List)

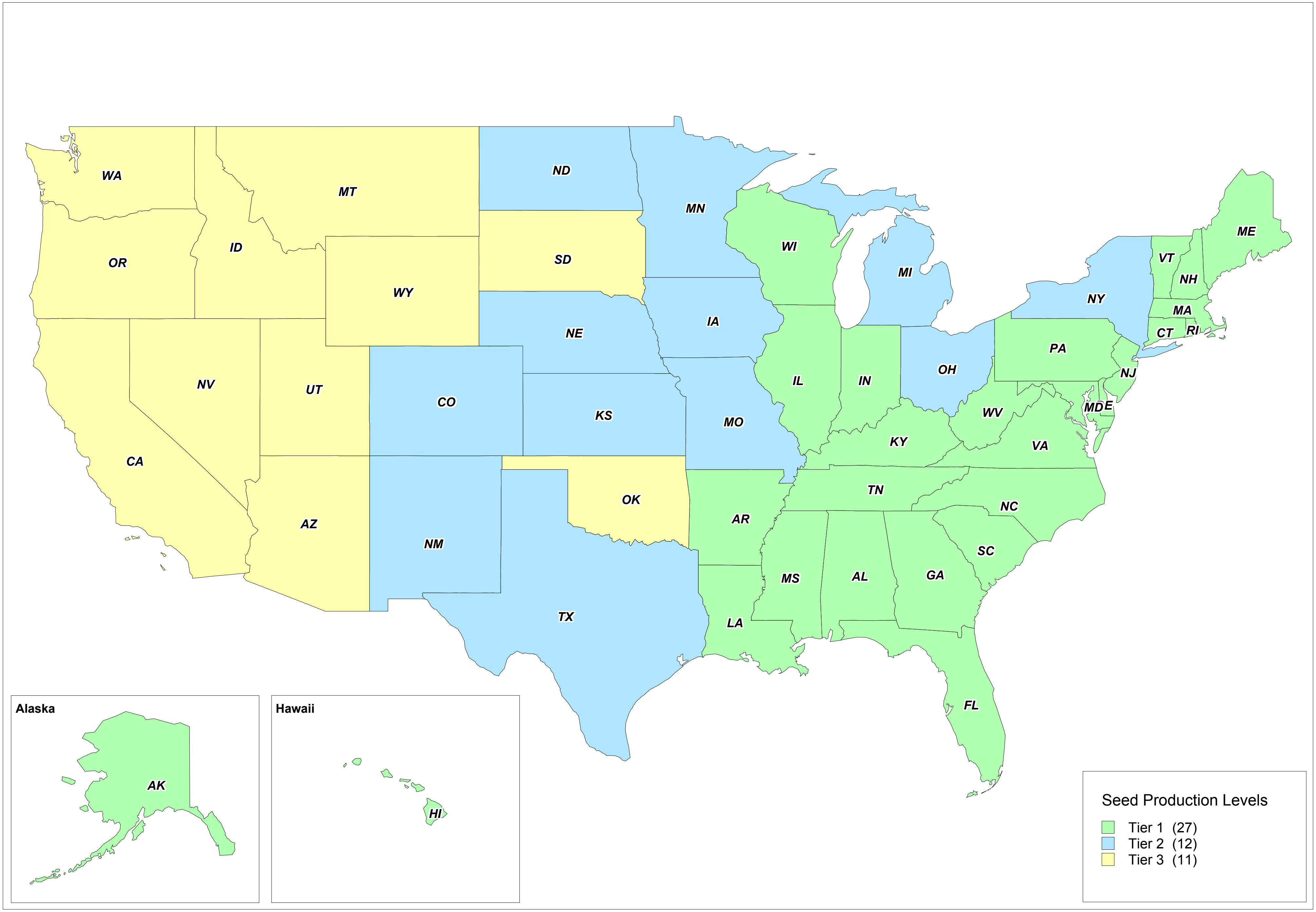
State	County	Seed Production Reported, 2007	Alfalfa For Forage Production	Seed - Acres Hvstd.	Seed - Operations	Seed - In Pounds		Alf. Hay - Acres	Alf. Hay - Operations	Alf. Hay - Tons	Hay % Operations Excluded	Hay % Operations Included
WASHINGTON	SKAMANIA							0	2	0		
WASHINGTON	SNOHOMISH			0	0	0		632	14	2,432		
WASHINGTON	THURSTON							307	16	641		
WASHINGTON	WAHKIAKUM							0	1	0		
WASHINGTON	WHATCOM							791	16	2,208		
			Subtotals	0	0	0	0	13,727	347	27,193	8%	
WASHINGTON	ADAMS	Yes	No new RRA forage production	0	1	0		20,982	104	125,759		
WASHINGTON	BENTON			0	3	43,225		12,412	162	67,352		
WASHINGTON	FERRY			0	1	0		3,866	56	9,124		
WASHINGTON	FRANKLIN			311	5	238,526		77,441	272	573,937		
WASHINGTON	GRANT			4,249	25	2,308,614		117,488	549	752,332		
WASHINGTON	KITTITAS			0	1	0		8,721	165	35,824		
WASHINGTON	KLICKITAT			0	1	0		26,515	160	35,517		
WASHINGTON	LINCOLN			0	1	0		14,545	127	41,293		
WASHINGTON	OKANOGAN			129	7	25,731		23,253	399	73,994		
WASHINGTON	SPOKANE			0	3	19,200		36,386	656	77,020		
WASHINGTON	STEVENS			0	6	46,112		32,477	436	58,452		
WASHINGTON	WALLA WALLA			10,759	14	7,510,760		14,772	123	93,678		
WASHINGTON	WHITMAN			0	2	0		8,456	130	27,003		
WASHINGTON	YAKIMA			713	12	409,045		37,363	608	184,071		
			Subtotals	16,161	82	10,601,213	0	434,677	3,947	2,155,356		92%
			Totals	16,161	82	10,601,213	0	448,404	4,294	2,182,549		
WYOMING	ALBANY	No	Yes, With Limits and GPS Reporting					6,972	33	16,137		
WYOMING	CAMPBELL							45,631	177	61,739		
WYOMING	CARBON							14,065	61	21,953		
WYOMING	CONVERSE							28,914	135	62,321		
WYOMING	GOSHEN							58,944	369	179,960		
WYOMING	HOT SPRINGS							9,766	94	23,140		
WYOMING	JOHNSON							21,923	103	53,077		
WYOMING	LARAMIE							22,606	106	83,138		
WYOMING	LINCOLN							39,848	271	89,104		

Counties Within Eleven States with Seed Production greater than 100,000 lbs in 2007 (County List)

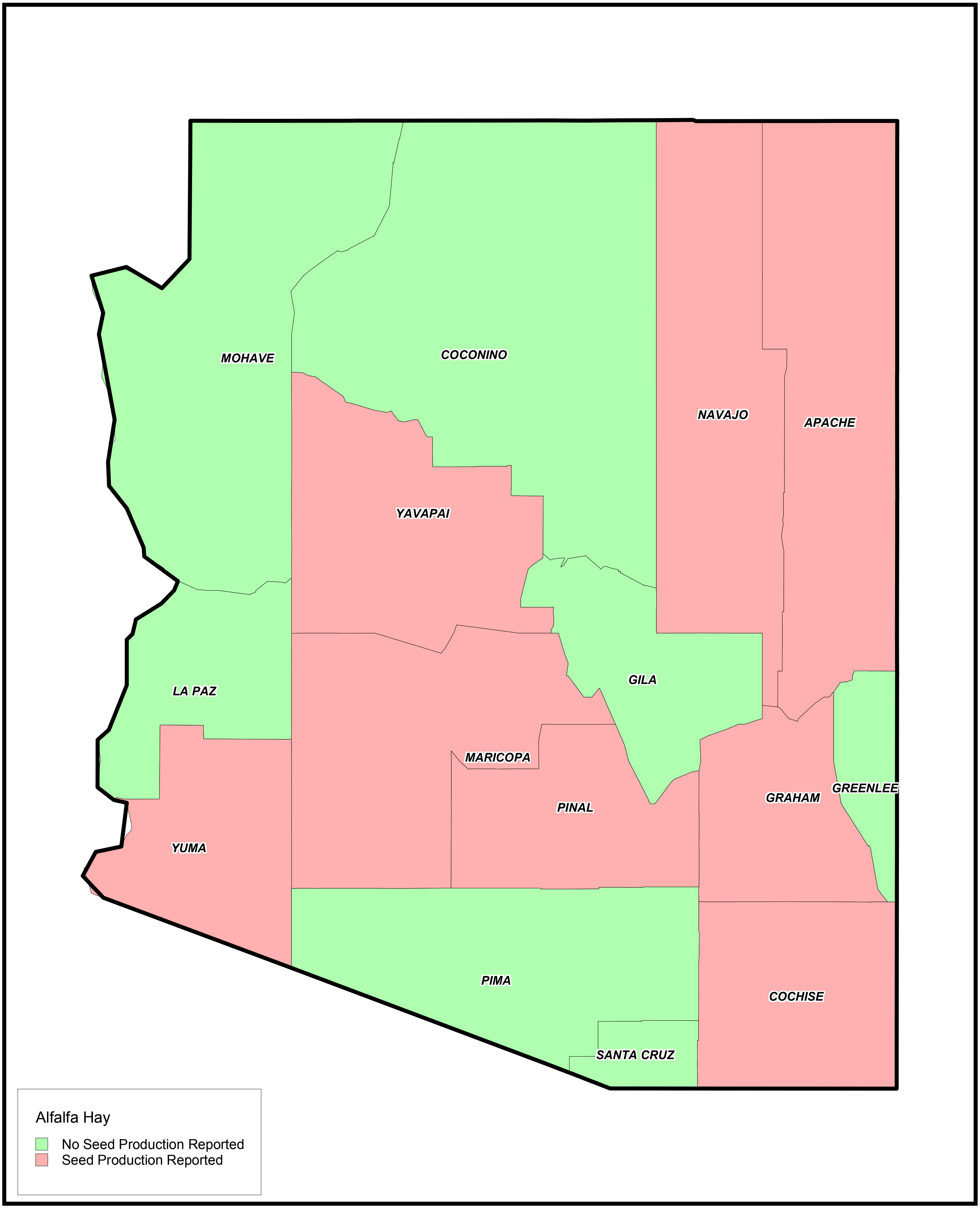
State	County	Seed Production Reported, 2007	Alfalfa For Forage Production	Seed - Acres Hvstd.	Seed - Operations	Seed - In Pounds		Alf. Hay - Acres	Alf. Hay - Operations	Alf. Hay - Tons	Hay % Operations Excluded	Hay % Operations Included
WYOMING	NATRONA							25,269	152	76,777		
WYOMING	NIOBRARA							12,974	60	30,041		
WYOMING	PLATTE							30,497	176	88,012		
WYOMING	SUBLETTE							5,485	29	10,312		
WYOMING	TETON							4,610	32	14,440		
WYOMING	UINTA							6,251	53	13,751		
WYOMING	WESTON							21,847	67	22,306		
			Subtotals	0	0	0	0	355,602	1,918	846,208	48%	
WYOMING	BIG HORN			0	18	2,816,147		35,845	332	126,064		
WYOMING	CROOK			0	3	0		77,829	232	104,988		
WYOMING	FREMONT			0	6	173,138		85,550	608	275,524		
WYOMING	PARK	Yes	No new RRA forage production	4,560	29	2,534,285		37,844	407	133,764		
WYOMING	SHERIDAN			0	1	0		45,376	268	113,207		
WYOMING	SWEETWATER			0	1	0		20,607	126	42,944		
WYOMING	WASHAKIE			0	4	244,826		15,631	116	53,739		
			Subtotals	4,560	62	5,768,396	0	318,682	2,089	850,230		52%
			Totals	4,560	62	5,768,396	0	674,284	4,007	1,696,438		
						Per State Average Exclusion/Inclusion:					46%	54%

Appendix B

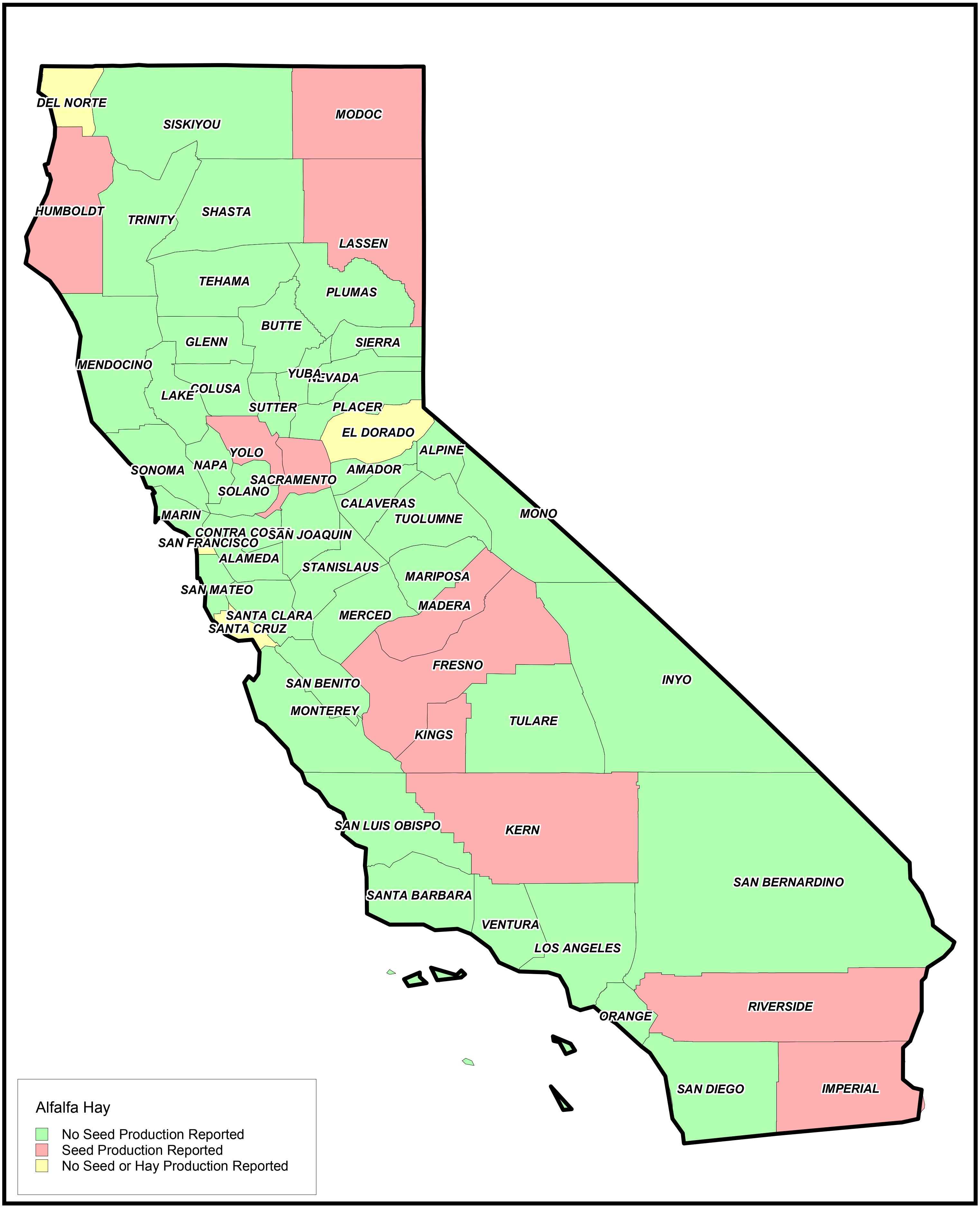
Seed Production Levels from 2007 Ag Census Data



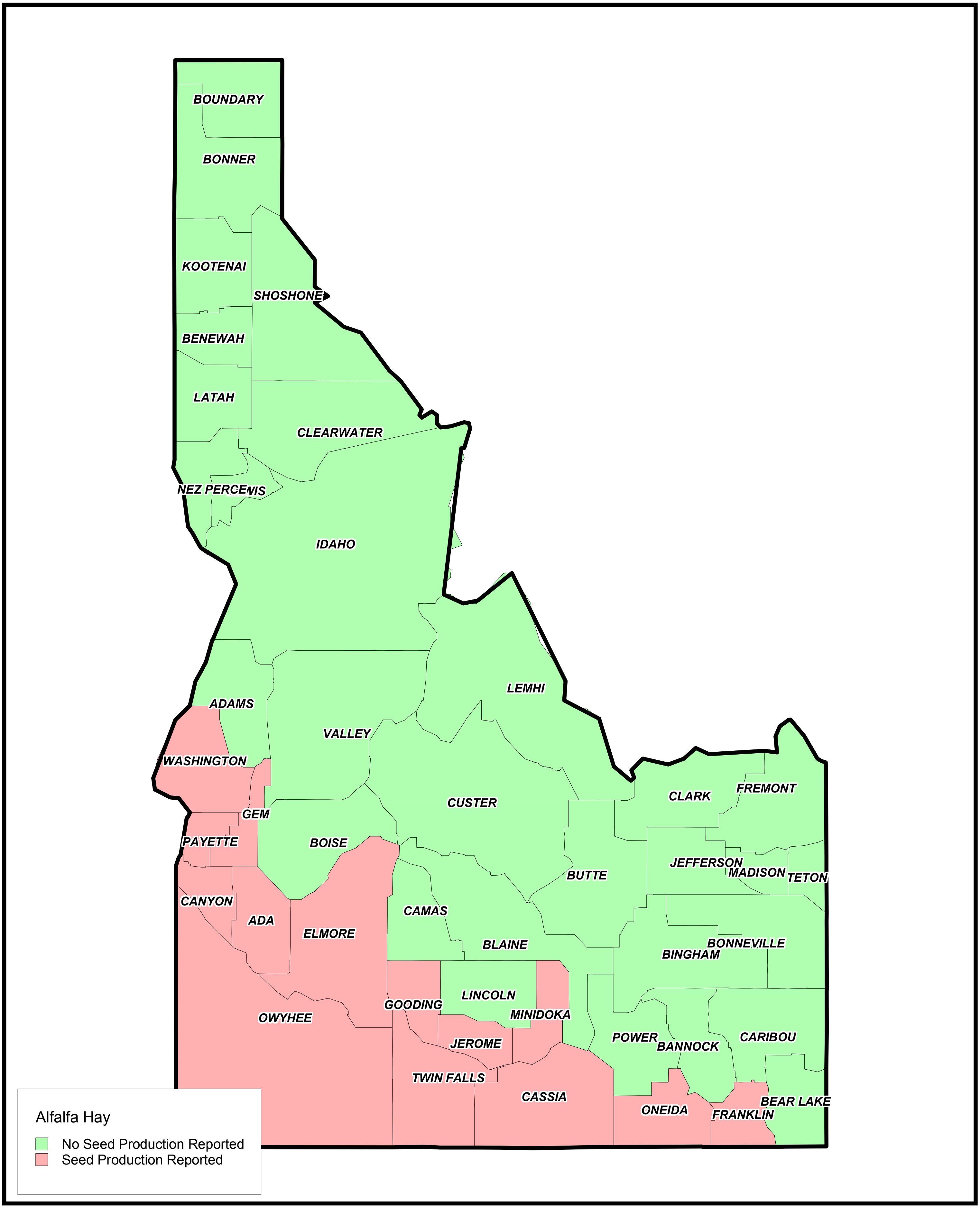
Arizona - Alfalfa Hay Counties
With and Without Seed Production



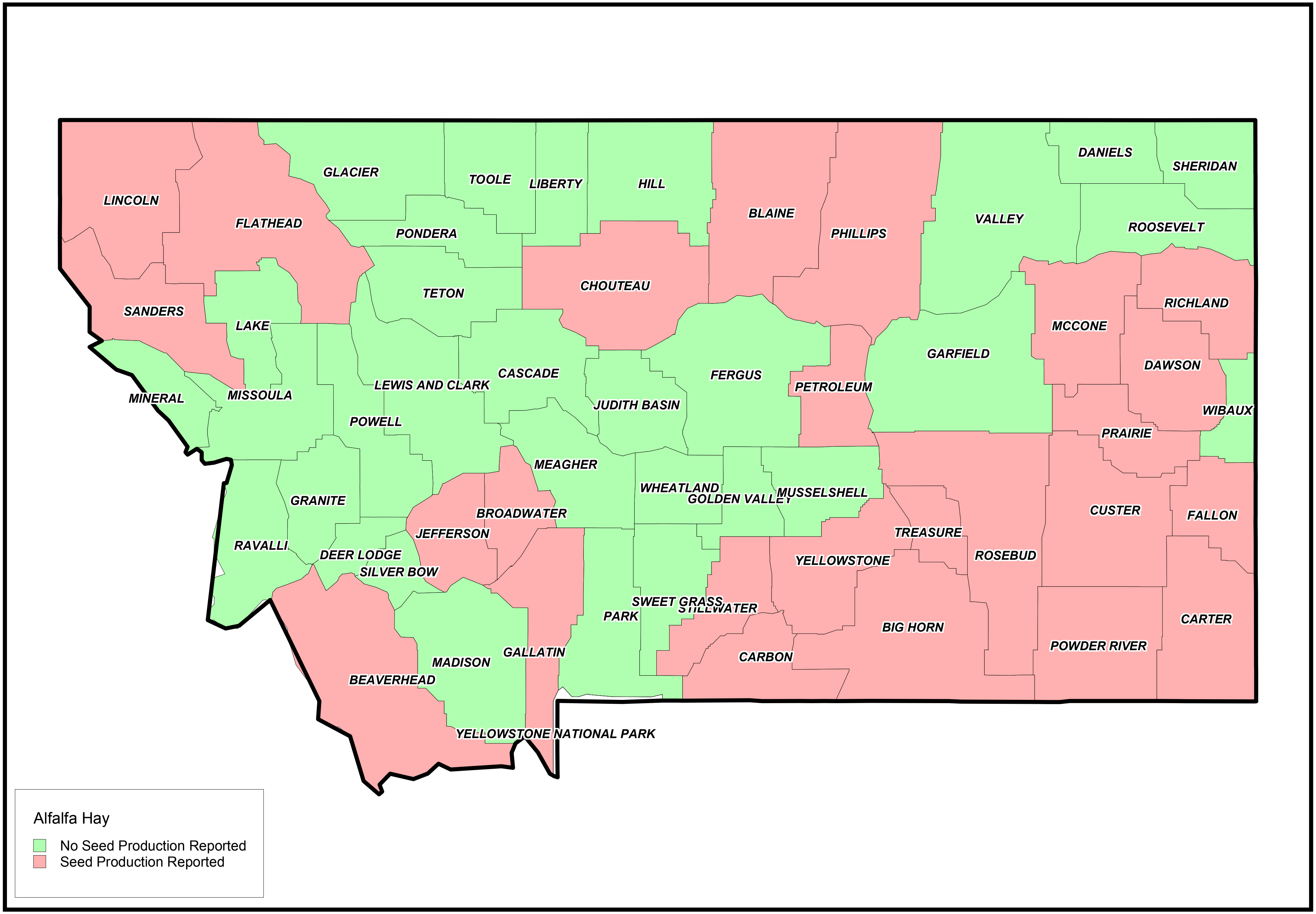
California - Alfalfa Hay Counties With and Without Seed Production



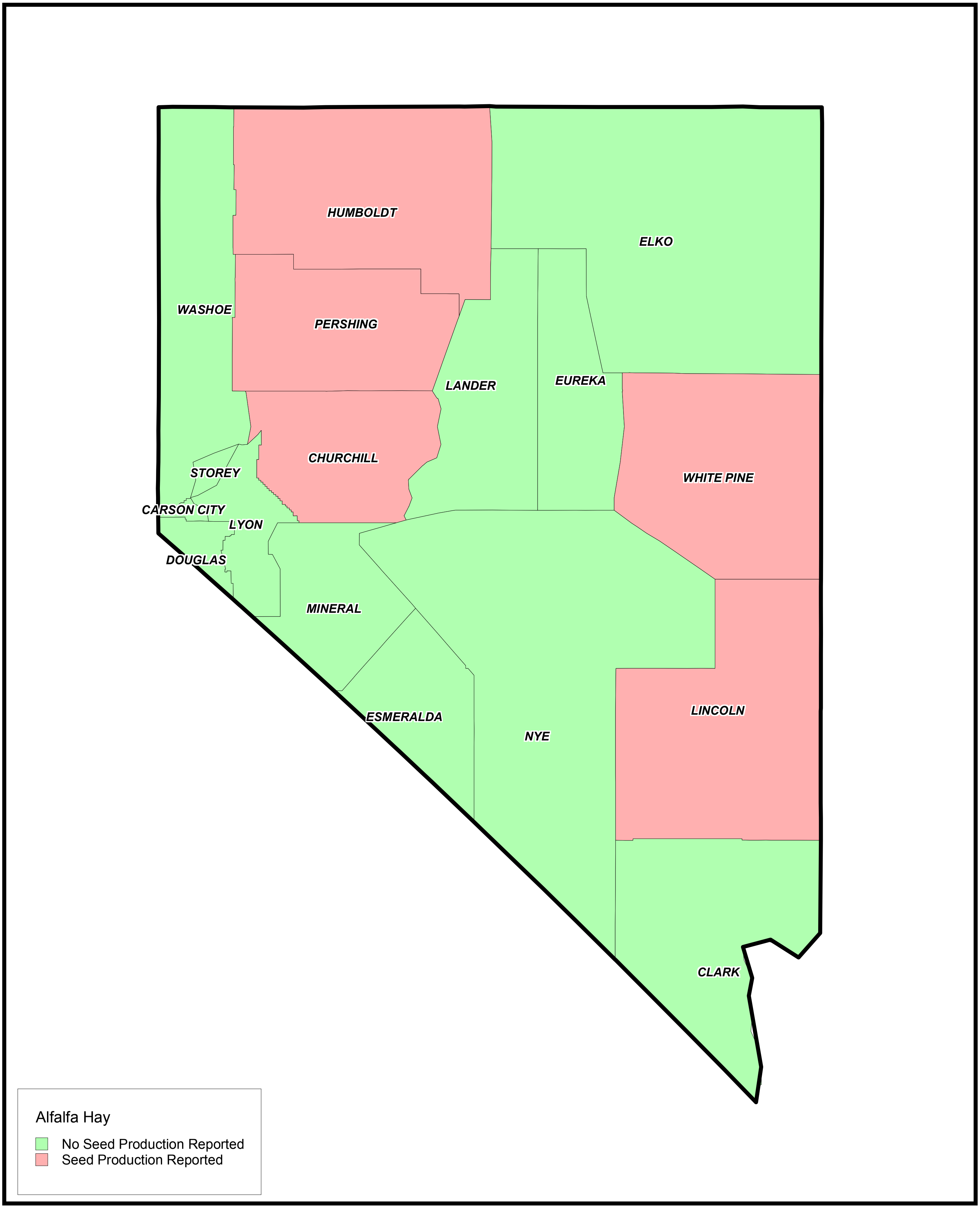
Idaho - Alfalfa Hay Counties With and Without Seed Production



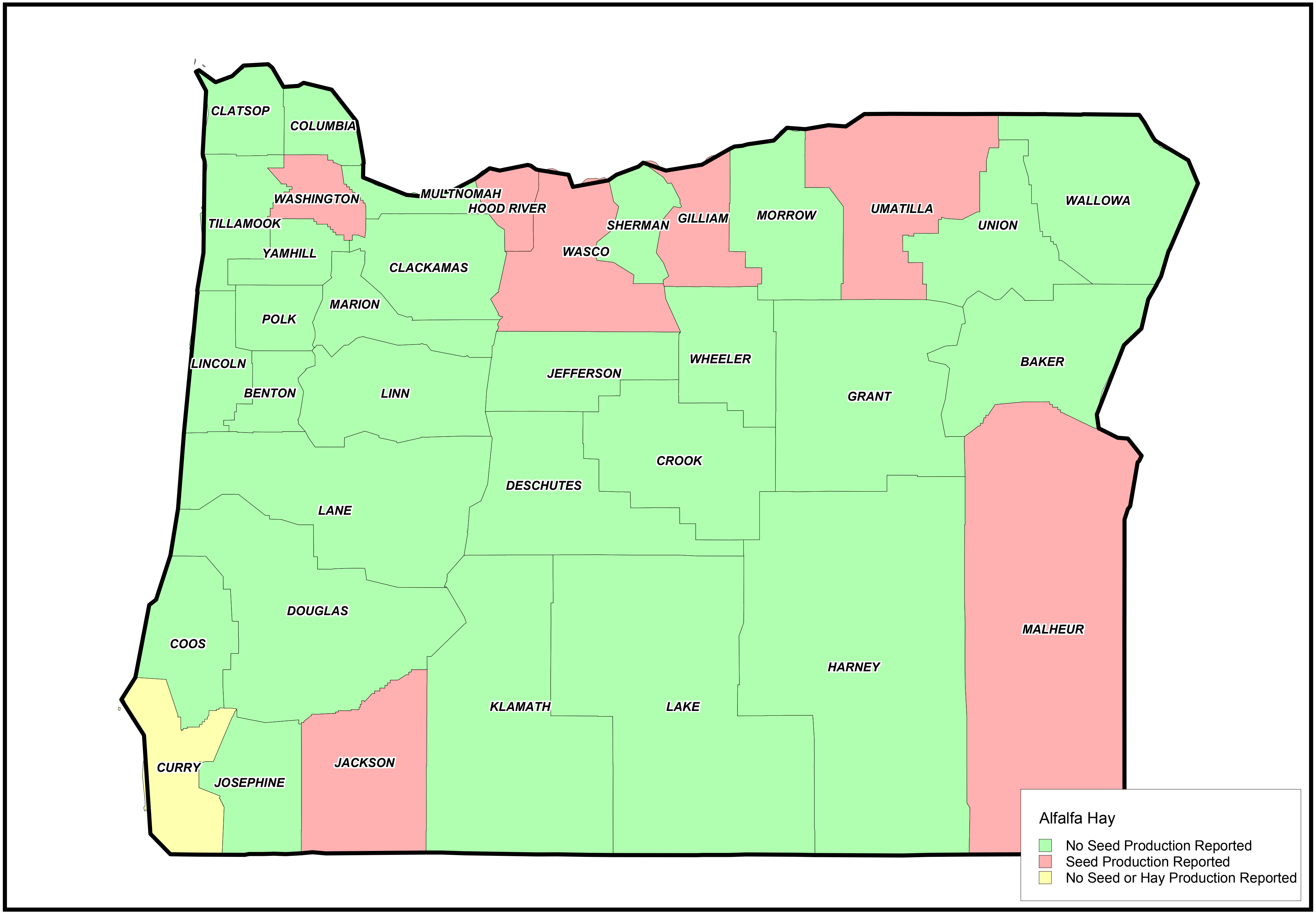
Montana - Alfalfa Hay Counties
With and Without Seed Production



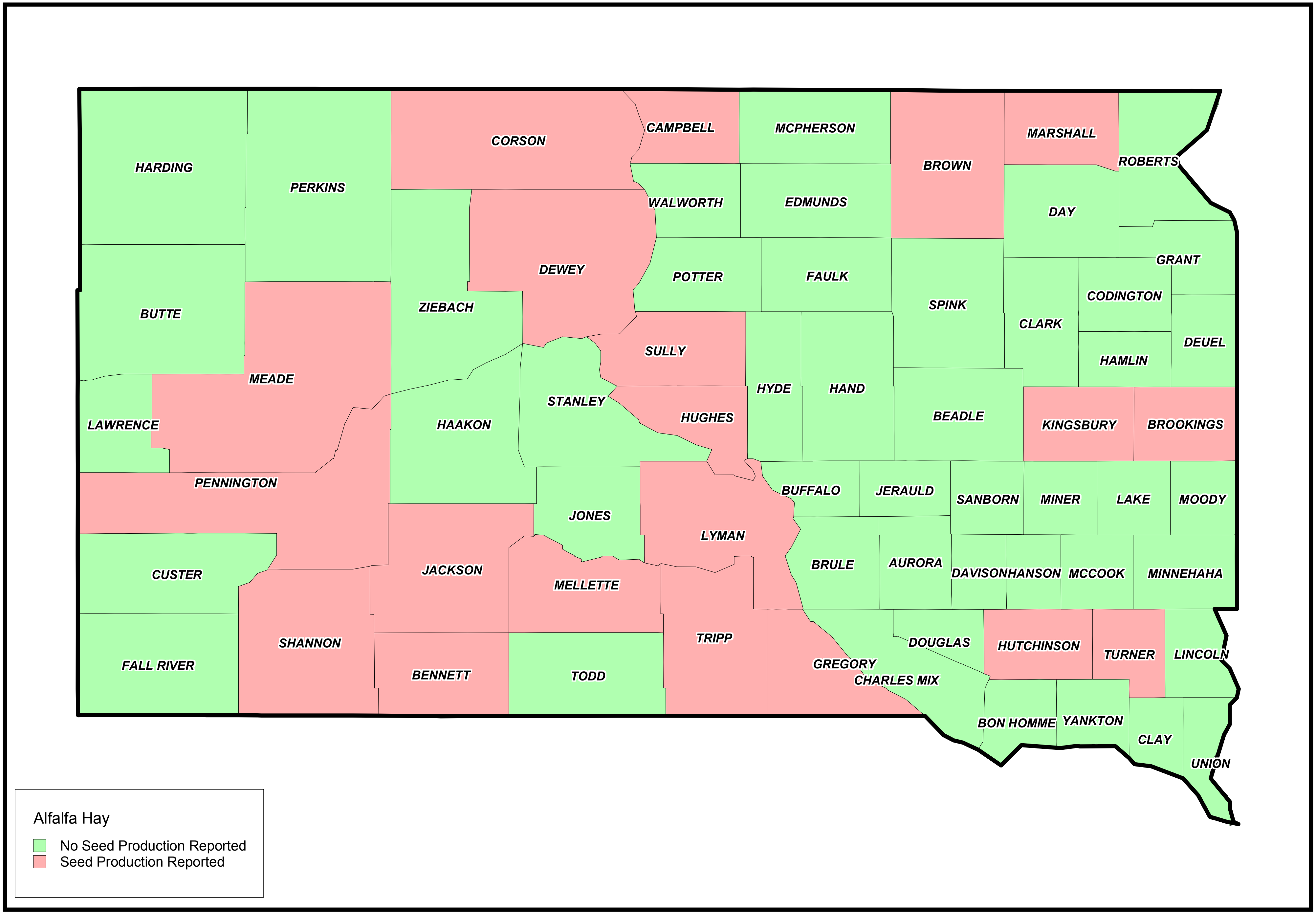
Nevada - Alfalfa Hay Counties
With and Without Seed Production



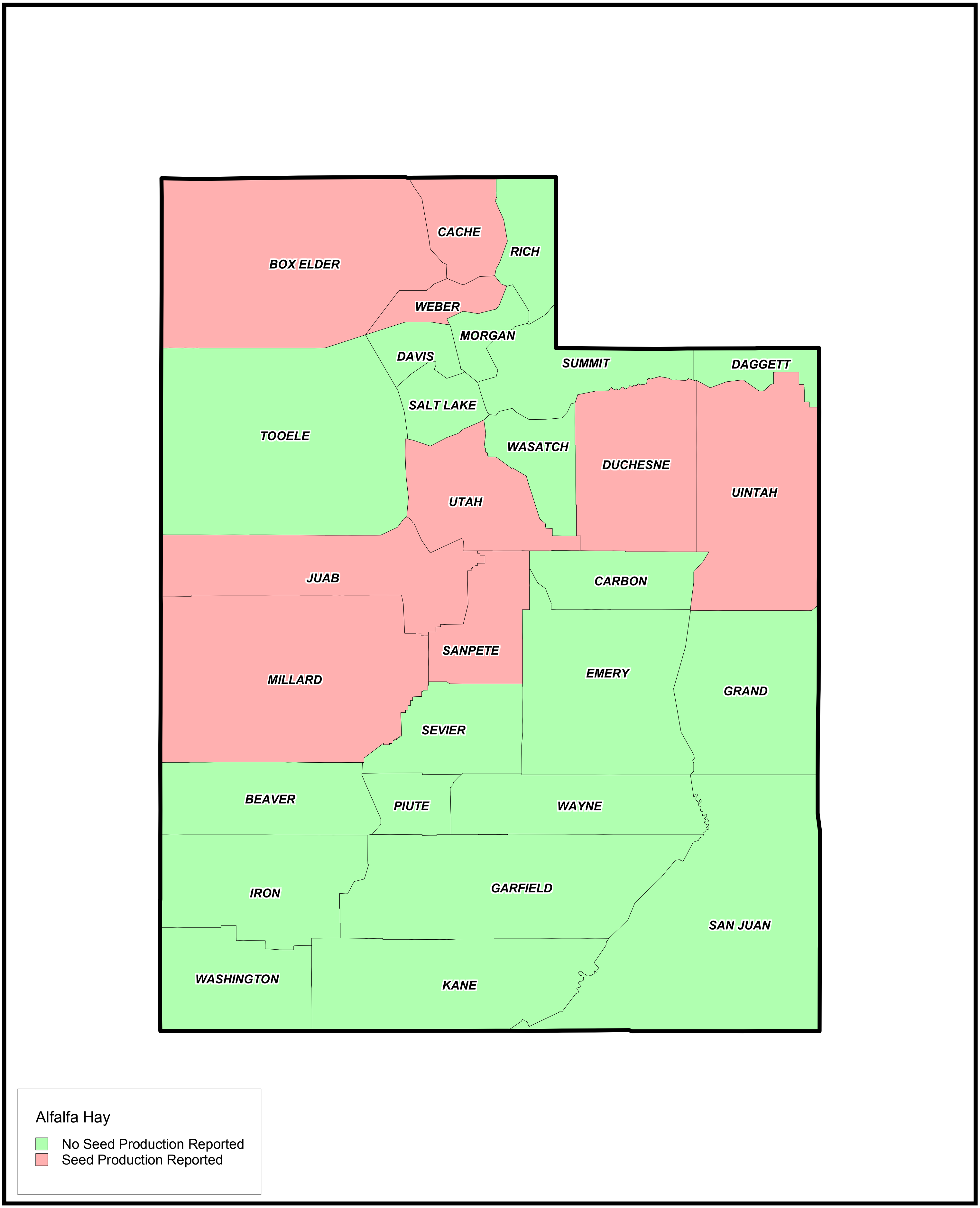
Oregon - Alfalfa Hay Counties
With and Without Seed Production



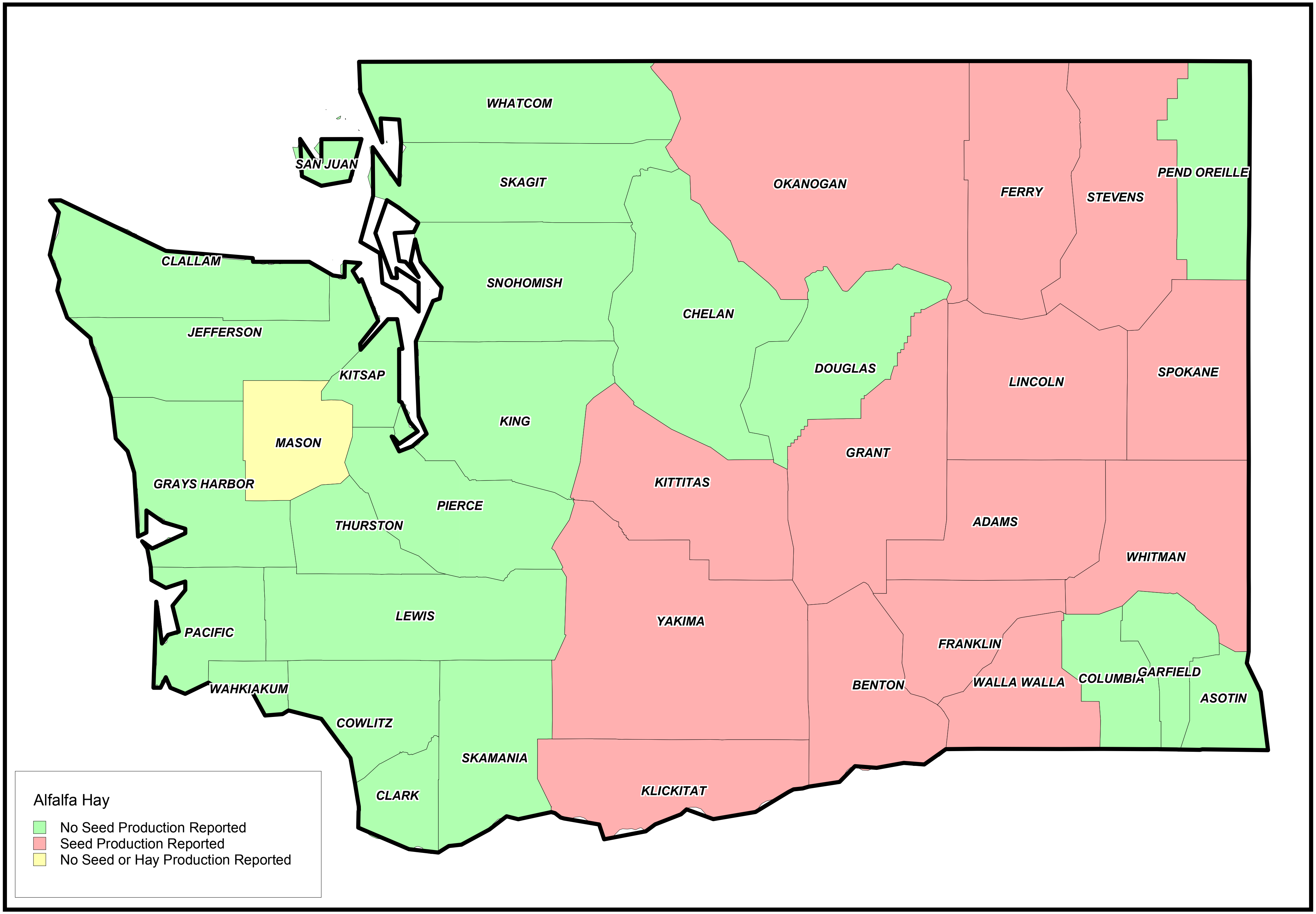
South Dakota - Alfalfa Hay Counties
With and Without Seed Production



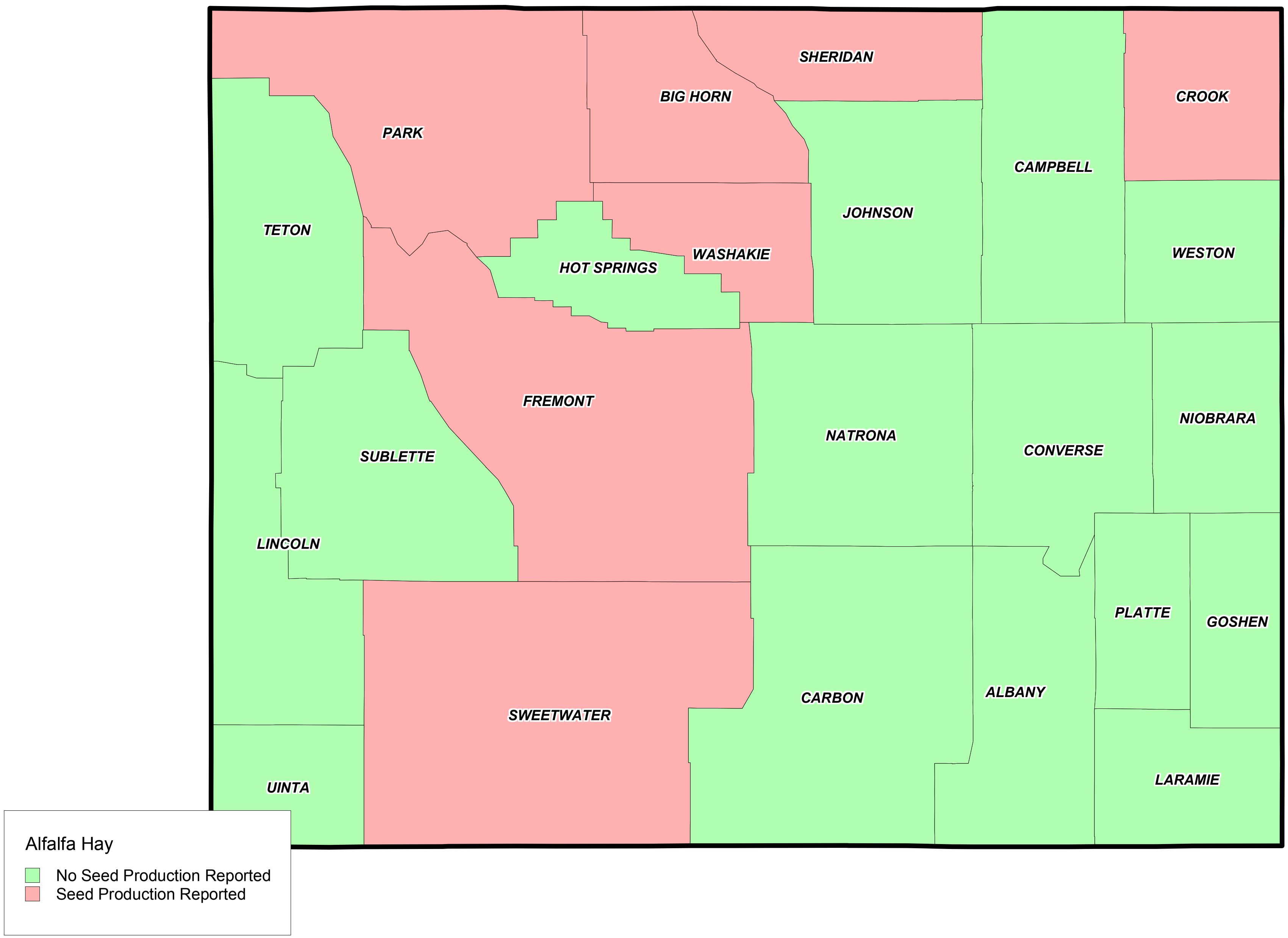
Utah - Alfalfa Hay Counties
With and Without Seed Production



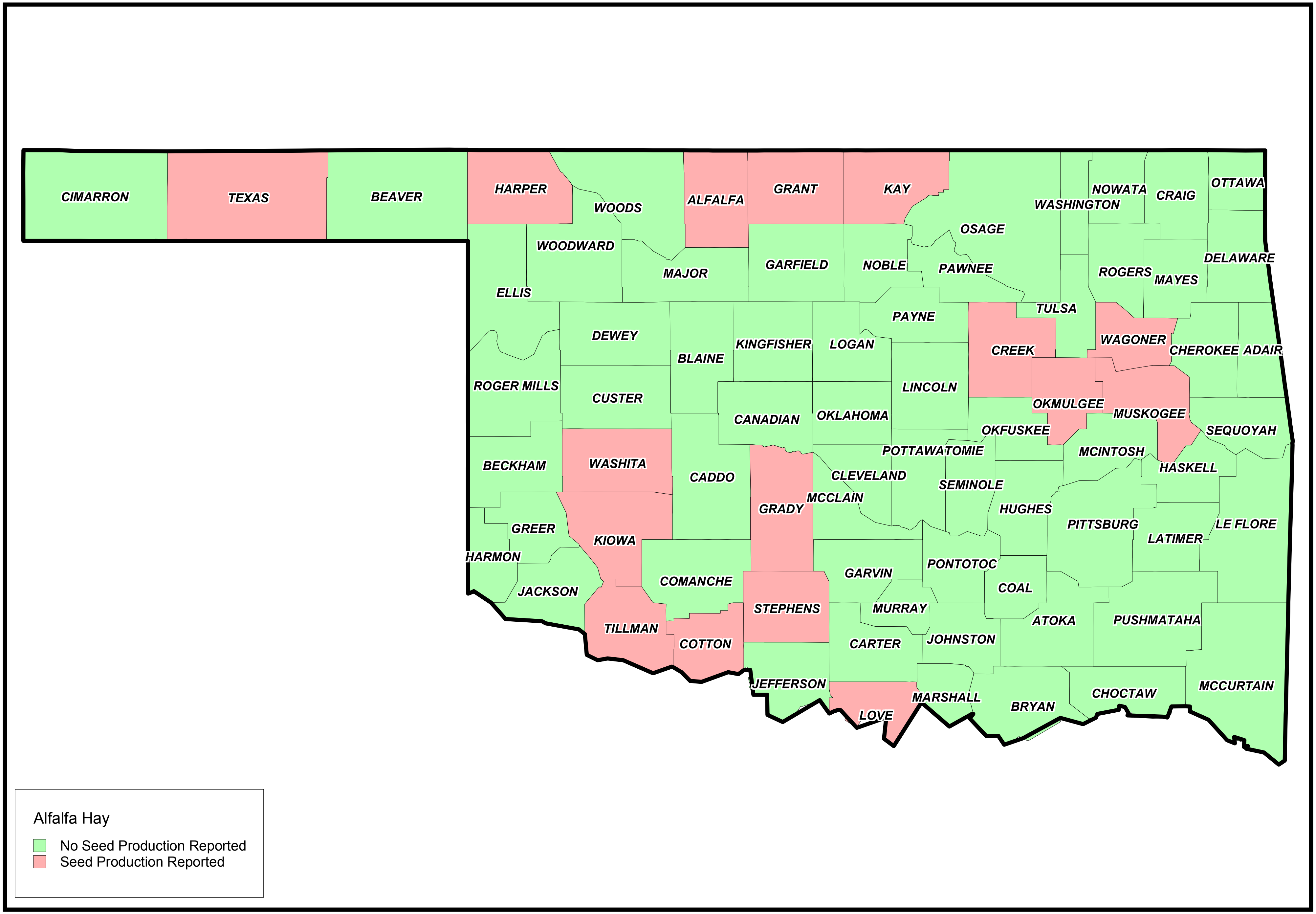
Washington - Alfalfa Hay Counties With and Without Seed Production



Wyoming - Alfalfa Hay Counties
With and Without Seed Production



Oklahoma - Alfalfa Hay Counties
With and Without Seed Production



Appendix C

National Alfalfa & Forage Alliance Best Management Practices for Roundup Ready® Alfalfa Seed Production

Best Management Practices for Roundup Ready® Alfalfa Seed Production

Introduction

The genetic supplier members (hereinafter called the "Companies") of National Alfalfa & Forage Alliance (NAFA) have agreed to jointly adopt, as a minimum, the following Best Management Practices for Roundup Ready Alfalfa (RRA) Seed Production in the United States. Compliance is required under a separate and binding agreement of the Companies to each other in this commitment. Forage Genetics International (FGI) is the exclusive licensed seed producer of RRA and will require all RRA seed production sub-licensees (herein after called the "RRA Seed Contractor(s)") to become a party to this binding agreement. It is not the intent of this document to establish best management practices for the production of alfalfa seed for GE sensitive markets. Changes to this document will require a recommendation from the Companies and approval by the NAFA Board of Directors.

Roundup Ready Trait Stewardship in Seed Production

- This document establishes RRA commercial seed production policies that exceed industry standards for Certified alfalfa seed production.
- Specifically, RRA seed production practices will meet or exceed Association of Official Seed Certifying Agencies (AOSCA) standards for the seed production of Foundation Class alfalfa seed production.
- All RRA seed growers must complete RRA seed stewardship training and agree to follow the RRA seed production policies as described herein and as required by RRA seed production contracts.

RRA Seed Contractors' Responsibilities

Isolation. The RRA Seed Contractor will insure that the isolation distance between the new planting and any established conventional seed production meets the following pollinator-specific isolation requirements for RRA seed production. Note the pollinator designated applies to normal pollinating bees introduced or locally cultured for alfalfa seed production in the area. If more than one pollinator species is introduced or locally cultured, the longer minimum distance applies.

- Leaf cutter bee – 900 feet
- Alkali bee – 1 mile
- Honey bee – 3 miles

Every year the Companies will collectively sample conventional seed lots, test for adventitious presence of the Roundup Ready trait, and use isolation distance from RRA seed production to monitor the effectiveness of current isolation standards. The Companies, along with three AOSCA representatives of state crop improvement associations or their designees, will analyze the data and make recommendations for changes to required isolation distances, if appropriate.

Reporting. The RRA Seed Contractor shall report GPS coordinates of all established and planned RRA seed production fields to local state seed certification officials as early as possible, but no later than two weeks prior to planting. State officials will confirm minimum isolation and establish a state pinning map for RRA seed production. The RRA Seed Contractor must authorize state officials to report to any seed grower or seed company, on request, the isolation distance between a planned new conventional alfalfa seed field and the nearest RRA seed field. GM-trait sensitive conventional or organic alfalfa seed producers can then use this third party service to assist them in planning their field locations to meet their company's isolation or field crop history goals or the certification agent may use the data to certify a stated isolation distance. The RRA Seed Contractor shall also notify local state seed certification officials, and officials shall confirm when a RRA seed production field is terminated.

GE-free seed production zones. The RRA Seed Contractor will limit RRA seed production contracts to the following states: Arizona, California, Colorado, Idaho, Montana, Nevada, Oregon, Texas, Utah, Washington and Wyoming. The RRA Seed Contractor will also respect any GE-free alfalfa seed production zone designated as such by a consensus of local seed growers. Recognition and designation of such zones will be based on the requirements of each state. It is envisioned that the local state seed certification agency would play an active role in administering programs of this nature.

Cooperation. All seed companies are encouraged to communicate and work together individually to manage joint seed quality issues and concerns.

RRA seed grower training. The RRA Seed Contractor will require RRA stewardship training for all new RRA seed growers. The RRA seed grower will confirm having received a copy of the NAFA Best Management Practices for Roundup Ready Alfalfa Seed Production (see Appendix 2).

RRA seed grower contracts. The RRA Seed Contractor shall stipulate which bee species can be introduced for pollination and incorporate key grower stewardship requirements (as listed below) in RRA seed production contracts.

License. The RRA Seed Contractor will have an FGI license for RRA seed production, including reporting requirements for acreage planted and seed harvested, by variety.

RRA Seed Growers' Responsibilities

Monsanto Technology/Stewardship Agreement (MTA). RRA Seed Grower must sign an MTA and are bound by the terms outlined in the current Monsanto Technology Use Guide (TUG). The MTA is a limited-use license for Monsanto traits, and renews automatically each year. The TUG is updated annually.

Observe patent rights. All RRA stock seed and harvested seed contains patent-protected, Roundup Ready trait, therefore:

- All seed transfer/sale is exclusive between RRA Seed Grower and the RRA Seed Contractor; no seed may be sold by RRA Seed Grower to other parties.
- RRA Seed Grower may not save seed for any purpose as per MTA.

Observe all federal, state and local regulations. It is the RRA Seed Grower's responsibility to know and obey current federal, state and local regulations affecting their agricultural practices. Some examples are as follows:

Federal Laws and Regulations:

- Pesticide use labels and restrictions;
- U.S. Patent Rights;
- Plant Variety Protection; Federal Seed Act.
- Phytosanitary laws governing import or export of seeds and pollinators.

State Laws and Regulations:

- Noxious or prohibited weeds, pathogens or insects;
- Pesticide use labels and restrictions

Local Laws and Regulations:

- Pesticide use notifications (field posting);
- County restrictions or prohibitions on the use of biotechnology, as applicable.

Bees. RRA Seed Grower will manage pollinators to minimize pollen flow to conventional/other variety fields.

- Only contract-specified bee species can be introduced for pollination supporting RRA seed production.
- There shall be no bee domicile movement from RRA to conventional alfalfa seed fields until pollination is finished for the year.
  - Once bees are in RRA seed fields, they may only be moved among RRA fields. It is the RRA Seed Grower's responsibility to inform their pollinator contractors or bee keepers of this requirement.
- RRA Seed Grower will locate domiciles to maximize domicile distance to other varieties, to the extent reasonable and appropriate to each field.
- The main pollinator bee species will be stated on each RRA Seed Grower Contract. Isolation requirements are specific to the main pollinator species.
- If honeybees are not the contract-stipulated pollinator species, the RRA Seed Grower will discourage neighbors from keeping honeybee hives in proximity to RRA seed production. In cases where this cannot be avoided, RRA Seed Grower is required to report the incident to the RRA Seed Contractor.

Isolation. RRA Seed Grower will assist RRA Seed Contractor with field location planning prior to planting, isolation zone monitoring after planting and facilitate crop improvement inspections as requested.

- The pollinator species-specific isolation policy is as follows (minimum distance to preexisting conventional seed at planting of RRA):
  - Leaf cutter bee – 900 feet
  - Alkali bee – 1 mile
  - Honey bee – 3 miles
- Once the RRA seed field is planted, State Certification officials will visit to confirm minimum isolation distances are in place. RRA Seed Grower must cooperate with this verification process.
- If the RRA Seed Grower learns that new alfalfa seed field(s) are planned or planted in close proximity the RRA seed field, RRA Seed Grower will communicate this information to RRA Seed Contractor. Management strategies for maintaining RRA seed quality (varietal/trait purity) can then be implemented by the RRA Seed Contractor.

Trait purity. RRA stock seed is guaranteed by the provider to have ≥90% RR plants; up to 10% non-RR plants, or "nulls", are normal and expected based on the breeding and genetics of the trait.

- Growers must apply sufficient Roundup® herbicide to kill the <10% nulls prior to 9 inches of growth in the establishment year.
- Apply only registered (labeled) Roundup brand herbicides to the field.

Weeds and in-crop volunteers. Manage weeds and volunteers using integrated weed control strategies (e.g., conventional practices supplemented with Roundup agricultural herbicide formulations applied according to the label for alfalfa seed production). Integrated weed control strategies:

- Minimize risk of weed shifts or development of tolerant weeds. Growers are required to use integrated weed control methods.
- Maintain variety true to type: RRA seed fields need non-Roundup practices to control in-crop Roundup Ready alfalfa volunteers sprouting from prior year

seed crop in carry-over fields. This is consistent with conventional alfalfa seed production practices for certified quality seeds.

Stand take-out.

- The RRA seed field must be destroyed at the expiration/termination of the seed contract. Take-out must be completed prior to first flower in the subsequent year so that seed certification inspectors can verify stand termination.
- Stand termination and volunteer management measures must be sufficient to allow seed certification inspectors to validate stand take-out and to render the alfalfa stand worthless for any unlicensed purpose or use (e.g., unlicensed seed, forage, hay or pasture production purpose).
- RRA stand take-out date and method must be reported to the RRA Seed Contractor and stand destruction verified by local crop improvement using the RRA stand take out form, or the equivalent, to report the information (see Appendix).
- Plan to use a subsequent crop that allows management of alfalfa and RRA alfalfa volunteers should they occur.

Sanitation requirements. Manage equipment to minimize seed mixture potential between different varieties and or variety types. Growers shall use dedicated equipment for planting and harvesting RRA seed production, when possible. Zero tolerance for seed admixture is not feasible under commercial production conditions; however, grower must take reasonable steps to assure that equipment is clean prior to and after use in the Roundup Ready seed field. *Examples:*

- Planter inspection, clean-down before and after use;
- Combine inspection, clean-down thoroughly before and after use;
- RRA seed bins may only be used for RRA seed; maintain physical separation of varieties in storage; inspect bins before use;
- Handle all like-trait varieties together; plan for harvest sequence of fields to maintain best separation of varieties by trait type;
- Clean all seed handling equipment to avoid mixing RRA and conventional seed;
- Return unused, unopened stock seed to the contracting seed company for credit; maintain in clean storage areas;
- When a contract harvester is used for RRA seed harvest, Growers must notify the contract harvester, in advance, that the field to be harvested is RRA.

Communication. Immediately communicate questions or concerns to the RRA Seed Contractor or to FGI.

Field records. RRA Seed Grower must record and communicate the following to RRA Seed Contractor:

- Planting date; actual acres planted; seed rate/acre; stock seed received/returned;
- Accurate field address with latitude/longitude (decimal degrees) and local field map;
- Roundup herbicide application date(s), rate(s), formulation used;
- Seed box/bin numbers used for harvest;
- Stand destruct date and methods used using the RRA stand take out form, or the equivalent, to report the information (see Appendix).

RRA Seed Contractors' Production Staff Responsibilities

- Working in close partnership with seed growers;
- Complying with binding agreements with local crop improvement organizations:
    - RRA Seed Contractor will report each field location, planting date and stand take-out date to local crop improvement organizations;
- Coating RRA stock seed purple for easy identification by seed growers;
- Recommending changes to this document, should the need arise.

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"Best Management Practices for Roundup Ready® Alfalfa Seed Production"

Coexistence Strategy Forum Steering Committee

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Reedsville, WI

Jim Cane, USDA-ARS, Logan Bee Lab
Logan, UT

Chuck Deatherage, CA Alfalfa Seed Prod. Rsrch. Brd.
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APPENDIX 1

VERIFICATION OF STAND TAKE-OUT TO TERMINATE THE PRODUCTION OF ROUNDUP READY® ALFALFA SEED

The AGREEMENT: The Grower planted the RRA Proprietary stock seed described below on the acreage described below. In accordance with the terms of the Proprietary Seed Services Agreement for the Production of Roundup Ready Alfalfa Seed, upon expiration or termination of the agreement, the grower must take such actions as are necessary to prevent any future seed harvest or unlicensed use for hay, forage or grazing. Stand destruction must occur not later than first flower in subsequent year. Grower must notify Contracting Seed Company of each stand take-out date and method used to destroy the stand. The Contracting Seed Company must perform on-site verification that each field has been killed and Contracting Seed Company will notify local crop improvement organization of stand termination.

Use a separate form for each field or field group reported to crop improvement.

	Experimental or Variety Name:					
#	Field names	Number of Acres	Field Location: Town-Range-Section & County	Latitude / Longitude (original GPS Coordinate)	# ACRES + DATE(s) + METHOD(s)	SITE VISIT VERIFICATIO N DATE(s)*
1						
2						
3						
Total no. acres this contract planted:				**Total no. acres reported to be killed:**		
Seed Company representative verifying information Signature(s) Date(s)				**Seed Company representative notifying Crop Improvement** Signature(s) Date(s)		

GROWER

By:__________________________(signature)

By: __________________________(printed name)

Title:______________________________

Company: __________________________

Address: ___________________________

____

CONTRACTING SEED COMPANY

By:____________________________(signature)

By:__________________________(printed name)

Title:_________________________________

Company: ___________________________

Address: _____________________________

____

APPENDIX 2

These signatures confirm that the RRA Seed Grower has received the NAFA Best Management Practices for Roundup Ready® Alfalfa Seed Production

Contracting Seed Company has communicated NAFA Best Management Practices for Roundup Ready Alfalfa Seed Production to the Grower prior to initial RRA seed field planting and will update Grower annually, thereafter.

RRA Seed Contractor Representative Conducting Initial Grower Training:

PRINT NAME AND ADDRESS	SIGNATURE AND DATE
Seed Company Representative:	______________________________ Date: _________________

RRA Seed Grower Acknowledgement of Training and/or Receipt of NAFA Best Management Practices for Roundup Ready Alfalfa Seed Production:

PRINT NAME AND ADDRESS	SIGNATURE AND DATE
Grower: Telephone number: _________________	______________________________ Date: _________________

Signature page original to be retained by RRA Seed Contractor.

Signature page copy to be retained by RRA Seed Grower.

Appendix D

Orloff, S., D.H. Putnam, M. Canevari and W.T. Lanini, *Avoiding Weed Shifts and Weed Resistance in Roundup Ready Alfalfa Systems,* University of California Division of Agriculture and Natural Resources Publication 8362 (2009)

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PUBLICATION 8362 / FEBRUARY 2009

Avoiding Weed Shifts and Weed Resistance in Roundup Ready Alfalfa Systems

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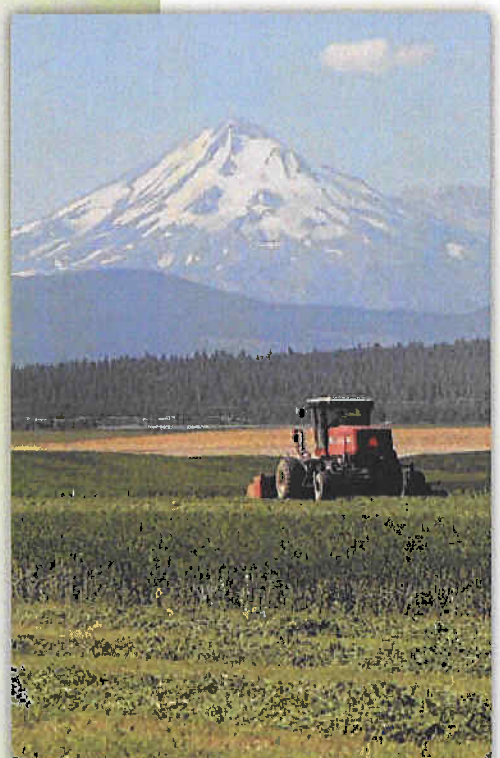
OVERVIEW

Weeds present a continual challenge for profitable alfalfa production. The Roundup Ready (RR) production system, using transgenic alfalfa, has the potential to simplify weed management by improving broad-spectrum control of both annual and difficult-to-control perennial weeds. The use of glyphosate, in combination with transgenic crops, has proven to be a reliable weed control strategy.



However, weed species shifts and the selection for glyphosate-resistant weeds can result from the increased use of this technology if the crop is not managed properly from the outset. Aspects of the alfalfa production system both favor and discourage the occurrence of weed shifts and the evolution of resistant weeds. Alfalfa is a competitive perennial crop that is cut multiple times per year, making it difficult for most weeds to become established. On the other hand, the RR alfalfa system may be vulnerable to weed shifts and resistant weeds for several reasons: tillage typically only occurs between crops, alfalfa is produced over a wide geographical area and in large fields with a great diversity of weeds, and there is potential for long-term repeated use of a single herbicide because it is a perennial crop. In this publication we recommend an integrated weed management system designed to prevent the proliferation of tolerant or resistant weeds. Elements include crop rotation, rotations with herbicides of different modes of action (preferably soil-residual herbicides), tank mixtures, and irrigation and harvest timing. Successful adaptation of these concepts into production systems would assure the long-term effectiveness and sustainability of the Roundup Ready system in alfalfa. A preemptive approach is warranted; these strategies should be employed before weed shifts and weed resistance occur.

IMPORTANCE OF WEED CONTROL IN ALFALFA

Alfalfa, the queen of forages, is the principal forage crop in the United States and frequently the third most important crop in value. It is a vital component of the feed ration for dairy cows and is a principal feed for horses, beef cattle, sheep, and other livestock. Because animal performance depends upon the palatability and nutritional value of alfalfa, livestock managers, especially those in the dairy and horse industry, expect high-quality hay. Although many factors influence quality, the presence of grassy and broadleaf weeds (of low forage quality) plays a significant role in reducing the feeding value of hay throughout the United States. Weeds that accumulate nitrates or are poisonous to livestock are also a major concern in alfalfa, since poisonous weeds sicken or kill animals every year (Puschner 2005). Most livestock producers demand weed-free alfalfa for optimum quality and maximum animal performance.

Weed-free alfalfa can be difficult to achieve, whether using nonchemical methods or conventional herbicides. Typically, no single herbicide controls all weeds present in a field, and some weeds—especially perennials—are not adequately controlled with any of the currently registered conventional herbicides. Cultural practices such as modifying harvest schedules, grazing, time of planting, and use of nurse crops such as oats (*Avena sativa* L.) help suppress weeds; however, these practices are almost never entirely effective and some of them suppress alfalfa seedling growth. In addition to being difficult to achieve, complete weed control in alfalfa is costly. Alfalfa growers continually seek ways to enhance the level of weed control while minimizing costs.

Roundup Ready technology was a major development in alfalfa weed control, providing growers with a useful weed management tool and a means to deal with some of the most difficult-to-control weed species.

THE ROUNDUP READY ALFALFA TECHNOLOGY

Glyphosate (Roundup) is generally considered the most effective broad-spectrum post-emergence herbicide available. The first commercially available glyphosate-resistant crops were soybean, canola, cotton, and corn, which were released in 1996, 1997, 1997, and 1998, respectively. Glyphosate-resistant or Roundup Ready alfalfa (RR alfalfa) was developed through biotechnology in late 1997 and became commercially available in the fall of 2005. This technology imparts genetic resistance to glyphosate by inserting a single gene from a soil bacterium into alfalfa. These biotechnology-derived alfalfa plants have an altered enzyme that allows them to tolerate a glyphosate application while susceptible weeds are killed. Glyphosate resistance is the first commercially available, genetically engineered (GE) trait in alfalfa.

This technology was a major development in alfalfa weed control, providing growers with a useful weed management tool and a means to deal with some of the most difficult-to-control weed species. Researchers have evaluated its effectiveness as a weed control strategy (Canevari et al. 2007; Sheaffer et al. 2007; Steckel et al. 2007, Van Deynze et al. 2004). The advantages and disadvantages of this technology have been reviewed (Van Deynze et al. 2004). Glyphosate was found to be especially effective for weed control in seeding alfalfa (Canevari et al. 2007). Glyphosate typically causes no perceptible crop injury, is much more flexible and less restrictive in application, and provides superior weed control across a range of weed species when compared with other currently used herbicides. One of the greatest advantages of this technology is that it provides a tool for suppressing perennial weeds such as dandelion (*Taraxacum officinale*), yellow nutsedge (*Cyperus esculentus* L.), bermudagrass (*Cynodon dactylon* (L.) Pers.), and quackgrass (*Elytrigia repens* (L.) Nevski) that have not been adequately controlled with conventional practices.

After deregulation of this trait in 2005, over 300,000 acres of RR alfalfa were planted in the United States, about 1.4 percent of U.S. acreage. (For equivalents between U.S. and metric systems of measurement, a conversion table is provided at the end of this publication.) However, in the spring of 2007, further plantings were suspended pending the outcome of a legal challenge and further environmental analysis by the U.S. Department of Agriculture's Animal and Plant Health Inspection Service (USDA-APHIS). There were two key issues in this process: the possibility of contamination of organic and conventional alfalfa through the adventitious presence of the gene, and the possibility of a greater level of weed resistance due to the adoption of the Roundup Ready technology in alfalfa (USDA 2008).

Grower experience in commercial fields following deregulation confirmed many of the benefits that early research had suggested in terms of the efficacy and safety of the RR system (Van Deynze et al. 2004). Growers have generally found that this technology is easy to use and provides superior weed control and improved forage quality in many cases compared with conventional herbicides. However, no new technology is a panacea, and, like other weed control strategies, RR alfalfa has its limitations. An important limitation of this new weed-management system is the potential for weed shifts and weed resistance. This publication discusses techniques that are available to manage the possibility of weed shifts and weed resistance occurring in Roundup Ready alfalfa weed control systems.

WEED SHIFTS AND WEED RESISTANCE

Change in weed populations as a result of repeated use of a single herbicide is not a new phenomenon. Such changes result from shifts in the weeds present from susceptible to tolerant species, or conversion of a population within a species to resistant individuals, as a consequence of selection pressure (Holt and LeBaron 1990; Prather et al. 2000).

Weed Shift

A weed shift refers to a change in the relative abundance or type of weeds as a result of a management practice (fig. 1). The management practice could be herbicide use or any other practice such as tillage, manure application, or harvest schedule that brings about a change in weed species composition.

In the case of chemical weed control, no single herbicide controls all weeds, as weeds differ in their susceptibility to an herbicide. Susceptible weeds are largely eliminated over time with continued use of the same herbicide. This allows inherently tolerant weed species to remain, which often thrive and proliferate with the reduced competition. As a result, there is a gradual shift to tolerant weed species when practices are continuously used that are not effective against those species. A weed shift does not necessarily have to be a shift to a different species. For example, with a foliar herbicide without residual activity like glyphosate, there could also be a shift within a weed species to a late-emerging biotype that emerges after application. In the case of weed shifts, the total population of weeds does not necessarily change as a result of an herbicide or an agronomic practice; these practices simply favor one species (or biotype) over another.

Weed Resistance

In contrast to a weed shift, weed resistance is a change in the population of weeds that were previously susceptible to an herbicide, turning them into a population of the same species that is no longer controlled by that herbicide (fig 2).

Figure 1. Weed shifts due to herbicide application. A weed species shift occurs when both susceptible and tolerant weed species are present in a field. After continued use of a single herbicide, the susceptible weed species is nearly eliminated. The tolerant weed species survives and proliferates, eventually becoming the prevailing species. In this example, a shift to a broadleaf weed is favored by use of a grass herbicide.

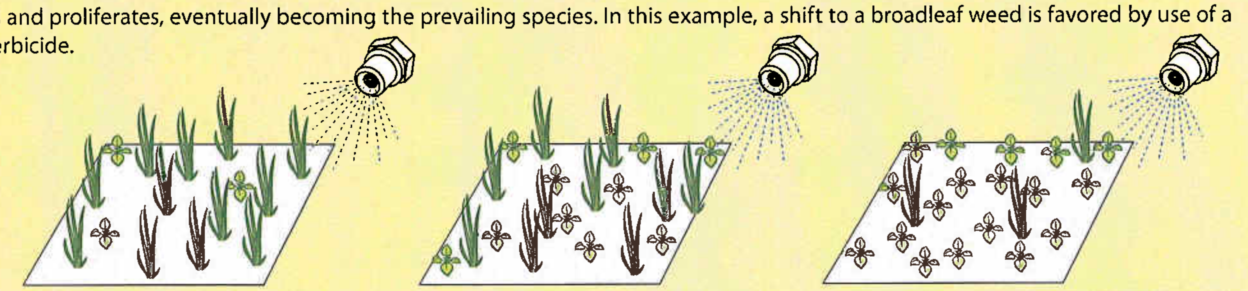
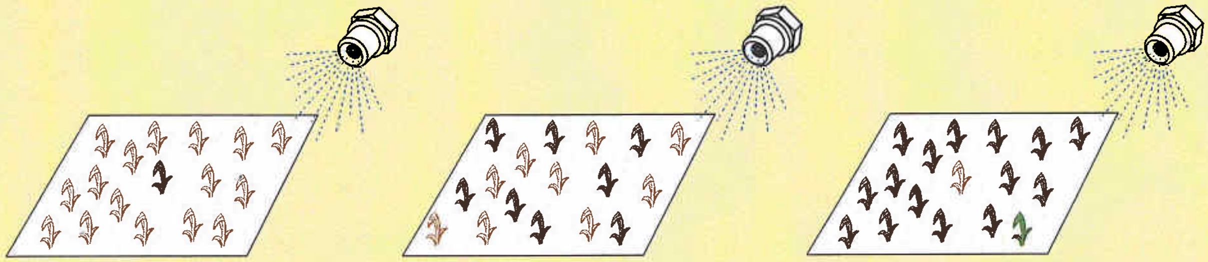


Figure 2. Evolution of herbicide resistance due to selection pressure. An herbicide controls susceptible weeds, preventing them from reproducing and leaving only those individuals carrying the genes for resistance. Typically an extremely small percentage of the weed population initially possesses the genes for resistance. These altered genes are thought to exist in weed populations at very low frequencies. As repeated use of an herbicide controls the susceptible individuals, the resistant weeds continue to multiply and ultimately become predominant.



initial population

population after years of selection pressure

While weed shifts can occur with any agronomic practice (crop rotation, tillage, frequent harvests, or use of particular herbicides), the evolution of weed resistance is only the result of continued herbicide application. The use of a single class of herbicides continually over time creates selection pressure so that resistant individuals of a species survive and reproduce, while susceptible ones are killed.

Which Is More Important, Weed Shifts or Weed Resistance?

A weed species shift is far more common than weed resistance, and ordinarily takes less time to develop. If an herbicide does not control all the weeds, the tendency is to quickly jump to the conclusion that resistance has occurred. However, a weed shift is a far more likely explanation for weed escapes following an application of glyphosate. See table 1 for a list of weeds sometimes found in alfalfa fields that are tolerant to or difficult to control with glyphosate.

Table 1. Annual weeds encountered in alfalfa fields that are potential candidates for weed shifts in continuous glyphosate systems

Latin name	Common name
*Brassica nigra**	black mustard
Chenopodium album[†]	lambsquarters
Echinochloa colona[†]	junglerice
Epilobium	Willowherb, panicle
*brachycarpum**	willowherb, panicle
*Eragrostis**	lovegrass
Erodium spp.[†]	filaree
Lamium amplexicaule[†]	henbit
Lolium multiflorum[†‡]	ryegrass
*Malva parviflora**	malva (cheeseweed)
Polygonum convolvulus[†]	wild buckwheat
Polygonum spp.[†]	knotweeds
Portulaca oleracea[†]	purslane
Sonchus oleraceus[†]	annual sowthistle
*Trifolium spp.**	clover
*Urtica urens**	burning nettle

Note: This table includes weeds that are listed as susceptible on the label but are difficult to control and weeds which are not controlled by glyphosate.
*Glyphosate-tolerant weeds—not listed as controlled on product label.
[†]Difficult to control weeds.
[‡]Glyphosate-resistant biotype has been confirmed.

Are Weed Shifts or Weed Resistance Linked Only to Genetically Engineered Crops?

A common misconception is that weed resistance is intrinsically linked to genetically engineered (GE) crops. However, this is not correct. The occurrence of weed shifts and weed resistance is not unique to genetically engineered crops. Weed shifts and resistance are caused by the practices that may accompany a GE crop (for example, repeated use of a single herbicide), not the GE crop itself. Similarly, some people believe that herbicide resistance is transferred from the GE crop to weed species. However, unless a crop is genetically very closely related to a naturally-occurring weed, weed resistance cannot be transferred from crop to weed. In the case of alfalfa, there are no known wild plants that cross with alfalfa, so direct transfer of herbicide resistance through gene flow to weedy species will not occur. However, the glyphosate-tolerant genes from RR alfalfa can be transferred to feral (wild) alfalfa plants if cross pollination occurs.

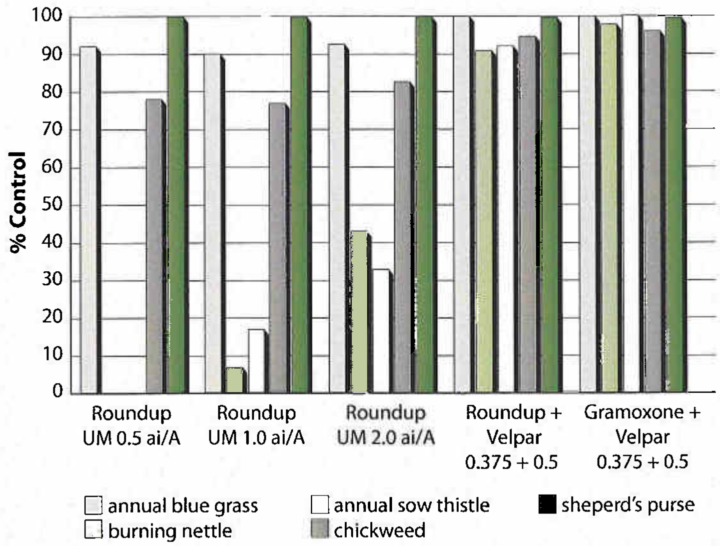
Link to Management Practices

The development of weed shifts or the evolution of weed resistance in cropping systems is primarily a result of management practices, not the crop itself. Continued use of the same management practice, in this case the use of a single herbicide, increases the probability of a weed shift or the evolution of resistant weeds as a result of constant selection pressure. For example, if the herbicide diuron (Karmex) is used alone for several years in established alfalfa, susceptible weeds are controlled. However, there is likely to be an increase in tolerant weeds such as common groundsel (*Senecio vulgaris*), Persian speedwell (*Veronica persica*), and others. Similarly, if imazethapyr (Pursuit) is used repeatedly for several years without rotating with other herbicides, there is likely to be an increase in the population of prickly lettuce (*Lactuca serriola*), annual sowthistle (*Sonchus oleraceus*), and many grassy weeds that are not controlled by this herbicide. Rigid ryegrass (*Lolium rigidum*) and horseweed (*Conyza canadensis*) resistance to glyphosate was the outcome of repeated glyphosate applications in California orchards and noncrop settings, respectively. Weed shifts and weed resistance are not new; evolved resistance was first reported in the 1970s and now occurs with a range of herbicide classes (Holt and LeBaron 1990; Heap 1999; Heap 2008).

RR Crops Present a Challenge

Transgenic herbicide-resistant crops do, nonetheless, have greater potential to foster weed shifts and resistant weeds since a grower is more likely to use a single herbicide repeatedly in herbicide-resistant crops such as RR alfalfa. Additionally, the accumulation of acreage of different RR crops (corn, soybean, and cotton) could increase the potential for weed shifts or weed resistance in cropping systems utilizing RR crops. This is because the probability of repeated use of the

Figure 3. Weed control 69 days after treatment in an established stand of Roundup Ready alfalfa, San Joaquin County, California, 2004.



same herbicide is higher and the potential applied acreage (and therefore the size and genetic diversity of the weed population) is greater. Fortunately, there are simple methods available to prevent weed shifts and weed resistance from occurring.

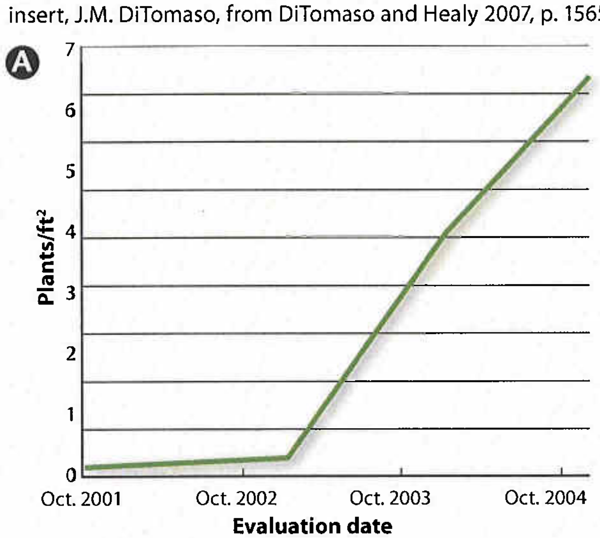
In studies conducted in San Joaquin County, California, weeds shifts were found to occur during the first few years of use when glyphosate-tolerant weeds were present (Van Deynze et al. 2004). Annual bluegrass and shepherd's purse were adequately controlled with glyphosate, whereas chickweed control was about 80 percent and burning nettle and annual sowthistle were not adequately controlled with any of the glyphosate rates (fig. 3). During the 3 years of this field trial, when glyphosate was used repeatedly, there was a gradual weed species shift away from annual bluegrass and shepherd's purse to higher populations of burning nettle and annual sowthistle (figs. 4A and 4B). A tank mix of glyphosate and Velpar, or a rotation to Velpar and Gramoxone, was needed to adequately control all weed species at this location.

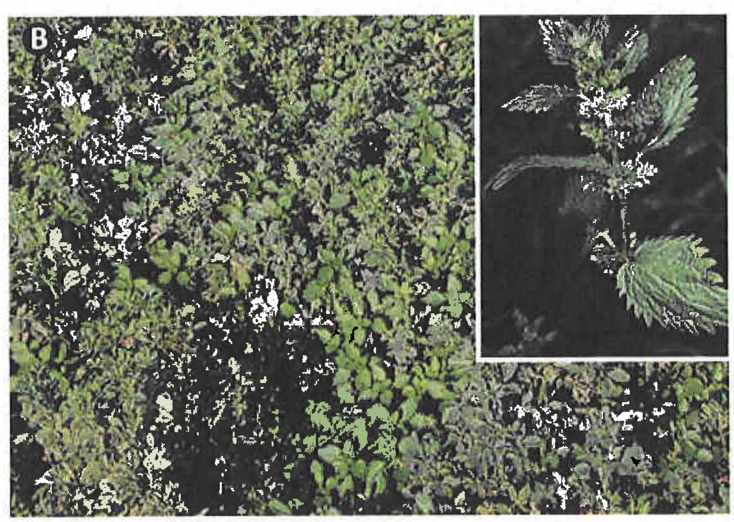
To our knowledge there have been no documented cases of weed resistance in alfalfa during the first 3 years of RR alfalfa production (2005 to 2008) in the United States.

WEED SHIFTS AND RESISTANCE WITH RR ALFALFA

The possibility of weed shifts and weed resistance is a concern with RR alfalfa. This is due to its perennial growth habit, its long stand life, and the potential for repeated use of a single herbicide over several years without crop rotation. Although some stands last 3 to 4 years, it is common in many areas of the United States to keep an alfalfa stand in production for 5 to 7 years or longer. If the rotation crop (e.g. a grain crop) is not treated with an herbicide, an even longer period of time without herbicide diversity could occur. In this instance, weed populations could slowly return to preglyphosate composition, but the new species or resistant biotypes would not disappear. In areas where alfalfa is rotated with transgenic RR corn, cotton, or soybean varieties, this

Figure 4. (A): Increase in burning nettle population in Roundup Ready alfalfa with repeated annual applications of glyphosate alone, San Joaquin County, California, 2006. **(B):** Plot overtaken with burning nettle after 3 years of continual glyphosate use. *Photos:* Mick Canevari; insert, J.M. DiTomaso, from DiTomaso and Healy 2007, p. 1565.





again could result in a prolonged time period where a single herbicide is used repeatedly.

There are aspects of the alfalfa production system that both favor and discourage the development of weed shifts and the evolution of resistant weeds.

Attributes of Alfalfa That Favor Weed Shifts and Resistance

First, crop rotation opportunities with a perennial crop like alfalfa are significantly reduced compared with annual cropping systems. Mechanical weed control, such as cultivation, is impractical in a solid-seeded perennial crop like alfalfa, and hand weeding is not economical. Alfalfa is grown over extensive acreage in the United States and fields can be large in size; therefore, the overall weed flora available for selection of resistant traits or for weed shifts is plentiful. Perennials like alfalfa, if sprayed repeatedly with the same herbicide, are likely candidates for weed shifts and weed resistance.

Attributes of Alfalfa That Discourage Weed Shifts and Resistance

On the other hand, many weeds do not flourish in an alfalfa field due to its perennial nature and the competitiveness of the crop after establishment. Alfalfa is an aggressive competitor with most weeds, which fail to establish in alfalfa fields due to the crop's vigorous growth and shading ability. In addition, many weed species do not tolerate the frequent cutting that occurs in alfalfa fields. The lack of soil disturbance once the alfalfa stand is established also reduces opportunities for germination of some weed species. Furthermore, the interval between alfalfa cuttings is short enough that seed production for many weeds is reduced compared with annual crops that allow completion of the weeds' life cycles.

Risk of Resistance Generally Lower with Glyphosate Than with Other Herbicides

Weed shifts or resistant weeds are unavoidable and will occur eventually with any herbicide used repeatedly, and the same is true with the use of glyphosate (Heap 1999). Fortunately, resistance to glyphosate is not as common as resistance to many other herbicides, such as acetolactate synthase (ALS) and acetyl-CoA carboxylase (ACCase) herbicides that have a single binding site and single target enzyme mechanisms of action (Heap 2008). The relatively low rate of resistance in weeds to glyphosate relative to the widespread use of this chemical has not been fully explained, but may be due to the number or frequency of mutations that may be required to confer resistance to glyphosate. Two resistance mechanisms, a weak target site mutation, and a reduced glyphosate translocation mechanism have been documented in weed species that have evolved resistance to this herbicide (Powles and Preston 2006).

Regardless of the mechanism, weed resistance to glyphosate is not as common as resistance to other herbicides. However, cases of weed resistance to glyphosate have been documented and are increasing. There is a range of species across the world with documented resistance to glyphosate (table 2). Fortunately, most of these species are not common in alfalfa fields. Two weed species in particular have evolved resistant populations in California: *Lolium* spp. (ryegrass) and *Conyza* sp. (marestail). The latter is not important in alfalfa, but ryegrass is frequently found in alfalfa fields. Glyphosate-resistant ryegrass is increasing in the Sacramento Valley and northern San Joaquin Valley of California and may become problematic during fall stand establishment of RR alfalfa.

Weed shifts and/or weed resistance have occurred with the other transgenic RR crops released before RR alfalfa (Duke and Powles 2008). Weed resistance is of greater concern than weed shifts and has occurred in RR soybean, cotton, and corn in less than a decade after their initial release (see table 2). Alfalfa growers can learn from experience with these crops and in noncrop areas as a preemptive measure to avoid, or at least minimize, the problems with weed shifts and weed resistance. These problems are sure to occur in alfalfa if proper weed management practices are not followed.

Alfalfa growers can learn from experience with other RR crops and in noncrop areas as a preemptive measure to avoid, or at least minimize, the problems with weed shifts and weed resistance.

WEED MANAGEMENT PRINCIPLES TO REDUCE WEED SHIFTS AND RESISTANCE IN ALFALFA

Glyphosate-resistant crops have provided growers with an easy-to-use, low-cost, and effective weed management tool. However, the effectiveness of weed control systems using RR crops can make growers complacent in their weed control practices. Even though this technology is highly effective, growers must follow sound weed management principles to prevent short- or long-term weed shifts or weed resistance from occurring. This includes weed identification, crop rotation, attention to application rate, proper timing of application, herbicide rotation, and tank mixtures.

Weed Identification

Effective weed management practices begin with proper identification to assess the competiveness of the weeds present and to select the proper herbicide if one is needed. A weed management strategy to prevent weed shifts and weed resistance requires knowledge of the composition of weeds present. Identification of young seedlings is particularly important because seedling weeds are easier to control. Resources for weed identification can be found at the UC IPM Web site (http://www.ipm.ucdavis.edu/PMG/weeds_common.html) and at the UC Weed Research and Information Center Web site (http://wric.ucdavis.edu/information/information.html).

Table 2. Glyphosate-resistant weed populations

Resistant weed	Common name	Location of resistant populations	Situation(s)	Year first reported
UNITED STATES			(In the U.S.)	
Amaranthus palmeri	Palmer amaranth	Arkansas, Georgia, North Carolina, Mississippi, Tennessee	corn, cotton, soybean	2005
Amaranthus rudis	common waterhemp	Illinois, Kansas, Minnesota, Missouri	corn, soybean	2005
Ambrosia artemisiifolia	common ragweed	Arkansas, Kansas, Missouri	soybean	2004
Ambrosia trifida	giant ragweed	Arkansas, Indiana, Kansas, Minnesota, Ohio, Tennessee	cotton, soybean	2004
Conyza bonariensis	hairy fleabane	California	roadsides	2007
Conyza canadensis	horseweed (marestail)	17 states including California	cotton, nurseries, road-sides (in CA), soybean	2000
Lolium multiflorum	Italian ryegrass	Mississippi , Oregon	cotton, orchards, soybean	2004
Lolium rigidum	rigid ryegrass	California	orchards	1998
Sorghum halepense	Johnsongrass	Arkansas	soybean	2007
WORLD			(in the world)	
Conyza bonariensis	hairy fleabane	Brazil, Colombia, South Africa, Spain	corn, orchards, soy-bean, vineyards, wheat	2003
Conyza canadensis	horseweed (marestail)	Brazil, China, Czech Republic, Spain	orchards, soybean, railways	2005
Digitaria insularis	sourgrass	Brazil , Paraguay	soybean	2006
Echinochloa colona	junglerice	Australia (New South Wales)	cropland	2007
Eleusine indica	goosegrass	Colombia , Malaysia	cropland , orchards	1997
Euphorbia heterophylla	wild poinsettia	Brazil	soybean	2006
Lolium multiflorum	Italian ryegrass	Argentina, Brazil, Chile, Spain	cropland orchards, soybean	2001
Lolium rigidum	rigid ryegrass	Australia, France, South Africa, Spain	asparagus, orchards, railways, sorghum, vineyards, wheat	1996
Plantago lanceolata	buckhorn plantain	South Africa	orchards, vineyards	2003
Sorghum halepense	Johnsongrass	Argentina	soybean	2005
Urochloa panicoides	liverseedgrass	Australia (New South Wales)	sorghum, wheat	2008

Source: International Survey of Herbicide Resistant Weeds, adapted from Heap 2008.

Frequent Monitoring for Escapes

It is difficult to detect an emerging weed shift or weed resistance problem if fields are not frequently monitored for weeds that escape current weed management practices. Identification and frequent monitoring can detect problem weeds early and guide management practices, including herbicide selection, rate, and timing.

Herbicide Rate and Timing

It is important to use the appropriate rate and timing for the weeds present. For example, some weeds that are considered somewhat tolerant to glyphosate (cheeseweed, filaree, and purslane) can be controlled effectively in seedling alfalfa with glyphosate, provided the proper rate is used and the application is made when the weeds are very small. Research in Nebraska over a 7-year period (Wilson 2004) demonstrated a rapid increase in lambsquarters when a low rate of glyphosate (0.5 lb ai/acre) was applied, but a higher rate (1.0 lb ai/acre) successfully controlled this weed. Just like with traditional weed management programs, the grower must be sure to use the recommended rate for the weed species present and treat at the appropriate time when the weeds are still small.

Crop Rotation

One of the most effective practices for preventing weed shifts and weed resistance is crop rotation, which allows growers to modify selection pressure imposed on weeds. Continuous (also called back-to-back) alfalfa is not recommended for other agronomic reasons, but especially would be ill advised when it comes to management of resistance and weed shifts. Crops differ in their ability to compete with weeds; some weeds are a problem in some crops, while they are less problematic in others. Rotation therefore would not favor any particular weed spectrum. Crop rotation also allows the use of different weed control practices, such as cultivation and application of herbicides with different sites of action. As a result, no single weed species or biotype should become dominant. The effectiveness of crop rotation to manage weed shifts and resistance is substantially reduced if another RR crop (such as corn or cotton) is planted in rotation with RR alfalfa, since the same herbicide and selection pressure would likely occur.

Using an effective herbicide with a different mode of action from the one to which the weeds are resistant controls both the susceptible and resistant biotypes, thus preventing reproduction and slowing the spread of the resistant biotype.

Agronomic Practices

In addition to crop rotation, several management practices may have an impact on the selection of problem weed populations. If problem weeds germinate at a specific time of year, crop seeding date can be shifted to avoid these weed populations, allowing a vigorous alfalfa crop to develop that is capable of outcompeting weeds. Delaying irrigation after alfalfa cutting can reduce germination of certain summer annual weeds. However, this practice only works on some soil types, and water stress in alfalfa can reduce yields. Harvest management can, in some cases, assist in eliminating or suppressing problem weed populations, but harvests must occur before weed seed production to prevent weed proliferation.

Rotation of Herbicides

Weed shifts occur because herbicides are not equally effective against all weed species and herbicides differ greatly in the weed spectrum they control. A weed species that is not controlled will survive and increase in density following repeated use of one herbicide. Therefore, rotating herbicides is recommended. Rotation of herbicides reduces weed shifts, provided the rotational herbicide is highly effective against the weed species that is not controlled with the primary herbicide. The grower should rotate to an herbicide with a complimentary spectrum of weed control, along with a different mechanism of action and therefore a different herbicide binding site. Weed susceptibility charts are useful to help develop an effective herbicide rotation scheme (Canevari et al. 2006). In addition, publications on herbicide chemical families are available to assist growers in choosing herbicides with different mechanisms of action (Retzinger and Mallory-Smith 1997).

Rotating herbicides is also an effective strategy for resistance management. Within a weed species there are different biotypes, each with its own genetic makeup, enabling some of them to survive a particular herbicide application. The susceptible weeds in a population are killed, while the resistant ones survive, set seed, and increase over time. Using an effective herbicide with a different mode of action from the one to which the weeds are resistant, however, controls both the susceptible and resistant biotypes. This prevents reproduction and slows the spread of the resistant biotype.

Herbicide Tank Mixtures

For the same reasons that rotating herbicides is effective, tank mixing herbicides is also recommended. The key is to select tank mix partners that have different target sites and that compliment each other so that, when combined, they provide complete or nearly complete weed control.

RECOMMENDED WEED MANAGEMENT PROGRAM FOR RR ALFALFA

The cost of RR alfalfa seed, including the technology fee, is generally twice or more than that of conventional alfalfa seed. Naturally, growers will want to recoup their investment as quickly as possible. Therefore, considerable economic incentive exists for the producer to rely solely on repeated glyphosate applications alone as a weed control program. Some producers may even be inclined to shave the rates to the minimum amount that would provide acceptable weed control. While relying solely on glyphosate and shaving rates may provide satisfactory results in the short term, it is a risky practice in the long run as it will accelerate weed species shifts and the evolution of resistant weeds. Sound weed management practices should be employed to maintain the effectiveness of the RR technology.

Roundup Ready alfalfa is still a relatively new technology, so there has been limited field experience with it to date. The following are some suggestions to consider based upon proven resistance management strategies, our understanding of alfalfa production practices, and our initial experience with RR alfalfa. Ultimately, growers and pest control advisors hold the key to avoiding weed shifts and resistance by reducing selection pressure, which is accomplished by developing a weed management program that does not rely solely on the continuous use of glyphosate. Any management practice that reduces the selection pressure (in this case, the selection pressure imposed by continual use of the same herbicide) will help avoid weed species shifts and resistance.

For Seedling Alfalfa, Use Glyphosate Alone or in a Tank Mix Combination

Seedling alfalfa is most vulnerable to weed competition because weeds are often more vigorous and competitive than young alfalfa. Additionally, complete weed control in seedling alfalfa is often difficult to achieve and frequently requires tank mixes of different herbicides to control the broad spectrum of weeds found in an individual field. Yield and stand loss from weed competition, and injury from conventional herbicides, are usually far greater in seedling than in established alfalfa. Numerous field trials throughout the United States have proven the effectiveness of RR alfalfa for stand establishment. Superior weed control with no perceptible alfalfa injury has occurred in most studies. Therefore, it is only logical to use glyphosate for weed control in RR seedling alfalfa for the cost savings, improved weed control, reduced crop injury, superior stand establishment, and the elimination of the small percentage of alfalfa seedlings (commonly called nulls) that do not carry the RR gene. Delayed removal of these nulls may cause weed control problems in the future by creating open spaces for weeds to grow.

Ordinarily, 1.0 pound per acre active ingredient of glyphosate is sufficient for weed control during the seedling period. However, a higher rate may be needed if the field contains some of the more tolerant weeds listed in table 1. A tank mix may be advised if especially-difficult-to-control weeds are present. For example, a tank mix of glyphosate with imazamox (Raptor) or imazethapyr (Pursuit) may be advised if burning nettle is present, or a tank mix with clethodim (Prism) will be necessary if the field or surrounding area is known to have glyphosate-resistant ryegrass.

Rotate or Tank Mix Herbicides at Least Once During the Life of an Alfalfa Stand

Alfalfa stand life varies considerably throughout the western United States depending on the production area, grower practice, and the existence of profitable rotation crop options. A stand life of 3 to 5 years is common in the Central Valley of California and other warm, long growing-season areas of the Southwest. A stand life of 5 to 7 years is common in much of the Northwest, and some alfalfa stands remain in production in excess of 10 years. As suggested by the principles outlined above, it is unwise to rely solely on glyphosate applications for weed control throughout the life of a transgenic alfalfa field. This practice would encourage weed shifts and resistance, and over time weed control would diminish in most cases. Once an herbicide is rendered ineffective as a result of resistant weeds, its usefulness as a weed control tool may be greatly diminished. After a resistant weed population has gained a foothold, it is practically impossible to eliminate it due to the presence of a weed seedbank.

Most alfalfa producers apply an herbicide to alfalfa during the dormant season to control winter annual weeds that infest the first cutting. It is strongly recommended that growers not rely solely on glyphosate for their winter weed control program for the duration of the stand. They should rotate to another herbicide or tank mix at least once in the middle of the life of a stand, and perhaps twice if the stand life is over 5 years (table 3).

Use an Herbicide with a Different Mode of Action

Fortunately, all of the herbicides currently registered in alfalfa—and there are several to choose from—have

Table 3. Comparison of weed management strategies for glyphosate-resistant alfalfa using continuous glyphosate applications versus a recommended approach where glyphosate is rotated with other herbicides during a 4-year alfalfa stand

Year	Objective	Season	Continuous glyphosate strategy	Rotational herbicide strategy
Seedling	control weeds that compete during stand establishment	fall	glyphosate	glyphosate
1	control late-emerging weeds during establishment	winter (late)	glyphosate	glyphosate*
	summer annual weed control may not be needed first year	spring		
		summer		
		fall		
2	control winter annual weeds and/or pre-emergence control of summer weeds	winter	glyphosate	soil residual herbicide or tank mix* of soil residual herbicide with glyphosate†
	summer annual weed control/dodder	spring		
		summer	glyphosate	
		fall		
3	control winter annual weeds and/or pre-emergence control of summer weeds	winter	glyphosate	soil residual herbicide or tank mix* of soil residual with gly-phosate†
	control summer annual grassy weeds/ dodder	spring	glyphosate	
		summer (mid)	glyphosate	
		fall		
4	control winter annual weeds	winter	glyphosate	glyphosate
	control summer annual grassy weeds/ dodder	spring	glyphosate	
		summer (mid)	glyphosate	glyphosate
	(stand take-out)	fall (late)	tillage and/or 2,4-D + dicamba as necessary	tillage and/or 2,4-D + dicamba as necessary
(4 years)	**Total number of glyphosate applications**		**10**	**4–6**

Note: A combination of soil residual herbicides and different modes of action is recommended to prevent weed shifts and herbicide resistance. These are examples only—appropriate strategies should be modified for different regions and weed pressures.

*Tank mixing with another herbicide is advised if significant populations of glyphosate, tolerant weeds such as burning nettle are present.

†Soil residual herbicide (depending on location and weed spectrum, use hexazinone, diuron, or metribuzin) for pre-emergence control of winter annual weeds. An application of a dinitroaniline herbicide (pendimethalin or trifluralin) applied at this time will control summer annual grassy weeds.

a different target site of action than does glyphosate. The soil-residual herbicides applied during the dormant season to established alfalfa [such as hexazinone (Velpar), diuron (Karmex), metribuzin (Sencor), and pendimethalin (Prowl)] would be appropriate herbicides for a rotation or tank-mix partner. The rotation herbicide or tank-mix partner of choice depends on the weeds present in the field and their relative susceptibility to the herbicides. Paraquat (Gramoxone) is another candidate for rotation, but paraquat, like glyphosate, lacks residual activity and is applied late in the dormant season. By rotating paraquat with glyphosate, growers could potentially be selecting for early-emerging weeds that may be too large to control at the typical timing for these herbicides. In addition, they could be selecting for late emerging weeds that germinate after the application.

Rotate Herbicides Early in Stand Life So Glyphosate Remains Effective

Weed control during the last year of an alfalfa stand is often challenging because the stand is typically less dense and competitive and also there are fewer herbicide options from which to choose. There are significant plant-back restrictions associated with many of the soil-residual herbicides used in alfalfa, so glyphosate is a good choice for controlling weeds in the final year of RR alfalfa field. The preference to use glyphosate in the final year of an alfalfa stand underscores the importance of rotating herbicides earlier so that glyphosate will remain effective and continue to control the majority of the weeds.

Consider a Soil-Residual Herbicide for Summer Annual Weed Control

Summer annual grass weeds such as yellow and green foxtail (Setaria spp.), barnyardgrass (*Echinochloa crus-galli*), cupgrass (*Eriochloa* spp.), and jungle rice (*Echinochloa colona*), and less frequently, broadleaf weeds like pigweed (*Amaranthus* spp.) or lambsquarters (*Chenopodium album*), can be problematic in established alfalfa. These weeds emerge over an extended time period whenever soil temperatures and moisture are adequate, typically from late winter or early spring (as early as February in the Central Valley) throughout the summer. Weeds may emerge between alfalfa cuttings, so several applications may be necessary in California's Central Valley for a foliar herbicide without residual activity like glyphosate to provide season-long control.

Multiple applications of a single herbicide during a season is cited as promoting weed resistance. Therefore, growers should not rely solely on glyphosate for summer grass control for multiple seasons. It remains to be seen how many applications of glyphosate will be required for season-long summer grass control. In some of the long growing-season areas of California, as many as two to three applications per season may be needed in older, thinner stands. Rather than making multiple applications of glyphosate, a better approach may be to apply a pre-emergence soil-residual dinitroaniline herbicide like trifluralin (Treflan) or pendimethalin (Prowl), or possibly EPTC (Eptam), and follow up with glyphosate later in the season as needed for escapes. Not only is this approach more in line with management practices to avoid weed shifts and resistance, but it may be more economical as well, compared with multiple applications of glyphosate.

The practice of rotating herbicides or applying tank mixtures is recommended for both dormant applications aimed at winter annual weeds and for spring/summer applications intended to control summer annual weeds. For example, rotating to hexazinone (Velpar) for winter annual weed control for a year does nothing to prevent weed species shifts or the evolution of resistance in the summer annual weed spectrum. Herbicides for summer annual weed control should be rotated as well.

Frequency of Rotation Depends on Weed Species and Escapes

There is no definitive rule on how often herbicides should be rotated. Our suggestion to rotate or tank mix at least once in the middle years of the life of a stand (or more often for long-lived alfalfa stands) may need to be modified depending upon actual observations of evolving weed problems. The key point, which cannot be overemphasized, is the importance of diligent monitoring for weed escapes. Producers should stay alert to the appearance of weed species shifts and evolution of resistant weeds. If the relative frequency of occurrence of a weed species increases dramatically, chances are that it is tolerant to glyphosate and immediate rotation of herbicides or a tank mix is advised. If a few weeds survive among a weed species that is normally controlled easily with glyphosate, it could be an indication of weed resistance, assuming misapplication and other factors can be eliminated as possible causes. Weed resistance should be confirmed by controlled studies conducted by a weed scientist. However, in these situations, it is imperative to prevent reproduction of a potentially resistant biotype. Treat weed escapes with an alternative herbicide or other effective control measure.

CONCLUSIONS

The Roundup Ready alfalfa production system has the potential to simplify weed management, while also improving the spectrum of weed control. However, growers should learn from the experience gained in other crops and stay alert to the occurrence of weed shifts and evolution of resistant weeds. The key is for growers to reduce selection pressure, not to rely on repeated applications of glyphosate year after year, application after application. Well-known management principles are available to manage weed shifts and weed resistance in RR alfalfa. Rotate crops, rotate herbicides, and utilize tank mixes as needed, depending on the weed species and weed escapes present. A grower should not wait for a problem to occur before he or she employs these practices; a preemptive approach is strongly encouraged.

METRIC CONVERSIONS

English	Conversion factor for English to metric	Conversion factor for metric to English	Metric
pound (lb)	0.454	2.205	kilogram (kg)
acre (ac)	0.4047	2.47	hectare (ha)
pound per acre (lb/ac)	1.12	0.89	kilogram per hectare (kg/ha)

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WARNING ON THE USE OF CHEMICALS

Pesticides are poisonous. Always read and carefully follow all precautions and safety recommendations given on the container label. Store all chemicals in their original labeled containers in a locked cabinet or shed, away from foods or feeds, and out of the reach of children, unauthorized persons, pets, and livestock.

Recommendations are based on the best information currently available, and treatments based on them should not leave residues exceeding the tolerance established for any particular chemical. Confine chemicals to the area being treated. THE GROWER IS LEGALLY RESPONSIBLE for residues on the grower's crops as well as for problems caused by drift from the grower's property to other properties or crops.

Consult your county agricultural commissioner for correct methods of disposing of leftover spray materials and empty containers. Never burn pesticide containers.

PHYTOTOXICITY: Certain chemicals may cause plant injury if used at the wrong stage of plant development or when temperatures are too high. Injury may also result from excessive amounts or the wrong formulation or from mixing incompatible materials. Inert ingredients, such as wetters, spreaders, emulsifiers, diluents, and solvents, can cause plant injury. Since formulations are often changed by manufacturers, it is possible that plant injury may occur, even though no injury was noted in previous seasons.

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Appendix E

Effects of Glyphosate-Resistant Weeds in Agricultural Systems (Appendix G from Draft EIS)

Appendix G. Effects of Glyphosate-Resisant Weeds in Agricultural Systems

Effects of Glyphosate-Resisant Weeds in Agricultural Systems

Executive Summary

Alfalfa is grown for forage, grazing, seed production (forage and sprouts), human consumption, and honey production. The most acreage is for dry hay forage. In 2005, 22,439,000 acres of dry hay alfalfa was harvested and 204,380 (0.9%) of those acres were certified organic. In addition to mechanical and cultivation techniques, conventional farming allows the use of 16 different herbicides to control weeds in alfalfa. Organic farming does not allow synthetic pesticides or the use of crop varieties produced through genetic engineering. Glyphosate-tolerant (GT) alfalfa allows for the application of glyphosate directly onto growing plants, which provides increased options for weed control over conventional and organic systems. GT alfalfa allows for flexibility in timing of glyphosate application to control weeds. In the two years that GT alfalfa seed was on the market ~200,000 acres were planted in 1,552 counties in 48 states.

Alfalfa Growing Regions

The seven growing regions in the United States have varying optimal alfalfa varieties and farming practices, such as frequency of cutting, companion cropping, and irrigation. California, South Dakota, Idaho, Nebraska, Montana, and Wisconsin are the top six alfalfa hay producing states (in 2007). South Dakota, Montana, Wisconsin, and North Dakota, have the largest acreage of alfalfa hay. California's acreage is highly productive.

Crop Rotations

Crop rotation options may be different between conventional and GT farming systems. Many of the non-glyphosate herbicides have follow-up planting restrictions that limit crop rotation choices in conventional farming. Farmers using GT cropping systems are advised to include some years of non-GT crops in rotation, so there may be limitations in the use of other GT crops if GT alfalfa is used in a rotation plan.

Alfalfa Stand Removal

Glyphosate is the primary tool used to remove conventional alfalfa stands. Use of herbicides other than glyphosate for removal of GT alfalfa is a major difference between GT alfalfa and conventional alfalfa. Non-glyphosate herbicides and tillage are recommended for effective GT alfalfa stand removal.

Volunteer Alfalfa

Farmers are not able to use glyphosate to control volunteer GT alfalfa in other GT crops. However, 11 other herbicides and mixtures of those herbicides are available to control volunteer GT alfalfa. These are the same herbicides that are used to control non-GT alfalfa with the exception that glyphosate can be used to control non-GT alfalfa.

Weeds in Alfalfa

Weeds are controlled in conventional alfalfa with chemicals (herbicides), cultural methods (rotation, companion crops, monitoring), and mechanical methods (tillage). The cultural and mechanical methods are permitted for organic farmers. GT systems allow for the use of one additional herbicide, glyphosate. Weeds are undesirable because they compete with crops, leading to lower yields, can lower the nutritional value of crops, can be poisonous or unpalatable to livestock, can cause off flavors in milk, and can cause trouble with bailing. At least 129 different weed species are identified as minor or major problems in alfalfa. Out of 14 new glyphosate resistant weeds found since 1998, eight are known to be weeds in alfalfa. Out of at least 21 weeds that have natural resistance to glyphosate, ten are known to be a problem in alfalfa. These 18 weeds that are both resistant to glyphosate and traditionally listed as problems in alfalfa include: common ragweed, horseweed, Italian ryegrass, Johnsongrass, Palmer Amaranth, buckhorn plantain, goosegrass, junglerice, bermudagrass, burning nettle, cheeseweed, common lambsquarters, field bindweed, filaree, large crabgrass, morningglory, nutsedge, and purslane. Although the composition of weed shifts is based on the local seedbank, these 18 weeds are candidates for becoming more prevalent than glyphosate-resistant sensitive weeds in rotations that include GT alfalfa.

Glyphosate Resistant Weed Distribution

Nineteen states and over two million acres of cropland contain new glyphosate resistant weeds. The heaviest infestation is in the Southeast and Midwest. Overlap with the major alfalfa producing states in the Intermountain regions (Washington, Oregon, Idaho, Montana, Wyoming, Colorado, Utah, Nevada, and parts of California) seems to be minimal at this point. However, given that there is overlap between glyphosate resistant weed locations and alfalfa hay acreage there is potential for rapid shifts of glyphosate resistant weeds into GT alfalfa fields if GT alfalfa were to be widely adopted. California is a concern because glyphosate resistant weeds are present and alfalfa is a major crop in California.

1.0 Introduction

The scope of this report covers how glyphosate-tolerant (GT) alfalfa could impact weed dynamics in agricultural systems. Gene flow from GT alfalfa is covered in another technical report in this series (Appendix J). In this report, different types of alfalfa crops and cropping systems are described. Regional differences in alfalfa farming are summarized and discussed within the context of weed management. Glyphosate resistant weeds and the potential risks from volunteer GT alfalfa are also discussed. This report is limited to weed dynamics in agricultural systems. Potential effects of farming with GT alfalfa on ecosystems is discussed in other technical reports. This report is limited to practices involving weed management and does not include discussion of control of diseases, insects, nematodes, and vertebrate pests and management of field fertility and soil conservation.

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 (e.g., common groundsel, fiddleneck, yellow starthistle, and poison hemlock) can make alfalfa hay unmarketable.
- 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 (either beef or milk).
- Some weeds can contribute to off flavors in milk (wild celery, Mexican tea, creeping swinegrass, and mustards).
- Weeds that contain higher moisture content than alfalfa (dandelion) can cause bail problems such as mold, off-color hay, and high bale temperatures, which are a fire hazard.

Without weeds, alfalfa can grow at a density of about 12 plants per square foot. Heavily infested stands can have less than one alfalfa plant per square foot (Canevari et al., 2007). In California, if weeds are not effectively controlled weeds can represent up to 76 percent of the first cutting yields (Gianessi et al, 2002). The limiting factor for weed control in alfalfa is that, by the time alfalfa reaches the stage of growth that is tolerant to herbicides, weeds are also beyond their susceptible stage (Gianessi et al., 2002). Glyphosate-tolerant alfalfa was developed so that the broad spectrum herbicide, glyphosate, could be applied directly to alfalfa fields to control weeds. The glyphosate-tolerant (GT) trait was introduced through genetic engineering. Although glyphosate-tolerance has arisen naturally in some plants due to decades of glyphosate use, so far, all crops with glyphosate-tolerance have had the trait introduced through genetic engineering.

1.1 Methodology

A literature search was designed to identify peer review articles and grey literature (e.g., government reports, State Agricultural Extension Office publications) on weeds in alfalfa (Appendix G-2 of this technical report). Several DIALOG databases were searched. Google, Google Scholar, Scirus, and Yahoo search engines supplemented the DIALOG search. Calculations for percentages of harvest were done with Microsoft Excel. Alfalfa harvest statistics were obtained from USDA's National Agricultural Statistics Service (http://www.nass.usda.gov/index.asp). In addition, USDA's Economics, Statistics and Market Information System (ESMIS), which is a collaborative project between Albert R. Mann Library at Cornell University and USDA, provided information on alfalfa harvesting (http://usda.mannlib.cornell.edu/MannUsda/homepage.do). USDA's Agricultural Marketing Service also provided information on harvests (http://www.ams.usda.gov). The common and scientific names for weeds (Appendix G-3 of this technical report) were found in the USDA Plants database (http://plants.usda.gov/java/invasiveOne).

2.0 Alfalfa Cropping Systems

This chapter discusses how alfalfa is used, the farming practices for growing alfalfa, and the alfalfa growing regions in the United States.

2.1 Alfalfa Uses

Alfalfa is grown for seed production, human food, honey, grazing, and forage. Forage comprises the largest acreage for alfalfa stands. In 2007, 72.5 million tons of dry hay alfalfa was produced from 21.6 million acres harvested (www.nass.usda.gov).

2.1.1 Forage

Alfalfa is considered the "Queen of Forages" because of its high nutritional content when fed to cattle and horse livestock (Putnam et al., 2001). Due to climate and other differences, farming practices differ regionally. However, some farming characteristics are shared among growing regions. Alfalfa stands have two growing phases, establishment of seedlings (first year) and established (two to eight years). Weed management differs for each phase (Orloff et al., 1997). During the seedling establishment phase, companion or nursery crops, such as oats, wheat, and barley can be used to help shelter the alfalfa seedlings, help prevent soil erosion, and suppress weeds because they germinate and grow faster than alfalfa (Canevari et al, 2007). Well established alfalfa that is not thinning has fewer issues with weeds because established alfalfa is a good competitor. Alfalfa can be harvested (mowed) every 30 to 50 days depending on growth conditions in the region, local weather patterns, and alfalfa variety. In most of the growing regions, alfalfa is only cut three to four times a year, but in the Southwestern U.S. growers can cut up to10 or 11 times per year (Putnam et al., 2001). To determine when to harvest, farmers balance yield and nutritional content. Yield increases as plants grow and peaks at 100% bloom, but nutritional content is highest in young vegetative plants and decreases until full flower. There is no optimal harvest schedule, because farmers make different decisions based on changing market demand. Farmers may choose to harvest between late bud stage and full bloom, however, alfalfa hay production experts recommend cutting alfalfa for hay at 10% bloom, as this stage provides the most valuable and nutritious forage (e.g., Sheaffer et al. 2000). . The highest quality hay (bud stage) is generally used for active dairy cows. Whereas hay that is lower in protein and higher in fiber, is fed to beef cattle, horses, heifers (too young to milk) and non-lactating dairy cows (Ball et al., no year). Alfalfa for livestock feed can be stored in a variety of forms:

- Hay - dry bailed at 18-20% moisture
- Haylage - round bale silage, baled at 50-60% moisture, wrapped in plastic
- Silage - chopped and blown into a silo or a truck

2.1.2 Grazing

Grazing is sometimes used as an alternative to harvesting alfalfa. Grazing allows for high nutritional gains per animal, but the risks include animal losses due to bloating and difficulties in alfalfa stand maintenance if continuous grazing is present. Farmers may choose grazing for dormant-season alfalfa stubble, a substitute for early or late season cutting, and rotational grazing during the growing season. It is strongly recommended that animals not graze before flowering begins. Alfalfa root carbohydrate reserves may not be sufficient if early grazing is permitted and the potential for bloat decreases with flowering (Orloff et al., 1997).

2.1.3 Seed Production (Hay and Sprouts)

Alfalfa is also consumed by humans (e.g., sprouts, dietary supplements, and herbal teas). Sprouts have been the source of several foodborne outbreaks due to bacterial contamination (FDA 1999). Epidemiological investigations suggest that seeds are the likely source in most, if not all, sprout-associated illness outbreaks. Seed grown for sprouts have more stringent restrictions for chemical applications during growing since the chemicals must be evaluated as food residues. Sources of animal waste in fields, such as grazing areas and irrigation water, must also be controlled to reduce the likelihood of pathogens from animal waste coming into to contact with seeds. For these reasons, sprout seed and hay seed are usually grown separately (FDA 1999).

FDA considers GT alfalfa not materially different from conventional alfalfa; therefore it is permitted for human consumption (FDA 2004). However, Monsanto does not allow GT alfalfa to be planted for sprouts (Hubbard 2008). If GT alfalfa was present in human food, it would not be considered adulterated and would not need to be removed from the market.

2.1.4 Honey

Alfalfa and clover are common nectar sources for honey bee hives. Although alfalfa is not specifically grown for bees, both managed and wild bee hives are often associated with alfalfa fields (Hammon et al., 2007).

2.2 Alfalfa Farming Practices

Alfalfa framing practices are broken into three categories, organic, conventional, and glyphosate-tolerant alfalfa. Only aspects of farming related to weed control are discussed. Practices for controlling disease, insects, nematodes, and vertebrate pests and management of field fertility and soil conservation are not discussed.

2.2.1 Organic Farming

For this report, organic production is only those cropping systems that fall under the USDA National Organic Program (NOP) definition of organic farming and are certified organic production systems. In organic systems, the use of synthetic pesticides, fertilizers, and genetically engineered crops is strictly limited. NOP publishes a list of approved substances for organic farming inputs (http://www.ams.usda.gov/AMSv1.0).

GT alfalfa is not approved for use in organic systems because it is genetically engineered and because glyphosate application is not permitted in organic systems.

In organic systems, where herbicides are not permitted, alfalfa is tilled and allowed to sit for seven to ten days. Two or more discing passes may be necessary if weed germination is observed. The field should also be treated with nutrients, such as compost and boron, and left for a week to check for further weed germination. Planting can occur once weed growth potential is minimized (Guerena and Sullivan 2003). Manure fertilizer should be composted to kill weed seeds (Canevari et al., 2007).

2.2.2 Conventional Farming

Conventional farming includes any farming system where synthetic pesticides or fertilizers are used. The definition of conventional farming usually includes the use of genetically engineered crops, but genetically engineered GT alfalfa is considered separately for this report (Harker et al., 2005). Conventional farming covers a broad scope of farming practices, ranging from farmers who only occasionally use synthetic pesticides to those farmers whose harvest depends on regular pesticide and fertilizer inputs. The 16 herbicides that may be used in conventional farming are summarized in table G-1 (based on OMAFRA 2008; Canevari et al., 2007; Rogan and Fitzpatrick 2004; Loux et al., 2007).

Table G-1. Herbicides Used in Conventional Alfalfa Farming

Herbicide (Brand)	Stand Stage	Weed	Notes
2,4-DB (Butyrac, Butoxone)	1-4 trifoliolate or established stands	Prickly lettuce Annual sowthistle Mustards Curly dock	• No harvesting or grazing allowed for 60 days following treatment
Benefin (Balan)	Before seeding	Annual grasses Broadleaf	• Not for use on soils high in organic matter
Bromoxynil (Buctril)	2-4 trifoliolate	Coastal fiddleneck Mustard0s Common groundsel Annual sowthistle	• Often tank mixed with other herbicides
Clethodim (Prism, Select)	2-4 trifoliolate or established stands	Summer grasses Yellow foxtail Green foxtail Barnyardgrass Bermudagrass Johnsongrass Goosegrass Volunteer cereals	• Well established perennials require multiple applications • Allow 15 days between application and grazing, feeding, or harvesting of alfalfa
Diuron (Karmex, Direx)	Established stands	Winter annuals Broadleaf Some grasses	• Persists in soil for one year, so cannot be used in last year of stand
EPTC (Eptam)	Established stands	Summer grasses Nutsedge	• Applied before germination • Controls for 30 to 45 days so repeated applications may be necessary

Hexazinone (Velpar)	6 inches of root growth in new stands or established stands	Broadleaf Grasses Common groundsel Chickweed miners Lettuce annual Bluegrass dandelion Buckhorn plantain Speedwell	• Many crops cannot be planted for 18 months without yield damage
Imazamox (Raptor)	2-4 trifoliolate or established stands	Winter annual Grasses Broadleaf	• Preharvest interval is 20 days
Imazethapyr (Pursuit)	2-4 trifoliolate or established stands	Winter annuals Mustards Shepherd's purse Creeping swinecress Chickweed	• Follow-up planting restrictions range from 4 to 40 months
Metribuzin (Sencor)	Established stands	Lamb's-quarters Wild mustard Redroot pigweed Common ragweed Shepherd's-purse Lady's-thumb Velvetleaf Jimsonweed Prostrate pigweed Russian thistle Yellow wood-sorrel Prickly mallow Chickweed Cocklebur Carpetweed Dandelion seedlings Barnyard grass Crab grass Foxtail Fall panicum Witch grass Johnson grass Cheat grass	• No grazing or harvesting allowed for 28 days following application
Norfluzaon (Solicam)	Established stands	Broadleaf Grasses Nutsedge	• Cannot be applied within 28 days of harvest • Does not control emerged weeds • 24 month rotation interval
Paraquat (Gramoxone Inteon)	3, 6, or 9 trifoliolate; established stands	Broad spectrum	• Rescue treatment when weeds form a canopy over alfalfa • No harvest or grazing until 60 days after application • Often used in the last year of the stand
Pronamide (Kerb)	First trifoliate leaf stage	Perennial grasses Quack grass Annual grasses Volunteer cereals Common chickweed	• No grazing or harvesting allowed for 120 days following application
Sethoxydim (Poast)	2-4 trifoliolate or established stands	Summer grasses Yellow foxtail Green foxtail Barnyardgrass Bermudagrass Johnsongrass Goosegrass	• Well established perennials require multiple applications
Terbacil (Sinbar)	Established stands	Barnyard grass Bluegrass Crab grass Foxtail Chickweed Cheat grass Perennial rye grass Wild barley Mustard Prickly lettuce Stinkweed Annual sow-thistle Henbit Lamb's-quarters Pigweed	• Can not plant any other crop for 2 years after Sinbar application

		Purslane Ragweed Partial control of: Quack grass Horsenettle Vetch Yellow nut sedge	
Trifluralin (Treflan/TR-10)	Established stands	Summer grasses	• Applied before germination • Rainfall or sprinkler irrigation is required within 3 days after irrigation to incorporate the herbicide • Controls dodder before germination

2.2.3 GT Farming

GT alfalfa can be integrated into conventional farming practices. Farming GT alfalfa is mostly the same as farming conventional alfalfa, with two important exceptions. Weeds can be controlled by the application of glyphosate directly on top of growing alfalfa and, when alfalfa stands reach the end of their life cycle (typically after 3-8 years depending on growing region), glyphosate cannot be used to kill the stand to prepare for another rotation (Miller et al., 2006). In GT alfalfa, herbicides other than glyphosate combined with tillage are required to obtain 100 percent removal. Several of the recommended GT alfalfa stand removal herbicides result in restrictions regarding what crops can be planted next, so careful crop rotation plans are necessary when using GT alfalfa. Stand removal is discussed in the technical report *Effects of Changes in Farming Practices on Water, Soil and Air Due to Use of Glyphosate-Tolerant Alfalfa* (appendix J).

Another important difference to some farmers is that non-GT crops cannot be used as companion crops for GT alfalfa. For farmers that plant pure alfalfa stands this difference does not matter. For farmers that traditionally use companion crops, this difference is important. Companion crops can increase overall forage yield but decrease hay quality (McCordick et al., 2008).

2.2.4 Crop Rotation in Alfalfa

For weed, insect, and disease management, it is recommended that alfalfa be used in rotation with other crops. It is also advised to rotate alfalfa because mature alfalfa produces medicarpin, which is auto toxic to seedling alfalfa (Guerena and Sullivan 2003). This autotoxicity is the primary problem for alfalfa seeded after alfalfa (Jennings, no year). Table G-2 presents rotation recommendations for control of several common alfalfa pests.

Table G-2. Recommended Rotations for Pest Reduction (Goodell 2006)

Pest	Recommended Rotation
Root knot nematode	1 year rotation with cotton
Stem nematode	3-4 year rotation with small grains, beans, cotton, corn, sorghum, lettuce, carrots, tomatoes, or forage grasses.*
Diseases: Bacterial wilt Anthracnose Spring blackstem Common leafspot Stagonospora	3-4 year rotation with small grains, beans, corn, sorghum, forage grasses.*
Winter weeds	A minimum of 1 year (preferably longer) in crops such as small grains, wheat, oats, winter forage grasses that allow the use of selective herbicides that are not registered in alfalfa.
Summer weeds	A minimum of 1 year (preferably longer) in crops such as small grains, beans, cotton, corn, sorghum, summer forage grasses that allow the use of selective herbicides that are not registered in alfalfa.
Dodder	At least 2 years with cotton or other nonhost crops such as small grains, beans, corn, sorghum, or forage grasses. Avoid rotations with crops such as tomatoes, onions, and carrots that also serve as a host for this weed.
Nutsedge	Two year rotation with corn or sorghum rotation that includes application of herbicide to control nutsedge.

* Three to four-year rotations give satisfactory results. A rotation for fewer years will provide minimal suppression.

Herbicides that can be used to remove GT alfalfa have rotation restrictions. For example, following clopyralid (Curtail® or Stinger®), pea, lentil, potato, and dry bean cannot be planted for 18 months. Picloram (Tordon®) can only be followed by grasses for the year after application. Sunflower, dry bean, and potato should not be planted for several years following picloram (Miller et al., 2006). Dicamba (Banvel®) should not be used prior to soybean and is also limited seasonally in California (Dillehay and Curran 2006). Because of these restrictions, alfalfa stand removal and rotation schedules should be closely coordinated. Non-glyphosate herbicides are available to manage alfalfa volunteers in wheat, oats, barley, sugar beet, and corn. Therefore rotations from GT alfalfa to those crops should be similar to rotations with non-GT alfalfa (Rogan and Fitzpatrick 2004).

Smother crops planted before alfalfa can suppress weeds. For example, sorghum-sudangrass hybrid or foxtail millet both suppressed weeds and enhanced subsequent alfalfa establishment (Forney et al., 1985).

No-till GT corn can be planted directly into alfalfa. In a study comparing no-till GT corn planted into cut or uncut alfalfa and various herbicide applications to control the alfalfa, corn yield was 13% higher following herbicide applications to uncut alfalfa. Application of glyphosate and dicamba at planting resulted in the greatest corn yield. Given that alfalfa is also a valuable crop, whether the corn yield gain is worth the loss of an alfalfa harvest should be weighed (Glenn and Meyers 2006).

2.3 Alfalfa Growing Regions

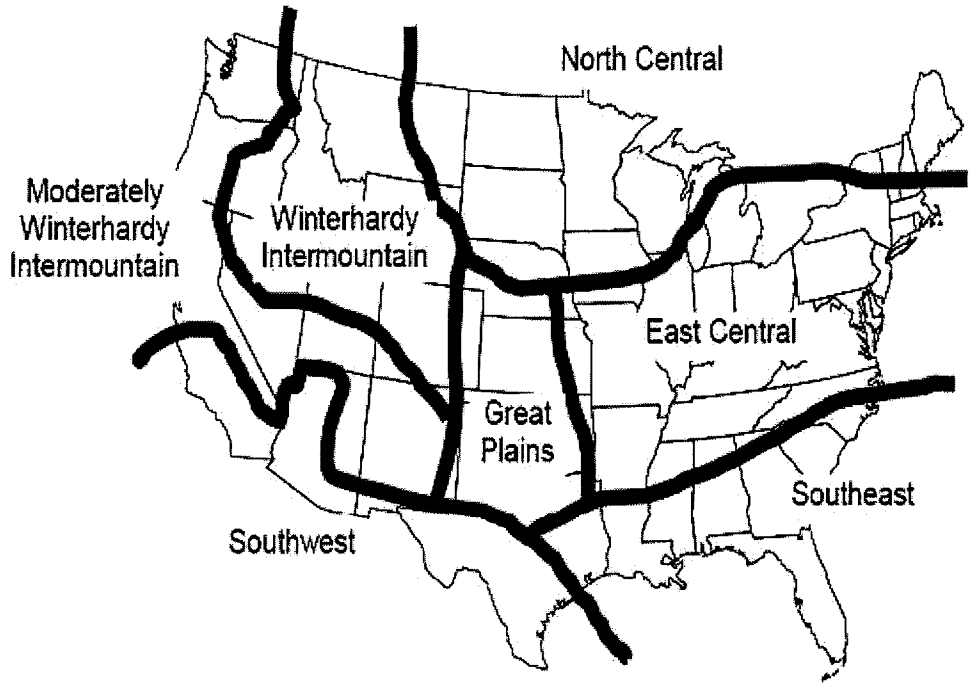

Figure G-1: Alfalfa growing regions (Rogan and Fitzpatrick 2004)

The Association of Official Seed Certifying Agencies, National Alfalfa and Miscellaneous Legumes Variety Review Board and USDA Plant Variety Protection Office recognizes seven growing regions in the United States, Moderately Winterhardy Intermountain, Winterhardy Intermountain, Southeast, Great Plains, North Central, East Central, and Southeast (figure G-1) (http://www.aosca.org/VarietyReviewBoards/Alfalfa.html). In addition, the Pacific Northwest, which includes Moderately Winterhardy Intermountain and Winterhardy Intermountain, is also sometimes recognized as a distinct growing region.

Table G-3 and table G-4 summarize the winter survival and fall dormancy ratings for alfalfa varieties. The National Alfalfa & Forage Alliance (NAFA) publishes a list of varieties and their winter survival ratings, fall dormancy ratings, and susceptibility to 17 different crop stresses (e.g., diseases, insects, grazing). The list is updated yearly and the 2007/2008 version lists 242 varieties of alfalfa (NAFA 2008). When selecting a variety, farmers consider yield, stand persistence, dormancy, pest and disease resistance, herbicide resistance, hay quality, price, seed certification, and other factors that may be specific to their farming situation (Orloff et al., 1997).

Table G-3. Winter Survival Ratings

Category	Check Variety	Score
Superior	ZG 9830	1
Very Good	5262	2
Good	WL325HQ	3
Moderate	G-2852	4
Low	Archer	5
Non Winterhardy	Cuf 101	6

Table G-4. Fall Dormancy Ratings

Check Variety	Rating
Maverick	1
Vernal	2
5246	3
Legend	4
Archer	5
ABI 700	6
Dona Ana	7
Pierce	8
CUF 101	9
UC-1887	10
UC-1465	11

1 is very dormant, 11 is extremely non-dormant

Table G-5 presents the U.S. states in order of percentage of alfalfa harvest (in 2005). For each state, the growing region, the percentage of the total national harvest of all alfalfa are presented for 2002, 2005, and 2007; and the percentage of the national organic certified harvest are presented for 2002 and 2005. In 2005, the most recent USDA organic harvest report, 22,439,000 acres of dry hay alfalfa was harvested and 204,380 (0.9 percent) of those acres were certified organic. The number of acres harvested in a state does not indicate the quantity of the harvest. For example, as shown in table G-5, because of the growing season length, California ranks top in production (in 2007, ~11 percent of the national harvest and ~7 million pounds) and South Dakota ranks second (in 2007, ~6.8 percent of the national harvest and ~4 million pounds) even though South Dakota has ~2 million acres and California has less than 1 million acres of alfalfa.In addition, even though the Northeastern states rank low in the percentage of acres and quantity of harvest, alfalfa is the number one crop for several of those states (NAFA 2007).

Table G-5. Alfalfa Growing Regions and Percentage of Dry Hay Harvest by State

State	Growing Region	Percent of harvest acres			Percent of organic harvest	
		2002	2005	2007	2002	2005
South Dakota	North Central	10.57	10.70	9.86	8.58	6.82
Montana	Winter Hardy Intermountain	6.76	7.80	9.23	3.66	2.60
North Dakota	North Central	6.13	7.35	7.20	11.22	10.09
Wisconsin	North Central	7.32	6.91	7.50	16.34	14.38
Minnesota	North Central	5.59	6.02	4.67	6.40	10.44
Iowa	North Central	5.16	5.57	4.10	6.11	4.50
Nebraska	North Central	5.92	5.57	5.36	2.71	4.01
Idaho	PNW-Intermountain	4.57	5.08	5.12	24.69	24.22
California	Moderate Winter Hardy Intermountain/ Southwest	5.19	4.63	4.88	2.92	6.48
Michigan	East Central	3.56	4.01	3.45	2.07	0.35
Kansas	Great Plains	4.14	3.79	3.92	1.40	0.32
Colorado	Winter Hardy Intermountain	3.40	3.57	4.25	3.45	4.38
Wyoming	Winter Hardy Intermountain	2.16	2.67	3.33	0.19	0.84
Utah	Moderate Winter Hardy Intermountain	2.48	2.41	2.71	0.60	0.45
Ohio	East Central	2.71	2.27	2.16	1.89	0.50
Pennsylvania	East Central	2.96	2.27	2.35	0.96	0.60
Missouri	East Central	1.77	2.01	1.46	0.23	0.58
New York	East Central	2.90	2.01	2.22	1.34	0.16
Washington	PNW-Intermountain	2.37	2.01	2.22	1.19	0.56
Illinois	East Central	1.84	1.78	1.59	0.80	1.22
Oregon	PNW-Intermountain	2.15	1.78	2.12	0.42	3.23
Indiana	East Central	1.41	1.52	1.19	0.03	0.29
Oklahoma	Great Plains	1.54	1.43	1.65	0.00	0.04
Kentucky	East Central	1.37	1.16	1.33	0.00	0.01
Nevada	Moderate Winter Hardy Intermountain	1.34	1.16	1.35	1.25	1.47
Arizona	Moderate Winter Hardy Intermountain/ Southwest	1.03	1.16	1.27	0.91	0.24
New Mexico	Moderate Winter Hardy Intermountain	0.83	1.07	1.17	0.14	0.33
Texas	Great Plains/ Southwest/ Southeast	0.72	0.67	0.76	0.18	0.55
Virginia	East Central	0.62	0.49	0.44	0.31	0.14
Vermont	East Central	0.20	0.20	0.16	0.00	0.00
Maryland	East Central	0.25	0.18	0.20	0.00	0.01
Tennessee	East Central	0.13	0.16	0.10	0.00	0.00
West Virginia	East Central	0.23	0.16	0.14	0.00	0.00
New Jersey	East Central	0.12	0.11	0.10	0.00	0.00
Arkansas	East Central	0.07	0.09	0.06	0.00	0.00
Massachusetts	East Central	0.07	0.06	0.05	0.00	0.00

State	Growing Region	Percent of harvest acres			Percent of organic harvest	
		2002	2005	2007	2002	2005
Maine	North Central	0.06	0.05	0.05	0.00	0.17
North Carolina	Southeast	0.10	0.05	0.05	0.00	0.00
Connecticut	East Central	0.04	0.04	0.04	0.00	0.05
New Hampshire	East Central	0.04	0.04	0.03	0.00	0.00
Delaware	East Central	ND	0.02	0.02	0.00	0.00
Rhode Island	East Central	0.01	0.01	0.01	0.00	0.00
Florida	Southeast	0.02	0.00	0.03	0.00	0.00
Georgia	Southeast	0.01	0.00	0.01	0.00	0.00
Louisiana	Southeast	0.03	0.00	0.01	0.00	0.00
Mississippi	Southeast	ND	ND	0.02	ND	ND
South Carolina	Southeast	0.01	0.00	0.02	0.00	0.00
Alabama	Southeast	0.04	ND	0.04	0.00	ND
Alaska		0.00	ND	0	0.00	ND
Hawaii		ND	0.00	0.00	0.00	0.00

ND = no data provided by USDA

Other differences in alfalfa farming are revealed by examining the number of farms that grow alfalfa and the number of farms that irrigate. Comparison of California and Wisconsin (table G-6) shows that in California ~97 percent of the farms irrigate, whereas in Wisconsin only 0.5 percent of the farms irrigate. In addition, the average farm size in California is much larger than in Wisconsin. It should be noted that the average farm size calculation is a bit misleading because in California mainly two farm sizes exist, small and very large (4,000 acres). In general, because farm size does not fit a normal distribution, the average farm size does not give a full picture of farm sizes. However average farm size does relay the general trend of farm size in a state. Like any census, these data may not include all alfalfa farms.

Table G-6. Alfalfa Dry Hay Harvest 2007 U.S. Agricultural Census

State	Number of Farms	Acres Harvested	Quantity (pounds) Harvested	Farms Irrigated	Acres Irrigated	% of Acres	% of Pounds	Avg. Acres per Farm
United States	290,726	20,244,497	65,349,074	56,390	6,556,652	100.0	100.0	70
California	3,587	986,982	7,057,014	3,488	963,086	4.9	10.8	275
South Dakota	12,653	1,996,599	4,414,338	716	75,913	9.9	6.8	158
Idaho	8,817	1,037,520	4,254,543	7,605	861,092	5.1	6.5	118
Nebraska	14,820	1,085,921	3,955,881	4,405	389,516	5.4	6.1	73
Montana	9,711	1,868,756	3,936,445	5,444	703,960	9.2	6.0	192
Wisconsin	30,810	1,517,522	3,673,619	171	8,809	7.5	5.6	49
North Dakota	8,985	1,457,604	3,072,682	240	21,773	7.2	4.7	162

Iowa	22,040	830,440	3,054,729	62	1,198	4.1	4.7	38
Kansas	9,643	793,140	2,986,134	1,115	207,455	3.9	4.6	82
Colorado	8,648	861,053	2,887,865	7,347	707,234	4.3	4.4	100
Minnesota	20,398	944,775	2,671,173	384	15,603	4.7	4.1	46
Washington	4,294	448,588	2,192,001	2,822	334,005	2.2	3.4	104
Utah	7,780	548,570	2,172,218	7,413	507,798	2.7	3.3	71
Arizona	943	257,407	1,968,043	920	257,263	1.3	3.0	273
Oregon	3,569	428,812	1,777,894	3,043	380,679	2.1	2.7	120
Michigan	16,431	698,595	1,707,036	291	8,080	3.5	2.6	43
Wyoming	4,007	674,284	1,696,438	3,357	471,126	3.3	2.6	168
Pennsylvania	14,402	475,873	1,357,225	109	462	2.4	2.1	33
Ohio	15,354	437,658	1,256,174	17	536	2.2	1.9	29
Nevada	1,128	274,004	1,217,586	1,128	274,004	1.4	1.9	243
New Mexico	4,272	236,103	1,176,242	4,091	222,018	1.2	1.8	55
Illinois	12,913	322,339	1,138,512	47	906	1.6	1.7	25
Oklahoma	3,781	334,990	1,131,938	294	33,000	1.7	1.7	89
New York	7,707	450,144	1,119,421	31	901	2.2	1.7	58
Missouri	8,229	295,021	782,847	63	1823	1.5	1.2	36
Texas	2,391	153,763	721,303	1,154	98,831	0.8	1.1	64
Indiana	10,775	241,129	665,767	139	2,185	1.2	1.0	22
Kentucky	10,538	269,610	524,565	109	1,210	1.3	0.8	26
Virginia	3,063	89,213	233,807	76	679	0.4	0.4	29
Maryland	1,429	40,576	120,402	49	712	0.2	0.2	28
Vermont	571	31,769	68,624	2	(D)	0.2	0.1	56
West Virginia	1,185	28,465	62,484	5	(D)	0.1	0.1	24
New Jersey	728	20,310	51,483	39	799	0.1	0.1	28
Tennessee	1,655	20,074	45,819	28	(D)	0.1	0.1	12
Arkansas	278	11,732	28,647	15	932	0.1	0.0	42
Maine	246	10,089	23,876	0	0	0.0	0.0	41
Massachusetts	406	9,921	22,537	1	(D)	0.0	0.0	24

Connecticut	349	8,343	18,441	0	0	0.0	0.0	24
Alabama	340	7,526	16,944	13	91	0.0	0.0	22
North Carolina	758	10,322	16,755	67	360	0.1	0.0	14
Florida	141	6,951	14,993	13	1,071	0.0	0.0	49
Delaware	177	3,687	13,530	22	421	0.0	0.0	21
New Hampshire	218	5,373	13,475	5	(D)	0.0	0.0	25
South Carolina	143	4,070	8,860	20	274	0.0	0.0	28
Mississippi	159	3,931	7,113	4	35	0.0	0.0	25
Georgia	134	1,655	4,810	18	243	0.0	0.0	12
Louisiana	52	2,164	4,768	2	(D)	0.0	0.0	42
Rhode Island	63	1,035	1,806	1	(D)	0.0	0.0	16
Hawaii	5	89	267	5	89	0.0	0.0	18

D = data withheld to protect identify of individual farms

2.4 Summary of Findings

Alfalfa is grown for forage, grazing, seed production (forage and sprouts), human consumption, and honey production. The most acreage is for dry hay forage. Alfalfa is currently grown through conventional farming practices, organic farming, and in glyphosate-tolerant systems. In addition to mechanical and cultivation techniques, conventional farming allows the use of 16 different herbicides to control weeds in alfalfa. Organic farming does not allow synthetic pesticides or the use of crop varieties produced through genetic engineering. GT alfalfa allows for the application of glyphosate directly onto growing plants, which provides increased options for weed control over conventional and organic systems. In 2005, 22,439,000 acres of dry hay alfalfa was harvested and 204,380 of those acres were certified organic.

Crop rotation options may be different between conventional and GT systems. Many of the non-glyphosate herbicides have follow-up planting restrictions that limit crop rotation choices in conventional farming. Farmers using GT cropping systems are advised to include some years of non-GT crops in rotation, so there may be limitations in the use of other GT crops if GT alfalfa is used in a rotation plan.

The seven growing regions in the United States have varying optimal alfalfa varieties and farming practices, such as frequency of cutting, companion cropping, and irrigation. California, South Dakota, Idaho, Nebraska, Montana, and Wisconsin are the top six alfalfa hay producing states (in 2007). South Dakota, Montana, Wisconsin, and North Dakota, have the largest acreage of alfalfa hay. California's acreage is highly productive.

3.0 Glyphosate-Tolerant Alfalfa (Roundup Ready®)

Glyphosate-tolerant (GT)[23] alfalfa was deregulated in 2005 and by 2006, ~80,000 ha (~200,000 acres) were planted in the United States (Beckie and Owen 2007).[24] USDA APHIS lists all the counties in the United States where GT alfalfa has been planted (http://www.aosca.org/VarietyReviewBoards Alfalfa.html). GT alfalfa has been planted in 1,552 counties and 48 states. Alaska and Hawaii do not have GT alfalfa. In March of 2007 USDA published notice in the Federal Register that GT alfalfa is a regulated article and GT alfalfa seed sales and plantings were halted. GT alfalfa planted in the 2005 and 2006 growing seasons is still permitted to be harvested, but has court ordered stewardship practices to minimize risk of co-mingling GT and non-GT alfalfa (Hubbard 2008).

3.1 Using GT Alfalfa

Van Deynze et al., (2004) reported that in field trials when Roundup® (glyphosate) was applied during alfalfa stand establishment at the 3 to 4 trifoliolate stage, weeds were controlled and usually no second application was needed. Early applications allowed for late germination of weeds and later applications allowed weeds to compete with alfalfa. For example in the intermountain region applications at the unifoliolate to first trifoliolate stage resulted in invasion by prickly lettuces and henbit and required a second application. In the Southwest annual bluegrass and canarygrass germinated in early December and required a second application of glyphosate for control. The effectiveness of the first application during stand establishment is a function of which weed species are present and their germination period as well as how soon after application the alfalfa canopy covers the soil surface. In California there is period of time in the winter when alfalfa stands are dormant and rain causes winter weeds to germinate.

Recommended application of glyphosate to GT alfalfa is 0.75 to 1.5 pounds acid equivalent per acre (22 to 44 fluid ounces Roundup Weathermax 4.5S® per acre) at the three to five trifoliolate stage during stand establishment and up to five days before harvest in established stands (Dillehay and Curran, 2006). The maximum labeled rate for a single use of glyphosate on GT alfalfa is 1.55 pounds glyphosate acid equivalent per acre.

Alfalfa is polyploid (tetraploid), so small percentages (three to seven percent) of the seedlings do not have the GT trait. This is similar for other genetic traits. If glyphosate is sprayed early enough, plants containing the GT trait will fill in gaps left by dead weeds and non-GT alfalfa that was killed (Van Deynze et al., 2004). Up to six percent injury was observed after the first glyphosate application in a new stand, but was gone by the time of first harvest (McCordick et al., 2008). In GT alfalfa, crop injury from glyphosate application is much less than for other herbicides (Canevari et al, 2007).

GT alfalfa is an option for weed control; however it may not be appropriate in the following situations (Dillehay and Curran, 2006):

[23] "Resistance' and" tolerance" are usually synonyms and are often used interchangeably. In this report "tolerance" is used to indicate crop varieties that are intentionally engineered to withstand glyphosate application. "Resistance" is used to indicate weeds and weed biotypes that can withstand glyphosate application.
[24] 2.471 acres = 1 ha = 104 m²

- Alfalfa-grass mixtures and alfalfa seeded with companion/nursery crops
- Fields that have a history of low weed populations
- Fields that are rotated between alfalfa and other GT crop varieties (e.g. Roundup Ready® soybean)

McCordick et al. (2008) tested GT alfalfa in 2004 and 2005 growing seasons in field studies in Michigan. Two seeding regimes were used, clear seeded (only alfalfa seed) and oat companion crop. In both of these seeding regimes glyphosate, imazamox, and untreated conditions were tested. For the oat companion crop stands, clethodim was added to the imazamox treatment to increase control of oat. In the first year (stand establishment), temporary stunting was observed with glyphosate treatment, but it did not affect yield or stand density. Clear seeded alfalfa treated with glyphosate yielded the highest alfalfa dry matter in both years, even though combined forage yield was higher in the oat companion crop. When no herbicide was applied the oat companion crop had lower weed biomass than clear seeded alfalfa.

3.1.1 Stand Establishment

Forage alfalfa is planted in the spring and in the early fall in the Southwest and western regions. Currently trifluralin, EPTC, imazethapyr, imazamox, sethoxydim, clethodim, and bromoxynil herbicides are sometimes used during spring stand establishment and could be replaced with glyphosate if GT alfalfa is used. Use of GT alfalfa also allows weed control during late-summer and fall establishment (Rogan and Fitzpatrick 2004).

3.1.2 Stand Removal

One of the major differences between conventional alfalfa and GT alfalfa occurs during stand removal. Whereas glyphosate is often used to kill old stands of conventional alfalfa for crop rotations, GT alfalfa has to be removed through other mechanisms. Application of an herbicide (e.g., 2,4-D, dicamba (Banvel®), and clopyralid (Stinger®)) and tillage is effective. In no-till systems 2,4-D and dicamba can be applied together. However dicamba cannot be used before planting soybean (Dillehay and Curran, 2006).

Renz 2007 reported that dicamba and 2,4-D (WeedMaster®) applied at 2 pt/A achieved zero resprouting of alfalfa in the spring following herbicide application. Lower concentrations of WeedMaster resulted in 0.3 to 2.5 percent resprouting. The other herbicides applications (dicamba or 2,4-D only) resulted in 0.5 to 26.5 percent resprouting. In another study, picloram and 2,4-D was more effective than dicamba and 2,4-D (Miller et al., 2006). Combined with plowing, clopyralid, clopyralid plus 2,4-D, dicamba plus 2,4-D, picloram, and picloram plus 2,4-D all controlled alfalfa 100 percent. Plowing alone provided 75 percent control (Miller et al., 2006).

Potential effects of changes in tillage practices due to the use of GT alfalfa are discussed in the technical report *Effects of Changes in Farming Practices on Water, Soil and Air Due to Use of Glyphosate-Tolerant Alfalfa* (appendix K).

Figure G-2 shows Monsanto's guidance for GT alfalfa stand removal (Monsanto 2008).

STAND TAKEOUT AND VOLUNTEER MANAGEMENT

Crop rotations can be divided into two main groups, alfalfa rotated to: 1) grass crops (e.g. corn and cereal crops); and 2) broadleaf crops. More herbicide alternatives exist for management of volunteer alfalfa in grass crops. The recommended steps for controlling volunteer Roundup Ready Alfalfa are:

Diligent Stand Takeout

Use appropriate commercially available herbicide treatments alone for reduced tillage systems or in combination with tillage to terminate the Roundup Ready Alfalfa stand. Refer to your regional technical bulletin for specific stand takeout recommendations. NOTE: Roundup agricultural herbicides are **not** effective for terminating Roundup Ready Alfalfa stands.

Start Clean

If necessary, utilize tillage and/or additional herbicide application(s) after stand takeout, and before planting of the subsequent rotational crop to manage any newly emerged or surviving alfalfa.

Plan for Success

Rotate to crops with known and available mechanical or herbicidal methods for managing volunteer alfalfa, keeping in mind that Roundup agricultural herbicides will not terminate Roundup Ready Alfalfa stands.

- Rotations to certain broadleaf crops are not advisable if the grower is not willing to implement recommended stand termination practices.
- In the event that no known mechanical or herbicidal methods are available to manage volunteer alfalfa in the desired rotational crop, it is suggested that a crop with established volunteer alfalfa management practices be introduced into the rotation.

Timely Execution

Implement in-crop mechanical or herbicide treatments for managing alfalfa volunteers in a timely manner; that is, before the volunteers become too large to control or begin to compete with the rotational crop.

Figure G-2: Monsanto's guidance for GT alfalfa stand removal (Monsanto 2008)

3.2 Volunteer GT Alfalfa

Crop rotation is the practice of alternating crop species in the same field in different years. Crops are considered volunteer when they grow in a field during a year when they have not been planted intentionally. Volunteer crops are weeds because they compete with the current crop for resources and they may harbor insect and disease pests. For example, volunteer GT cotton in GT soybean can harbor boll weevil. Boll weevil is a serious cotton pest and is monitored aggressively in cotton for eradication. However boll weevil is not monitored in soybean (York, et al., 2004).

Volunteer GT crops have to be controlled through the use of other herbicides. For example GT wheat and canola is best controlled through paraquat and diuron (Rainbolt et al., 2004). Volunteer GT canola needs to be controlled before replanting canola because cultivars with different resistance genes can cross and result in multiple herbicide resistance (Rainbolt et al., 2004).

Herbicides that are used to control alfalfa, including GT alfalfa include (Rogan and Fitzpatrick 2004; Renz 2007; Dillehay and Curran, 2006; Miller et al., 2006):

- 2,4-D
- Clopyralid
- Dicamba
- Dicamba and diflufenzopyr
- Glufosinate
- Primsulfuron-methyl

- Mixtures of dicamba, 2,4-D, and clopyralid
- Picloram
- Picloram and 2,4-D
- Halsulfuron and dicamba
- Acetochlor
- Acetochlor and atrizine
- Acetochlor and atrizine and dicamba
- Atrizine and dicamba
- Clopyralid and flumetsulam

Monsanto demonstrated in their Deregulation Petition that the last five herbicides and mixes on the above list can control volunteer GT alfalfa in corn (Rogan and Fitzpatrick 2004). Clopyralid is effective at controlling volunteer alfalfa in broccoli (Tickes 2002). Clopyralid or 2,4-D provide control of volunteer alfalfa in 33 different crops. Exceptions include potatoes and popcorn (Rogan and Fitzpatrick 2004).

Feral alfalfa (alfalfa not in fields) is discussed in more depth in the technical report *Effects of Glyphosate-tolerant Weeds in Non-agricultural Ecosystems* (appendix H).

3.3 Summary of Findings

GT alfalfa allows for flexibility in timing of glyphosate application to control weeds. In the two years that GT alfalfa seed was on the market ~200,000 acres were planted in 1,552 counties in 48 states.

Glyphosate is the primary tool used to remove conventional alfalfa stands. Use of herbicides other than glyphosate for removal of GT alfalfa is a major difference between GT alfalfa and conventional alfalfa. Non-glyphosate herbicides and tillage are recommended for effective GT alfalfa stand removal.

Farmers are not able to use glyphosate to control volunteer GT alfalfa in other GT crops. However, eleven other herbicides and mixtures of those herbicides are available to control volunteer GT alfalfa. These are the same herbicides that are used to control non-GT alfalfa with the exception that glyphosate can be used to control non-GT alfalfa.

4.0 Weeds in Alfalfa

Although weeds can be a problem in alfalfa, once alfalfa is established, it acts as a suppressor of weeds and is commonly used in rotations for weed reduction. For example, prior rotation in alfalfa can reduce weed densities in sunflower to the same level as herbicide treatment and alfalfa in corn rotations also benefited corn yield and suppressed weeds (Clay and Aguilar 1998). Fields with a history of perennial weed infestation are not well suited for alfalfa (Canevari et al, 2007).

Wilson (1981) tested seven herbicides on dormant alfalfa in Nebraska and found good weed control that resulted in increased protein and total digestible nutrients (except for hexazinone application) compared to untreated control plots. Weeds that were successfully controlled included kochia, downy brome, tansymustard, Russian thistle, and prickly lettuce. Out of 48 weeds in alfalfa listed by the University of California Pest Management Guidelines, five weeds are not controlled by glyphosate: green foxtail, filed bindweed, yellow nutsedge, buckhorn plantain, and burning nettle. There was no data on pepperweeds. Three weeds stand out (field bindweed, yellow nutsedge, and buckhorn plantain) because they are not controlled well by glyphosate or any of the other 16 herbicides evaluated (table VII-3 in Rogan and Fitzpatrick 2004).

A list of 129 weeds that are known to infest alfalfa are in Appendix G-3 of this technical report, including the U.S. region where they are most prevalent as well as their scientific and common names.

General rules for managing weeds at establishment or in the seedling year include (Loux et al., 2007):

- Weeds that emerge with the crop are generally more destructive.
- Maintain the forage relatively weed-free for the first 60 days.
- Weeds that emerge beyond 60 days will not influence that year's forage yield.
- Later-emerging weeds may still influence forage quality.
- Winter annual weed competition in early spring is most damaging to forages.
- Broadleaved weeds are generally more competitive against legumes than grassy weeds.

4.1 Glyphosate Resistance in Weeds

Herbicide resistance can be defined as the inherited ability of a weed population to survive and reproduce following a herbicide application that is normally lethal to the vast majority of individuals of that species (lethal to the wild type) (Puricelli and Tuesca, 2005; Stoltenberg and Jeschke, no year). Farmers are concerned about glyphosate-tolerant weeds (Johnson and Gibson 2006). Figure G-3 represents the different weed populations in alfalfa. Since 1998, 14 new glyphosate resistant weeds have been found globally. Nine of these have glyphosate resistant biotypes in the United States. Eight of the new glyphosate resistant weeds known globally are also known to be weeds in alfalfa stands (see Appendix G-3 in this technical report for list of weeds in alfalfa). At least 21 weeds that have natural resistance to glyphosate exist. Ten of these naturally glyphosate resistant weeds are known to be a problem in alfalfa. Table G-7 lists the weeds known to be glyphosate resistant in general or have glyphosate resistant biotypes. Figure G-4 summarizes the results of a recent farmer survey regarding their satisfaction with GT alfalfa and which weeds were controlled.

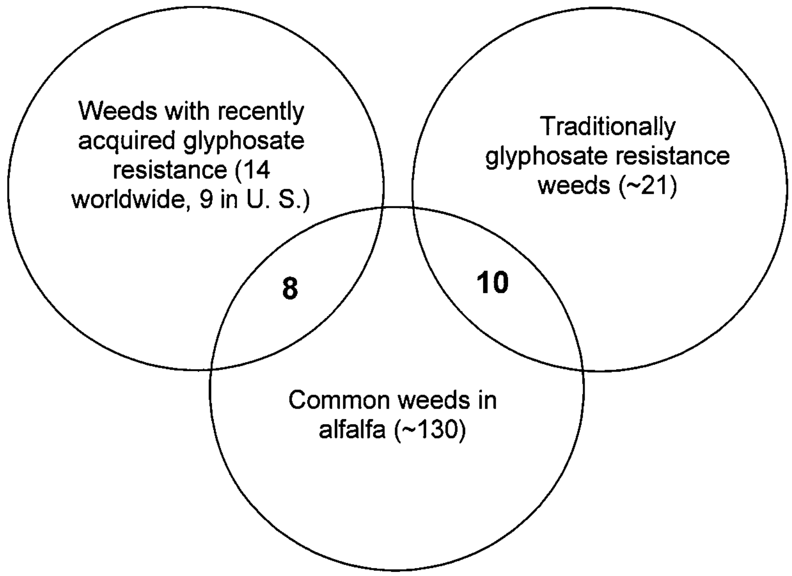

Figure G-7: Weeds in alfalfa

Table G-7. Glyphosate-resistant weeds

Common Name	Scientific Name	Resistant Biotype Reported in U.S.	Identified Problem in Alfalfa (Appendix G-3)	Listed on Roundup® Label	Source
Recently Evolved or Selected Resistant Biotypes					
Common Ragweed	*Ambrosia artemisiifolia*	Yes	Yes	Yes (with resistant biotype note)	Heap et al., 2008
Common Waterhemp	*Amaranthus rudis* and *Amaranthus tuberculatus*	Yes	No	Yes (with resistant biotype note)	Heap et al., 2008; Nandula et al., 2005
Giant Ragweed	*Ambrosia trifida*	Yes	No	Yes (with resistant biotype note)	Heap et al., 2008
Hairy Fleabane	*Conyza bonariensis*	Yes	No	Yes	Heap et al., 2008; Nandula et al., 2005
Horseweed	*Conyza canadensis*	Yes	Yes	Yes (with resistant biotype note)	Heap et al., 2008; Nandula et al., 2005

Italian Ryegrass	*Lolium multiflorum*	Yes	Yes	Yes (with resistant biotype note)	Heap et al., 2008; Nandula et al., 2005
Johnsongrass	*Sorghum halepense*	Yes	Yes	Yes (mixture also recommended)	Heap et al., 2008
Palmer Amaranth	*Amaranthus palmeri*	Yes	Yes	Yes (with resistant biotype note)	Heap et al., 2008
Rigid Ryegrass	*Lolium rigidum*	Yes	No	Yes (with resistant biotype note)	Heap et al., 2008; Nandula et al., 2005
Buckhorn Plantain*	*Plantago lanceolata*	No	Yes	No	Heap et al., 2008
Goosegrass	*Eleusine indica*	No	Yes	Yes	Heap et al., 2008; Nandula et al., 2005
Junglerice	*Echinochloa colona*	No	Yes	Yes (mixture also recommended)	Heap et al., 2008
Sourgrass	*Digitaria insularis*	No	No	No	Heap et al., 2008
Wild Poinsettia	*Euphorbia heterophylla*	No	No	No	Heap et al., 2008

Historically Naturally Resistant					
Asiatic dayflower	*Commelina communis*		No	No	Nandula et al., 2005
Birdsfoot trefoil	*Lotus corniculatus*		No	No	Nandula et al., 2005
Bermudagrass	*Cynodon dactylon*		Yes	Yes (partial control notes)	Cerdeira and Duke 2006
Burning nettle	*Urtica uren*		Yes	No (mixture recommended)	Van Deynze et al., 2004; Canevari et al., 2004
Cheeseweed	*Malva parviflora*		Yes	No (mixture recommended)	Van Deynze et al., 2004
Chinese foldwig	*Dicliptera chinensis*		No	No	Nandula et al., 2005
Common lambsquarters	*Chenopodium album*		Yes	Yes (mixture also recommended)	Nandula et al., 2005

Field bindweed*	*Convolvulus arvensis*		Yes	No (mixture recommended)	Nandula et al., 2005
Filaree	*Erodium* spp.		Yes	Yes (mixture also recommended)	Van Deynze et al., 2004
Florida pellitory	*Parietara debilis*		No	No	Cerdeira and Duke 2006
Hemp sesbania	*Sesbania exalta*		No	Yes	Cerdeira and Duke 2006
Large crabgrass	*Digitaria sanguinalis*		Yes	Yes (mixture also recommended)	Cerdeira and Duke 2006
Morning glory	*Ipomoea purpurea*		Yes	Yes (mixture also recommended)	Hilgenfeld et al. (2004; Cerdeira and Duke 2006
Nutsedge*	*Cyperus* spp.		Yes	Yes	Cerdeira and Duke 2006
Oval-leaf false buttonweed	*Spermacoce latifolia*		No	No	Cerdeira and Duke 2006
pillpod sandmat	*Chamaesyce hirta*		No	No	Cerdeira and Duke 2006
Purslane	*Portulaca oleracea*		Yes	Yes (mixture also recommended)	Van Deynze et al., 2004
Tropical Mexican clover	*Richardia brasiliensis*		No	No	Cerdeira and Duke 2006
Tropical spiderwort	*Commelina benghalensis*		No	No	Nandula et al., 2005
Velvet leaf	*Abutilon theophrasti*		No	Yes (mixture also recommended)	Nandula et al., 2005
Waterhemp	*Amarathus rudis and A. tuberculatus*		No	Yes (with resistant biotype note)	Cerdeira and Duke 2006

Cline 2004 reports that fleabane and henbit are also difficult to control with glyphosate. * These 3 weeds are not fully controlled by any of the 16 herbicides listed in the University of California Pest Management Guidelines (Rogan and Fitzpatrick 2004).

Survey of GT Alfalfa Farmers

Canevari (2007) reported survey results from interviews with alfalfa growers and industry representatives from California, Idaho, Nevada, Arizona, Washington, and New Mexico (43 respondents). The major weeds in alfalfa that were controlled by using a GT alfalfa system are listed below. Weeds that were cited as causing problems in alfalfa but were not mentioned by farmers as being controlled by glyphosate are highlighted in grey. A more comprehensive list of weeds in alfalfa is in appendix B.

Of the 24 growers surveyed all were satisfied with GT alfalfa. Advantages included less herbicide needed, yield increase, control of volunteer crops, excellent weed control, hay quality increase, better stand and water efficiency. Farmer concerns were that the seed is no longer available, the need for bale identification due to court order, and reluctance of the horse market. For the pest consultants, dealers, and researchers, concerns included export concerns, seed costs, weed resistance, weed shifts, market acceptance.

Bindweed	Dandelion	Knapweed	Morningglory
Bur clover	Dodder	Knotweed	Nutsedge
Canada thistle	Fiddleneck	Kochia	Pepperweed
Cocklebur	Foxtail	London rocket	Plantain
Common groundsel	Hoary cress	Lovegrass	Pigweed
Curly dock	Johnson grass	Mexican tea	Quackgrass
			Water grass

Figure G-4: Survey of GT alfalfa farmers

The 18 weed species (table G-7) that are both resistant to glyphosate and traditionally present problems in alfalfa likely pose the greatest threat for weed shifts in a GT cropping system. Eight weeds with newly identified resistance and ten weeds known to have some natural resistance to glyphosate are briefly described below.

4.1.1 New Glyphosate Resistant Weeds

Glyphosate resistant biotypes have recently been identified for the following eight weeds that are also common in alfalfa: common ragweed, horseweed, Italian ryegrass, Johnsongrass, Palmer Amaranth, buckhorn plantain, goosegrass, and junglerice. Each is briefly discussed below.

Common ragweed (*Ambrosia artemisiifolia*) germinates in May and early June, flowers in August to September, and sets seed in September. Each plant can release more than 30,000, three mm-long seeds, which can remain viable for more than 39 years buried. Seeds are dispersed by water and animals and can be blown across crusted snow in the winter. Common ragweed can thrive in soil containing high amounts of clay, gravel, or sand. It is found in cropland, abandoned fields, vacant lots, fence rows, waste areas, and along roadsides and railroads. Because it can accumulate large quantities of trace metals, it is very competitive and can cause nutritional deficiencies in crops. Not only does it taste bitter to livestock but it also causes nausea and mouth sores in livestock. It is very difficult to control as it can tolerate mowing, trampling, and grazing (Lanini, no year a). Common ragweed has a biotype that has multiple herbicide resistance to acetolactate synthase (ALS) inhibitors and PPO inhibitors (Heap et al., 2008).

Horseweed (*Conyza canadensis*) is a summer or winter annual that grows 1.5 to 6 feet tall (Loux et al., 2006). It produces a large number of seeds (200,000 per plant) that are wind-dispersed. Seed dispersal in a corn field ranged from 12,500 seeds per square yard at 20 feet from the seed source, to more than 125 seeds per square yard at 400 feet from the seed source (Loux et al., 2006). Seeds can disperse a quarter mile when winds are only 10 miles per hour (Barnes et al., 2003). Seeds are able to germinate in no-till fields (undisturbed soil, includes non-crop sites) and tilled fields. Outcrossing among horseweed occurs at 1.2 to 14.5 percent which facilitates the spread of resistance traits (Stoltenberg and Jeschke, no year; Nandula et al., 2005; Loux et al., 2006). The known cases of glyphosate-resistant horseweed are characterized by frequent use of glyphosate, little or no use of alternative herbicides that control horseweed, and long-term no-tillage crop production practices (Loux et al., 2006). In addition to direct competition for light, water, and nutrients, horseweed can host the tarnished plant bug, an alfalfa pest, and the viral disease aster yellows, which is transmitted by aster leafhoppers to a wide variety of plants (Loux et al., 2006). Horseweed contains volatile oils, tannic acid and gallic acid that may cause mucosal and skin irritation in livestock (especially horses) and humans (Steckel, no year a). There are horseweed biotypes that are also resistant to ALS inhibitors. Several herbicides are effective at the rosette stage, but once horseweed is over six inches tall a three-way mixture of glyphosate, plus 2,4-D ester, plus chlorimuron or cloransulam, is recommended. Biotypes that are resistance to glyphosate and/or ALS inhibitors cannot be effectively controlled (Loux et al., 2006). In Ohio, a biotype that is resistant to both ALS inhibitors and glyphosate and a biotype in Michigan that is resistant to photosystem II inhibitors and ureas and amides have been identified (Heap et al., 2008). Over 500,000 acres in the Midwest are reported to be infested with glyphosate-resistant horseweed (Cline 2004). Others estimate that over two million acres in the U.S. are infested (Heap et al., 2008).

Italian Ryegrass (*Lolium multiflorum*) is an annual grass and is related to perennial ryegrass (*Lolium perenne*). Italian ryegrass can be intentionally cultivated with alfalfa as a companion crop and is good for grazing, hay, and silage (Hall 1992). However in cool, wet environments, it may outcompete alfalfa and, in very dry situations, it might not provide adequate ground cover (Schneider and Undersander 2008). Italian ryegrass is a weed in wheat because it stays green longer than wheat and causes cut wheat to heat and spoil (Peeper 2000). There are biotypes that exhibit multiple herbicide resistance to acetyl-CoA carboxylase (ACCase) inhibitors, ALS inhibitors, and Chloroacetamides (Heap et al., 2008). At least 5,000 acres in CA are reported to be infested with glyphosate resistant ryegrass (Cline 2004).

Johnsongrass (*Sorghum halapense*) is one of the ten most noxious weeds in the world. It is a fast-growing competitive perennial grass. Established Johnsongrass can be seven to nine feet tall and releases chemicals that inhibit surrounding plant growth. A plant produces 100 to 400 seeds that withstand silage and passage through livestock digestive systems. Seeds can germinate from 6 inches deep and are viable for three years. Stresses that interrupt normal growth, such as freezing, cutting, wilting, trampling, and herbicide exposure, can cause the release of toxic amounts of hydrocyanic acid which are poisonous to livestock. Johnsongrass is thought to be introduced from Egypt sometime after the Revolutionary War and was previously grown as forage in the south. If herbicides are not used it can be controlled by intense grazing and mowing for two years until the rhizomes are depleted. (CDFA, no year a; Lanini no year b). There are separate biotypes of Johnsongrass that have resistance to ACCase inhibitors, Dinitroanilines and ALS inhibitors (Heap et al., 2008).

Palmer amaranth (***Amaranthus palmeri***) is closely related to waterhemp and is the dominant pigweed in the Southwest. It is the most competitive and rapidly growing species of the weedy pigweeds and can reach a height of six feet (Steckel no year b). It is susceptible to herbicides when it is 4 to 6 inches tall (Scarpitti et al., 2007). Biotypes of Palmer amaranth have been identified with resistance to Dinitroanilines, photosystem II inhibitors, and ALS inhibitors (Heap et al., 2008).

Buckhorn Plantain (***Plantago lanceotata***) competes with crops for soil nutrients, water, and light and does well in droughts. It reproduces by seed and by tap root. Buckhorn plantain establishes slowly in alfalfa, but, once established, is difficult to control because of its extensive crown system (Wall and Whitesides, 2008). Glyphosate resistance is the only identified herbicide resistance in buckhorn plantain and has only been found in South Africa, so far (Heap et al., 2008).

Goosegrass (***Eleusine indica***) is an annual grass with an extensive root system that can produce 50,000 seeds per plant (Duble, no year). It is one of the five most troublesome weeds world-wide. It is found in agricultural fields, homeowner lawns, waste areas, roadsides, pastures, and golf courses. When it emerges with or shortly after a crop it can be a very competitive weed. Later in the growing season, it can produce enough biomass to hinder harvest (Steckel no year c). Some goosegrass biotypes exist that are known to be resistant to ACCase inhibitors, Bipyridiliums, Dinitroanilines, and ALS inhibitors. In Malaysia, a case of multiple resistance to ACCase inhibitors and glyphosate was found (Heap et al., 2008).

Junglerice (***Echinochloa colonum***) is a summer annual grass that is invasive in Tennessee, Hawaii, and Arizona (NPS 2007). It has little or no dormancy in tropical areas and germinates throughout the year. It can grow two to three feet high (Virginia Tech, no year). In Costa Rica, a biotype has been identified that has multiple resistance to ACCase inhibitors, ALS inhibitors, and ureas and amides. A glyphosate resistant biotype has been identified in Australia (Heap et al., 2008).

4.1.2 Traditionally Glyphosate Resistant Weeds

Ten weeds that are common in alfalfa and historically have some tolerance for glyphosate include bermudagrass, burning nettle, cheeseweed, common lambsquarters, field bindweed, filaree, large crabgrass, morningglory, nutsedge, and purslane. Each is briefly discussed below.

Bermudagrass (***Cynodon dactylon***) is a perennial grass that propagates through seed, root, or stem cuttings. If bermudagrass is cultivated, the soil should be dry because, if it is moist, the cut shoots will form new plants (Cudney and Elmore 2007). Bermudagrass is also grown as a forage crop (Undersander and Pinkerton 1988).

Burning nettle (***Urtica urens***) is a summer annual that flowers from June to November and is wind-pollinated. One plant can produce from 1,000 to 40,000 seeds. When left undisturbed in soil for six years, germination declined by 61 percent. However, 20 to 100 year-old seeds from excavations have been known to germinate. Seeds can also survive livestock digestive systems (Organic Garden 2007). Burning nettle stinging hairs contain histamine, formic acid, acetylcholine, acetic acid, butyric acid, leukotrienes, 5-hydroxytryptamine, and other irritants.

Dermal contact with the hairs leads to a mildly painful sting and itching or numbness for a period lasting from minutes to days (Thorne Research 2007). In Australia, a biotype resistant to photosystem II inhibitors has been identified (Heap et al., 2008).

Cheeseweed (*Malva neglecta*) is an annual or biennial dicot that reproduces from seeds. It is found on cultivated ground, new lawns, farmyards, and waste places (Mitich, no year). It is very competitive in alfalfa and, once established, is difficult to control. The fatty acids malvalic acid and sterculic acid may cause the plant to be toxic to horse, cattle, and sheep (Canevari 1997). Selenium or nitrate concentration has also been cited as the cause of toxicity (Hill 1993; USU, no year; Barnard, 1996).

Common lambsquarters (*Chenopodium album*) is a summer annual dicot that is adaptable to many environments. A plant can produce 100,000 seeds which can survive 30 to 40 years in soil (Lanini, no year c). Biotypes that are resistant to photosystem II inhibitors and ALS inhibitors have been identified in the United States (Heap et al., 2008). Glyphosate resistant lambsquarters has been reported in the Midwest and in a Madera, CA almond orchard (Cline 2004).

Field bindweed (*Convolvulus arvensis*) is a perennial dicot that reproduces by seed and vegetatively from deep-creeping roots and rhizomes. Young plants seldom produce seed in the first year, but one plant can produce 500 seeds. In fields, seeds can survive 20 years or more. Field binweed can harbor the viruses that cause potato X disease, tomato spotted wilt, and vaccinium false bottom. In addition, it contains tropane alkaloids and can cause intestinal problems in grazing horses (CDFA no year b).

Filaree (*Erodium cicutarium*) is a winter annual dicot that grows two to five inches high. It is adapted to a broad range of soil types and is found in oak woodlands, semi-desert grassland, desert shrublands, fields, lawns, and wasteplaces. Redstem filaree can be excellent forage for livestock and wildlife, but can cause bloating under heavy grazing (Pratt et al., 2002). It is competitive with crops and can cause yield reductions (Trainor and Bussan 2001).

Large crabgrass (*Digitaria sanguinalis*) is a summer annual that reproduces by seeds (Stritzke, no year). It is primarily a turfgrass weed, but can be founding thinning alfalfa stands (Elmore 2002). A biotype with multiple resistance to ACCase inhibitors and ALS inhibitors has been identified in Australia. Photosystem II inhibitor resistant biotypes have also been identified (Heap et al., 2008).

Morning glory (*Ipomoea purpurea*) is a perennial climbing vine that reproduces by seed (Pittwater Council, no year). It is a problem in crops because of competition. Morning glory seeds are toxic to humans (Filmer, no year). Morning glory foliage is toxic to livestock due to nitrates. Symptoms of acute nitrate poisoning are trembling, staggering, rapid breathing, and death. Chronic poisoning may result in poor growth, poor milk production and abortions. In cattle, there is evidence that vitamin A storage is affected (Robinson and Alex 1989).

Nutsedge (*Cyperus* spp.) is a hardy weed due to tubers that grow 8 to 14 inches below the ground and, when mature, can re-sprout 10 to 12 times after cutting before tuber resources are depleted. In addition, many herbicides are not translocated to tuber, and, therefore, do not effectively control growth (Wilen et al., 2003). Alfalfa should not be planted in a field where nutsedge is a known problem (Canevari et al., 2003). In a study in California, nutsedge was reduced 96 to 98 percent using crop rotation and herbicides. The rotation was two years alfalfa with applications of EPTC herbicide, two years of barley double-cropped with corn and application of thiocarbamate herbicide, and two years of barley followed by fallow glyphosate applications (Canevari et al., 2007). Biotypes of *Cyperus difformis* that are resistant to ALS inhibitors have been found in California and globally (Heap et al., 2008).

Purslane (*Portulaca oleracea*) is a summer annual dicot that produces 240,000 seeds per plant and can survive five to 40 years. It can re-root after cultivation or hoeing, so it is difficult to control mechanically. It is a minor crop in the United States because it is edible and is used in ethnic cooking. In other crops, it is a weed because of competition (Cudney et al., 2007).

4.1.3 Mechanisms of Glyphosate-Tolerance

Glyphosate inhibits 5-enolpyruvylshikimate-3-phosphate (EPSP) synthase, which is a key enzyme in the shikimate pathway in plants and is required for plant growth. The effects of glyphosate can be stopped in several ways (Cerdeira and Duke, 2006; Stoltenberg and Jeschke, no year; Nandula et al., 2005):

Resistant EPSP synthase - A version of EPSP synthase that is not affected by glyphosate has been found in bacteria (*Agrobacterium*) and has been transferred into crop plant genomes. Also, the maize version of EPSP synthase has been modified by site directed mutagenesis to be resistant to glyphosate. A version of EPSP synthase with decreased binding to glyphosate has been found in the weed goosegrass (*Eleucine indica*).

Degrade glyphosate - A glyphosate-degrading enzyme has been found in bacteria (*Ochrobactrun anathropi*) and has been transferred into crop plant genomes.

Inactivate glyphosate - An enzyme found in bacteria (*Bacillus licheniformis*) has a weak ability to inactivate glyphosate through N-acetylation. The efficiency of this enzyme was increased by directed evolution in the lab and, when transferred to plants, confers resistance to glyphosate in field settings. A fungal gene encoding glyphosate decarboxylase has been discovered and patented for eventual use in crop plants.

Altered translocation of glyphosate – There is limited evidence that, in some glyphosate resistant ryegrass, glyphosate accumulates in mature leaf tissue rather than in the growing parts. Although the mechanism of resistance in horseweed is unknown, translocation experiments suggest that resistant biotypes do not translocate glyphosate to the growing parts of the plant (e.g., roots, young leaves, and crown).

Other – Resistant plants exist for which the mechanism of glyphosate resistance is not known. In addition, it is likely that there are mechanisms of resistance that have yet to evolve.

4.2 Weed Shifts in GT Alfalfa

Adopting new weed control strategies eventually leads to shifts in the weeds that are of greatest concern. Weed shifts can occur due to changes in tillage, irrigation, soil fertility, planting date, crop rotation, and herbicide use (Hilgenfeld et al., 2004). Changes to a no-till system results in a more diverse seedbank. Within weedy species variations in characteristics help weeds escape or tolerate weed management. These characteristics include seed dormancy, emergence patterns, growth plasticity, life cycle, life duration, shade tolerance, late-season competitive ability, seed dispersal mechanisms, and morphological and physiological variations (Hilgenfeld et al., 2004).

Because weed seedbanks in the soil can contain large reservoirs of dormant weed seed, short-term studies (a few years) might not detect the full potential shift in weed communities (Harker et al., 2005). However sometimes weeds shift can be observed within a few years. For example, in a field trial in an established GT alfalfa stand in the Southwest (San Joaquin Valley) burning nettle was not controlled and the population of burning nettle increased significantly over the three-year trail period (Canevari et al., 2004; Van Deynze et al., 2004). Tank mixtures with Velpar (hexazinone) or paraquat controlled burning nettle. Weeds that are difficult to control with glyphosate, such as dodder and cheeseweed, may need to be treated early and require a second application. Van Deynze et al (2004) recommend that the best way to prevent weed shifts is to avoid using the same herbicide year after year, rotate herbicides and crops, and include non-herbicide strategies to control weeds.

Puricelli and Tuesca (2005) found that continuous (once before planting, once at 40 days after planting, once in winter fallow in August) glyphosate application in field studies on three crop rotation sequences and two tillage systems lead to quantitative and qualitative changes in weed communities. They found that glyphosate application was a more important factor than crop sequence to explain weed community changes in summer crops. They also predicted that continual glyphosate application for longer than the five years in their study might lead to the development or higher increases in abundance of weeds tolerant to glyphosate. Weed species diversity in conventional versus no-tillage plots did not differ significantly.
Harker et al., (2005) reported that field studies of spring wheat-canola-spring wheat rotations of various combinations of GT and non-GT varieties under conventional tillage or low soil disturbance direct seeding systems indicate that weed community shifts are dependent on rotation pattern in a site-dependent manner. In the western Canada field locations, within 3 years, crop systems without GT varieties were associated (using canonical discriminant analysis) with green foxtail, redroot pigweed, sowthistle spp., wild buckwheat, and wild oat. The specific weeds associated with all GT variety systems included Canada thistle at the Brandon site, henbit at the Lacombe site, and volunteer wheat, volunteer canola, and round-leaved mallow at the Lethbridge site. One surprising finding was that high variability in wild buckwheat between the systems. Glyphosate is not very effective on wild buckwheat, so the authors propose that wild buckwheat seed production or viability may be restricted by glyphosate more than the wild buckwheat biomass. Therefore after glyphosate application the plant may appear visually robust, but its ability to reproduce has been effected, so in following years less wild buckwheat is observed (Harker et al., 2005).

It is plausible that the 18 weeds discussed in section 4.1 are the first candidates for weed shifts in GT alfalfa. However, as discussed in the studies summarized above, weed shifts are dependent on the composition of the weed seedbank in the soil and surrounding sources of weeds.

4.2.1 Weed Management Options

Weed management strategies in organic alfalfa systems, conventional alfalfa systems, and glyphosate-tolerant alfalfa systems differ. Management options for conventional systems include (Nandula et al., 2005; Guerena and Sullivan 2003):

- Chemical (See table G-6)
    - Alternating herbicides with different modes of action
    - Tank mixing herbicides
    - Sequences of herbicides
    - Application timing
- Cultural
    - Rotation between GT cultivars and non-GT cultivars
    - Winter crops in rotation
    - Companion crops/co-cultivation/interseeding/nurse crop)
    - Cover crops (smother crops) (prior to planting alfalfa)
    - Field scouting for early detection
    - Monitor for weed species and population shifts
- Mechanical
- Tillage cultivation

Organic alfalfa systems can use the cultural and mechanical strategies (except for use of GT cultivars). Nurse crops of peas or oats produce good hay for the horse market (Guerena and Sullivan 2003). GT alfalfa systems can use all of the strategies of conventional systems plus application of glyphosate directly on growing alfalfa. Options for rotating between GT cultivars and non-GT cultivars are reduced with GT alfalfa, since GT corn and GT soybean are popular rotation crops for alfalfa.

Cutting intervals affect weed infestation. For example, if alfalfa is cut too frequently (20 to 25 days) there is not enough time for root storage of carbohydrates so growth after cutting is not vigorous and weeds have a competitive advantage. However sometimes early harvest can rescue a heavily weed-infested new stand if the weeds are beyond the stage of optimum herbicide treatment (Canevari et al, 2007). Alternating long and short intervals between cuttings enables alfalfa to maintain root reserves so plants can recover from defoliation quickly and more vigorously compete with weeds (Canevari et al, 2007).

4.3 Distribution of Glyphosate Resistant Weeds

Table G-8 shows that currently 19 U.S. states are affected by glyphosate resistant weeds. The majority of new glyphosate resistant weeds are located in the Southeast and Midwest. The overlap with the major alfalfa producing states in the Intermountain regions seems to be minimal at this point (table G-6). However, given that there is overlap between glyphosate resistant weed locations and alfalfa hay acreage there is potential for rapid shifts of glyphosate resistant weeds into GT alfalfa fields if GT alfalfa were to be widely adopted. California is a concern because glyphosate resistant weeds are present and alfalfa is a major crop in California. More detailed records of local weed infestations may be kept by state extension offices.

Table G-8. Glyphosate-Resistant Weed Infestations by State (Heap et al., 2008)

State	Weed species	~ Number of Sites in State Infested	~ Number of Acres in State Infested	Situation	Year Reported
Arkansas	***Conyza canadensis*** Horseweed	6-10 increasing	1,001-10,000 increasing	Cotton	2003
	Ambrosia artemisiifolia Common Ragweed	1	11-50	Soybean	2004
	Ambrosia trifida Giant Ragweed	6-10 increasing	101-500 increasing	Soybean	2005
	Amaranthus palmeri Palmer Amaranth	1 increasing	unknown	Soybean	2006
	Sorghum halepense Johnsongrass	1	unknown	Soybean	2007
California	***Lolium rigidum*** Rigid Ryegrass	11-50 increasing	1,001-10,000 increasing	Almonds	1998
	Conyza canadensis Horseweed	1	unknown	Roadside	2005
	Conyza bonariensis Hairy Fleabane	2-5	unknown	Roadside	2007
Delaware	***Conyza canadensis*** Horseweed	101-500	10,001-100,000	Soybean	2000
Georgia	***Amaranthus palmeri*** Palmer Amaranth	101-500 increasing	100,001-1,000,000 increasing	Cotton Soybean	2005
Illinois	***Conyza canadensis*** Horseweed	1,001-10,000 increasing	10,0001-1,000,000 increasing	Soybean	2005
	Amaranthus rudis Common Waterhemp***	1 increasing	51-100 increasing	Corn Soybean	2006
Indiana	***Conyza canadensis*** Horseweed	2-5 increasing	101-500 increasing	Soybean	2002
	Ambrosia trifida Giant Ragweed	1 increasing	11-50 increasing	Soybean	2005
Kansas	***Conyza canadensis*** Horseweed	51-100 increasing	10,001-100,000 increasing	Cotton Soybean	2005
	Ambrosia trifida Giant Ragweed	2-5 increasing	501-1,000 increasing	Soybean	2006
	Amaranthus rudis Common Waterhemp	2-5 increasing	101-500 increasing	Soybean	2006
	Ambrosia artemisiifolia Common Ragweed	1 increasing	11-50 increasing	Soybean	2007
Kentucky	***Conyza canadensis*** Horseweed	2-5 increasing	51-100 increasing	Soybean	2001
Maryland	***Conyza canadensis*** Horseweed	6-10 increasing	501-1,000 increasing	Soybean	2002
Michigan	***Conyza canadensis*** Horseweed	1 increasing	51-100 increasing	Nursery	2007

Minnesota	***Ambrosia trifida*** Giant Ragweed	2-5 increasing	101-500 increasing	Soybean	2006
	Amaranthus rudis Common Waterhemp	2-5 increasing	51-100 increasing	Soybean	2007
Mississippi	***Conyza canadensis*** Horseweed	101-500 increasing	1,001-10,000 increasing	corn, cotton, rice, and soybean	2003
	Lolium multiflorum Italian Ryegrass	unknown	1,001-10,000 increasing	Cotton Soybean	2005
Missouri	***Conyza canadensis*** Horseweed	101-500 increasing	10,001-100,000 increasing	Cotton	2002
	Ambrosia artemisiifolia Common Ragweed	1	11-50	Soybean	2004
	Amaranthus rudis Common Waterhemp**	1 increasing	1,001-10,000 increasing	Corn Soybean	2005
New Jersey	***Conyza canadensis*** Horseweed	6-10 increasing	101-500 increasing	Soybean	2002
North Carolina	***Conyza canadensis*** Horseweed	2-5 increasing	6-10 increasing	Cotton	2003
Ohio	***Conyza canadensis*** Horseweed	101-500 increasing	1,001-10,000 increasing	Soybean	2002
	Conyza canadensis Horseweed*	2-5 increasing	101-500 increasing	Soybean	2003
	Ambrosia trifida Giant Ragweed	2-5 increasing	101-500 increasing	Soybean	2004
Oregon	***Lolium multiflorum*** Italian Ryegrass	1 stable	1-5 stable	Orchards	2004
Pennsylvania	***Conyza canadensis*** Horseweed	2-5 increasing	101-500 increasing	Soybean	2003
Tennessee	***Conyza canadensis*** Horseweed	501-1,000 increasing	>2,000,000 increasing	Cotton Soybean	2001
	Amaranthus palmeri Palmer Amaranth	2-5 increasing	101-500 increasing	Cotton	2006
	Ambrosia trifida Giant Ragweed	101-500 increasing	1,001-10,000 increasing	Cotton Soybean	2007

* resistant to chlorimuron-ethyl, cloransulam-methyl, and glyphosate ** resistant to acifluorfen-Na, cloransulam-methyl, fomesafen, glyphosate, imazamox, imazethapyr, and lactofen *** resistant to chlorimuron-ethyl, glyphosate, and imazethapyr

Monsanto's guidance for weed resistance management in GT alfalfa is as follows (Monsanto 2008):

- Scout fields before and after each herbicide application.
- Use the right herbicide product at the right rate and at the right time.
- To control flushes of weeds in established alfalfa, make applications of Roundup WeatherMAX herbicide at 22 to 44 oz/A before weeds exceed 6", up to 5 days before cutting.
- Use other herbicide products tank-mixed or in sequence with Roundup agricultural herbicide if appropriate for the weed control program.
- Report repeated non-performance to Monsanto or your local retailer.

4.4 Summary of Findings

At least 129 different weed species are identified as minor or major problems in alfalfa. Out of 14 new glyphosate resistant weeds found since 1998, eight are known to be weeds in alfalfa. Out of at least 21 weeds that have natural resistance to glyphosate, ten are known to be a problem in alfalfa. These 18 weeds that are both resistant to glyphosate and traditionally listed as problems in alfalfa include: common ragweed, horseweed, Italian ryegrass, Johnsongrass, Palmer Amaranth, buckhorn plantain, goosegrass, junglerice, bermudagrass, burning nettle, cheeseweed, common lambsquarters, field bindweed, filaree, large crabgrass, morningglory, nutsedge, and purslane. Although the composition of weed shifts is based on the local seedbank, these 18 weeds are candidates for becoming more prevalent than GT sensitive weeds in rotations that include GT alfalfa.

Mechanisms of glyphosate resistance include resistant EPSP synthase, degradation of glyphosate, inactivation of glyphosate, and altered translocation of glyphosate.

Nineteen states and over two million acres of cropland are infested with new glyphosate resistant weeds. The heaviest infestation is in the Southeast and Midwest. Overlap with the major alfalfa producing states in the Intermountain regions seems to be minimal at this point. However, given that there is overlap between glyphosate resistant weed locations and alfalfa hay acreage there is potential for rapid shifts of glyphosate resistant weeds into GT alfalfa fields if GT alfalfa were to be widely adopted. California is a concern because glyphosate resistant weeds are present and alfalfa is a major crop in California.

Weeds are controlled in conventional alfalfa with chemicals (herbicides), cultural methods (rotation, companion crops, monitoring), and mechanical methods (tillage). The cultural and mechanical methods are permitted for organic farmers. GT systems allow for the use of one additional herbicide, glyphosate.

Appendix G-1. References

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Appendix G-2. Literature Search

1.0 Literature Search Strategy

The following literature search was done for two of the technical reports:

Effects of Glyphosate-tolerant weeds in agricultural systems (former title: Increase in RR resistant weeds in crops)

Effects of Glyphosate-tolerant weeds in non-agricultural ecosystems (former title: Increase in RR resistant weeds in non-crop ecosystems)

1.1 Purpose

The purpose of this literature search is to locate references about the potential impacts of glyphosate-tolerant weeds in agricultural systems and in natural ecosystems.

The following DIALOG databases were included in the search:
- File 10:AGRICOLA 70-2008/Jun
- (c) format only 2008 Dialog
- File 156:ToxFile 1965-2008/Jun W2
- (c) format only 2008 Dialog
- File 266:FEDRIP 2008/Feb
- Comp & dist by NTIS, Intl Copyright All Rights Res
- File 245:WATERNET(TM) 1971-2008Apr
- (c) 2008 American Water Works Association

File 55:Biosis Previews(R) 1993-2008/Jun W2
- (c) 2008 The Thomson Corporation

File 6:NTIS 1964-2008/Jun W4
- (c) 2008 NTIS, Intl Cpyrght All Rights Res

File 41:Pollution Abstracts 1966-2008/May
- (c) 2008 CSA.

File 40:Enviroline(R) 1975-2008/Apr
- (c) 2008 Congressional Information Service

File 76:Environmental Sciences 1966-2008/Jun
- (c) 2008 CSA.

File 24:CSA Life Sciences Abstracts 1966-2008/Mar
- (c) 2008 CSA.

File 117:Water Resources Abstracts 1966-2008/Mar
- (c) 2008 CSA.

File 144:Pascal 1973-2008/Jun W2
- (c) 2008 INIST/CNRS

File 50:CAB Abstracts 1972-2008/Apr

□ (c) 2008 CAB International
File 44:Aquatic Science & Fisheries Abstracts 1966-2008/Mar
(c) 2008 CSA.

□ File 71:ELSEVIER BIOBASE 1994-2008/May W4
□ (c) 2008 Elsevier B.V.
File 143:Biol. & Agric. Index 1983-2008/Apr
(c) 2008 The HW Wilson Co
□ File 203:AGRIS 1974-2008/Feb
Dist by NAL, Intl Copr. All rights reserved

Descriptions of these files are available at http://library.dialog.com/bluesheets/.

1.2 Scope of Search

The search focused on any published references between 2000 and the present. A list of titles was screened followed by screening of abstracts for relevant titles. There were no limits on language for titles but only English language publications were retrieved for evaluation.

1.3 Keywords

A list of search parameters is listed below.

Synonyms of key topic
Glyphosate toleran*
Glyphosate resistan*
Roundup® Ready

Key words in combination with key topic Weed management Weed mitigation Weed control
Alfalfa
Medicago
Evolution

1.4 Results

S1 4711 GLYPHOSATE()(TOLERAN? OR RESIST?) OR ROUNDUP()READYS2 3534 S1/2000:2008S3 121649 ALFALFA OR MEDICAGO S4 1796168 WEED? OR EVOLUTION
S5 27 S2 AND S3 AND S4
S6 14 RD S5 (unique items)

□ 7/K,6/1 (Item 1 from file: 144)DIALOG(R)File 144:(c) 2008 INIST/CNRS. All rts. reserv.
17594709 PASCAL No.: 06-0183713
Alfalfa management in no-tillage corn
2006
Glyphosate-*resistant* corn was no-till planted into *alfalfa* that wasin the early bud stage (UNCUT) or had been cut 3 to 4 d earlier and baledfor hay (CUT). *Alfalfa* control and corn yield were measured in nontreatedplots as well as plots treated with......or tank-mixed with 2,4-D or dicamba applied at planting (AP) or POST.*Alfalfa* control was greater for all AP treatments of UNCUT compared toCUT *alfalfa*. Glyphosate plus dicamba applied AP controlled *alfalfa*better than the other AP treatments resulting in increased corn yieldcompared with other

AP...Postemergence applications of glyphosate alone ortank-mixed with 2,4-D or dicamba controlled *alfalfa* better 6 weeks after treatment than AP applications of the same herbicides; however, corn yield...... same herbicides. Corn yield averaged 13% higher following herbicideapplications to UNCUT compared with CUT *alfalfa*, so the value of *alfalfa* hay must be weighed against the loss of corn yield when makingdecisions concerning the management of an *alfalfa*-corn rotation.Descriptors: Zero tillage; *Weed* control; *Weed* science; *Medicago* sativa

□ 7/K,6/2 (Item 2 from file: 10)DIALOG(R)File 10:(c) format only 2008 Dialog. All rts. reserv.4712341 43956730 Holding Library: AGL

Comparing *Roundup* *Ready* and Conventional Systems of *Alfalfa* Establishment

2007

URL: http://dx.doi.org/10.1094/FG-2007-0724-01-RS

Roundup *Ready* (RR) technology provides a new approach for *weed*

□ control during *alfalfa* (*Medicago* sativa L.) establishment. We determined the effect of RR and conventional establishment systems on*alfalfa* yield, *weed* yield, and forage quality when *alfalfa* was established using solo-seeding or oat mulch methods. A RR system was a RR*alfalfa* in combination with glyphosate (Roundup) and a conventional system was a non-RR variety with imazamox (Raptor). Non-RR and RR alfalfaswere also seeded with an oat companion crop. *Alfalfa* yields, plantpopulations, and forage quality were similar for the RR and conventionalsystems within solo-seeding and oat establishment methods in the seedingyear. Total seeding-year *alfalfa* yield was greater when solo-seeded usingan herbicide than when seeded with an oat companion crop harvested at boot.*Alfalfa* yield for the oat mulch and oat companion crop treatments werenot consistently different over...

DESCRIPTORS: *Medicago* sativa......*alfalfa*; ......*weeds*; ......*weed* control;
Identifiers: *Roundup* *Ready* *alfalfa*Section Headings: F120 PLANT PRODUCTION-FIELD CROPS; F900 *WEEDS*

□ 7/K,6/3 (Item 3 from file: 55)DIALOG(R)File 55:(c) 2008 The Thomson Corporation. All rts. reserv.18335235 BIOSIS NO.: 200510029735 Influence of *Roundup* *Ready* (R) soybean production systems and

glyphosate application on pest and beneficial insects in wide-row soybean*2004* ABSTRACT: *Roundup* *Ready* (R) soybean, Glycine max (L.) Merrill, in

widerow planting systems were investigated in 1997 and...

□ ...pest and beneficial insects. Populations of adult bean leaf beetle,Cerotoma trifurcata (Forster), and threecornered *alfalfa* hopper,Spissistilus festinus (Say), and larvae of green cloverworm, Hypenascabra (F.), and velvetbean caterpillar, Anticarsia gemmatalis (Hubner),were not affected by genetically altered *Roundup* *Ready* soybean or byapplications of glyphosate. Numbers of adult big-eyed bug, Geocoris punctipes (Say...influenced G. punctipes densities in 3 of 11 weeks. These

1.0 effects were attributed to increased *weed* densities having a positive effect on G.punctipes numbers during this 3-week period. Increased...

□ ...1 of 2 years. These elevated numbers, however, were also related tohigher densities of *weeds*. The results presented herein demonstratedthat the *Roundup* *Ready* soybean system, including applications ofglyphosate, had no detrimental effects on pest and beneficial insects......ORGANISMS: Spissistilus festinus {threecornered *alfalfa* hopper}

(Homoptera......strain-*Roundup* *Ready*;

□ 7/K,6/4 (Item 4 from file: 55)DIALOG(R)File 55:(c) 2008 The Thomson Corporation. All rts. reserv.17883376 BIOSIS NO.: 200400254133 Influence of *Roundup* *Ready* soybean production systems and glyphosate

application on pest and beneficial insects in narrow-row soybean.*2004* ABSTRACT: *Roundup* *Ready*(R) soybeans, Glycine max (L.) Merrill, in

narrow-row planting systems were investigated in 1998...

...numbers for meaningful analysis included adult bean leaf beetle,Cerotoma trifurcata (Forster); adult three-cornered *alfalfa* hopper,Spissistilus festinus (Say); adult big-eyed bug, Geocoris punctipes (Say), and; larvae of green...

...C. trifurcata, S. festinus, P. scabra and A. gemmatalis were not reducedin genetically altered *Roundup* *Ready* soybean, or by recommended (bylabel) or delayed applications of glyphosate. Numbers of G. punctipesalso were not reduced in *Roundup* *Ready* soybean, but were reduced byrecommended applications of glyphosate during weeks three and four
following......been indirectly reduced by glyphosate within sample weeks two and threebecause of variations in *weed* densities after treatment with the herbicide.
...ORGANISMS: Spissistilus festinus {*alfalfa* hopper} (Homoptera......oil crop, *Roundup* *Ready* line... *Roundup* *Ready* productionsystems......*weed* densities

□ 7/K,6/5 (Item 5 from file: 10)DIALOG(R)File 10:(c) format only 2008 Dialog. All rts. reserv.4598987 43898530 Holding Library: AGL
□ Evaluating Glyphosate Treatments on *Roundup* *Ready* *Alfalfa* for Crop
2.0 Injury and Feed Quality*2007* URL: http://dx.doi.org/10.1094/FG-2007-0201-01-RS*Weed* control is one of the factors that impact *alfalfa* producers,
with negative effects on quality often in the year of establishment.Glyphosate is a broad-spectrum herbicide that controls many troublesomeannual and perennial *weeds* , and new cultivars that are tolerant of glyphosate application have been developed. The crop response of glyphosateon these new varieties has not been reported. This research examined*alfalfa* tolerance under field conditions, and high rates were used tochallenge the plants to determine......ranging from 0.75 to 3 lb a.e./acre sprayed before each of four *alfalfa* harvests had no meaningful crop injury in the establishment yearor in the subsequent two...of 9 lb a.e./acre over a 3-year period caused noreduction in *alfalfa* yield or nutritive value at any cutting in any of thethree years.
DESCRIPTORS: *Medicago* sativa......*alfalfa*;
......postemergent *weed*control;Identifiers: *Roundup* *Ready* *alfalfa*

□ 7/K,6/6 (Item 6 from file: 55)DIALOG(R)File 55:(c) 2008 The Thomson Corporation. All rts. reserv.0020265061 BIOSIS NO.: 200800312000 Establishment systems for *glyphosate*-*resistant* *alfalfa**2008* ABSTRACT: Glyphosare-resistant *alfalfa* offers new *weed* control options for *alfalfa* establishment. Field studies were conducted in 2004 and 2005 to determine the effect of establishment method and *weed* control method on forage production and *alfalfa* stand establishment. Seedingmethods included clear seeding and companion seeding with oats. Herbicidetreatments included...reduce forage yield or stand density in 2004. No
glyphosate injury was observed in 2005. *Weed* control with glyphosate was
3.0 more consistent than with imazamox or imazarnox + clethodim. In 2004, total seasonal forageyield, which consisted of *alfalfa*, *weeds*, and oats (in sometreatments), was the highest where no herbicide was applied in the...
...was reduced where herbicides were applied in both establishment systems.In 2005, seeding method or *weed* control method did not affect totalseasonal forage production. *Alfalfa* established with the clear-seededmethod and treated with glyphosate yielded the highest *alfalfa* dry

matter in both years. Imazamox injury reduced first-harvest *alfalfa*yield in the clear-seeded system in both years. When no herbicide wasapplied, *alfalfa* yield was higher in the clear-seeded system. The oatcompanion crop suppressed *alfalfa* yield significantly in both years.*Alfalfa* established with an oat companion crop had a lower *weed*biomass than the clear-seeded system where no herbicide was applied in both
years....ORGANISMS: *Medicago* sativa {*alfalfa*} (Leguminosae)

□ 7/K,6/7 (Item 7 from file: 10)DIALOG(R)File 10:(c) format only 2008 Dialog. All rts. reserv.4823604 44034732 Holding Library: AGL
Glyphosate-*resistant* crops: adoption, use and future considerations*2008* URL: http://dx.doi.org/10.1002/ps.1501BACKGROUND: *Glyphosate*-*resistant* crops (GRCs) were first introduced
in the United States in soybeans in 1996. Adoption has......13.2 million ha), cotton (5.1 million ha), canola (2.3 million ha) and*alfalfa* (0.1 million ha). Currently, the USA, Argentina, Brazil andCanada have the largest plantings of GRCs. Herbicide use patterns wouldindicate that over 50% of *glyphosate*-*resistant* (GR) maize hectares and70% of GR cotton hectares receive alternative mode-of-action treatments... ...production system. Tillage

was likely used for multiple purposes rangingfrom seed-bed preparation to *weed* management.CONCLUSION: GRCs representone of the more rapidly adopted *weed* management technologies in recenthistory. Current use patterns would indicate that GRCs will likely continueto be a popular *weed* management choice that may also include the use ofother herbicides to complement glyphosate. Stacking...

☐ 7/K,6/8 (Item 8 from file: 55)DIALOG(R)File 55:(c) 2008 The Thomson Corporation. All rts. reserv.18808410 BIOSIS NO.: 200600153805 *Glyphosate*-*resistant* crops: History, current status, and future*2004*

...ORGANISMS: *alfalfa* (Leguminosae MISCELLANEOUS TERMS: *weed* management...

☐ 7/K,6/9 (Item 9 from file: 50)DIALOG(R)File 50:(c) 2008 CAB International. All rts. reserv.0009113458 CAB Accession Number: 20063199990

☐ *Glyphosate*-*tolerant* *alfalfa* is compositionally equivalent to conventional *alfalfa* (*Medicago* sativa L.).Publication Year: 2006 *Glyphosate*-*tolerant* *alfalfa* (GTA) was developed to withstand

☐ over-the-top applications of glyphosate, the active ingredient in...

☐ ... United States during the 2001 and 2003 field seasons along with controland other conventional *alfalfa* varieties for compositional assessment.Field trials were conducted using a randomized complete block design withfour replication blocks at each site. *Alfalfa* forage was harvested atthe late bud to early bloom stage from each plot at...

... from GTA J101 x J163 is compositionally equivalent to forage from the control and conventional *alfalfa* varieties. IDENTIFIERS: *alfalfa*; ....*weedicides*; ...*weedkillers*...*Medicago*sativa

☐ 7/K,6/10 (Item 10 from file: 50)DIALOG(R)File 50:(c) 2008 CAB International. All rts. reserv.0007976368 CAB Accession Number: 20003004906

Roundup *Ready* *alfalfa*.Publication Year: 2000 Genetic engineering has been used to develop *Roundup* *Ready* SUP TM

☐ (i.e. glyphosate herbicide tolerant) *alfalfa*. There is a significant interest in the use of RR *alfalfa* to improve options for effective, crop-safe *weed* control, both for establishment and for the control of tough perennial *weeds* in established stands. The project to develop *Roundup* *Ready* *alfalfa* is a collaboration between Monsanto, Montana State University and Forage Genetics International (FGI). Transformation,

event...

... application of Roundup Ultra. Applications at later reproductive stagesreduced seed yield. The current RR *alfalfa* timeline predicts thecommercial release of a wide range of RR *alfalfa* varieties in 2004.ORGANISM DESCRIPTORS: *Medicago* sativa...CABICODES: *Weeds* and Noxious Plants

☐ 7/K,6/11 (Item 11 from file: 10)DIALOG(R)File 10:(c) format only 2008 Dialog. All rts. reserv.4660649 43931909 Holding Library: AGL

Is *Roundup* *Ready* *alfalfa* right for you
2007
URL: http://cropwatch.unl.edu/
DESCRIPTORS: *alfalfa*; ......*weed* control;
Section Headings: F120 PLANT PRODUCTION-FIELD CROPS; H000

PESTICIDES-GENERAL; F200 PLANT BREEDING; F900 *WEEDS*

7/K,6/12 (Item 12 from file: 10)DIALOG(R)File 10:(c) format only 2008 Dialog. All rts. reserv.

☐ 4442412 30961704 Holding Library: WYU; AGX *Roundup* *Ready*.reg. *alfalfa* a new technology for high plains hay

producers / Stephen D. Miller ... [et al.]*2006* URL:
http://www.uwyo.edu/CES/PUBS/B1173.pdfDESCRIPTORS:
Alfalfa; ......*Weeds*;

□ 7/K,6/13 (Item 13 from file: 50)DIALOG(R)File 50:(c) 2008 CAB International. All rts. reserv.0008500330 CAB Accession Number: 20033167182

□ Seed bank changes following the adoption of *glyphosate*-*tolerant*

□ crops.Publication Year: 2003 *Weed* seed banks in long-term tillage/rotation plots were sampled in the early spring of 1999 and 2002, before and after the adoption of*glyphosate*-*tolerant* soyabean (Glycine max) and maize (Zea mays),respectively. Canonical discriminant analysis was used to characterize......first canonical function was strongly associated with crop rotation. Themaize-oat (Avena sativa)-lucerne (*Medicago* sativa) rotation clustered separately from continuous maize and maize-soyabean rotations when visualized in a...05), suggesting that practices used in the varyingsystems selected for divergent communities. After employing *glyphosate**tolerant* maize and soyabean varieties for three growing seasons (1999-2001), differences incommunity composition between...use of a single, non-selective herbicideacross all treatments resulted in a more homogeneous *weed* seed bankcommunity.
...ORGANISM DESCRIPTORS: *Medicago*; ...

S9 9600 HERBICIDE? ?()(TOLERAN? OR RESIST?)/2000:2008S3 121649 ALFALFA OR MEDICAGO S4 1796168 WEED? OR EVOLUTION S5 27 S2 AND S3 AND S4 S10 35 S9 AND S3 AND S4 NOT S5 S11 20 RD S10 (unique items)

□ 12/K,6/1 (Item 1 from file: 55)DIALOG(R)File 55:(c) 2008 The Thomson Corporation. All rts. reserv.18075829 BIOSIS NO.: 200400443748 Development of 2,4-D-resistant transgenics in Indian oilseed mustard(Brassica juncea)*2004* ...ABSTRACT: monooxygenase, cloned downstream to the 35S promoter along with a leader sequence from RNA4 of *alfalfa* mosaic virus (AMV leader

□ sequence), for improved expression of the transgene in plant cells.Southern... ...available transgenic lines can be used for testing the potential of
2,4-D in *weed* control including the control of parasitic *weeds*
(Orobanche spp) of mustard and for low-till cultivation of mustard.
ORGANISMS: *Alfalfa* mosaic virus (Bromoviridae...vegetable crop,

herbicide *resistant* transgenic line......pest, *weed*

□ 12/K,6/2 (Item 2 from file: 50)DIALOG(R)File 50:(c) 2008 CAB International. All rts. reserv.0008797522 CAB Accession Number: 20053050074

□ Efficacy of imidazolinone herbicides applied to imidazolinone-resistant maize and their carryover effect on rotational crops.Publication Year: 2005 ... a 31% petroleum hydrocarbon adjuvant at 125 and 250 mL ha SUP -1 ,

□ respectively. Overall *weed* control varied from 85%, up to 95%. *Weed*species controlled were Setaria sp., Chenopodium album , Solanum sp.,Amaranthus retroflexus and Digitaria sanguinalis , and...
...to low, was the following: Beta vulgaris > Capsicum annum > Lycopersicumesculentum > Cucumis melo > Hordeum vulgare > *Medicago* sativa > Loliummultiflorum > Avena sativa > Pisum sativum > Allium cepa > Zea mays ....DESCRIPTORS: *herbicide* *resistance*; ......*weed* control......*weeds*...ORGANISM DESCRIPTORS: *Medicago*; ...

□ 12/K,6/3 (Item 3 from file: 50)DIALOG(R)File 50:(c) 2008 CAB International. All rts. reserv.0009065754 CAB Accession Number: 20063137864

□ Influence of forage legume species, seeding rate and seed size on competitiveness with annual ryegrass (Lolium rigidum) seedlings.Publication Year: 2006 ... as short-term forage crops are an important non-chemical option for
the control of *herbicide*-*resistant* annual ryegrass (Lolium rigidum L.). The relative ability of 5 annual forage legume species (Trifoliumsubterraneum L., T. michelianum Savi., T. alexandrinum L., *Medicago*murex Wild and Vicia benghalensis L.) to suppress annual ryegrassseedlings was examined in a......DESCRIPTORS: *weed* control ...ORGANISM DESCRIPTORS: *Medicago* murex

☐ 12/K,6/4 (Item 4 from file: 156)DIALOG(R)File 156:(c) format only 2008 Dialog. All rts. reserv.3840082 NLM Doc No: 12852606

Influence of *herbicide* *tolerant* soybean production systems on insectpest populations and pest-induced crop damage.Jun *2003*

Conventional soybean *weed* management and transgenic *herbicide*-*tolerant* management were examined to assess their effects on soybeaninsect pest populations in south Georgia...... leafhopper, Empoasca fabae (Harris), and grasshoppers Melanoplus spp.were more numerous on either conventional or *herbicide*-*tolerant* varieties on certain dates, although these differences were not consistentthroughout the season. Soybean looper, Pseudoplusia includens (Walker),threecornered *alfalfa* hopper, Spissistilus festinus (Say), and whitefringed beetles, Graphognathus spp , demonstrated no varietal preference in this study. Few *weed* treatment differences were observed,but if present on certain sampling dates, then pest numbers were higher inplots where *weeds* were reduced (either postemergence herbicides or preplant herbicide plus postemergence herbicide). The exception to this*weed* treatment effect was grasshoppers, which were more numerous in *weedy* plots when differences were present. In post emergence herbicideplots, there were no differences in...the conventional herbicides (e.g.,Classic, Select, Cobra, and Storm) compared with specific gene-inserted*herbicide*-*tolerant* materials (i.e., Roundup and Liberty).Defoliation, primarily by velvetbean caterpillar, was different betweensoybean...... We did not observe differences in seasonal abundance of arthropod pestsbetween conventional and transgenic *herbicide*-*tolerant* soybean.

☐ 12/K,6/5 (Item 5 from file: 50)DIALOG(R)File 50:(c) 2008 CAB International. All rts. reserv.0008298057 CAB Accession Number: 20023152152

Effect of herbicide treatment on the productivity of some annual pasturelegumes.

Book Title: 13th Australian *Weeds* Conference: *weeds* "threats now and forever?", Sheraton Perth Hotel, Perth, Western Australia, 8-13September 2002: papers and proceedings

Publication Year: 2002

... seed production of 11 pasture legume cultivars (Trifolium subterraneum cultivars Dalkeith and Urana, burr medic [*Medicago*polymorpha] cv. Santiago, French serradella [Ornithopus sativus] cv.Cadiz, yellow serradella [O. compressus] cv. Charano......DESCRIPTORS: *herbicide* *resistance*; ......*weed* control......*weeds*...ORGANISM DESCRIPTORS: *Medicago* polymorpha

☐ 12/K,6/6 (Item 6 from file: 55)DIALOG(R)File 55:(c) 2008 The Thomson Corporation. All rts. reserv.18860532 BIOSIS NO.: 200600205927

Effects of Artemisia afra leaf extracts on seed germination of selected crop
and *weed* species
2005

ABSTRACT: *Herbicide* *resistance* in *weeds* is a phenomenon threateningsustainable cereal production in the winter rainfall region of SouthAfrica. Every possible *weed* control measure that may be used tocomplement chemical *weed* control measures should be investigated. Theeffect of aqueous leaf extracts of the aromatic shrub African wormwood(Artemisia afra) on germination of selected crop and *weed* species wereinvestigated. The selected plant species included wheat (Triticumaestivum L.), *herbicide* *resistant* and non-resistant ryegrass (Lolium,spp.), canola (Brassica napus) and lucerne (*Medicago* sativa). Various dilutions were investigated and the original extract was the most effective in inhibiting......ORGANISMS: *Medicago* sativa (Leguminosae

☐ 12/K,6/7 (Item 7 from file: 50)
DIALOG(R)File 50:(c) 2008 CAB International. All rts. reserv.

0008298120 CAB Accession Number: 20023152089 *Evolution* of paraquat resistance in barley grass (Hordeum leporinumLink. and H. glaucum Steud.).Book Title: 13th Australian *Weeds* Conference: *weeds* "threats now and forever?", Sheraton Perth Hotel, Perth, Western Australia, 8-13September 2002: papers and proceedingsPublication Year: 2002

Herbicide *resistance* in *weed* species can eliminate the usefulnessof herbicides. In Australia, 25 *weed* species have been documented withresistance to one or more of nine herbicide groups. Two *weedy* barleygrass species, H. glaucum and H. leporinum [H. murinum subsp. leporinum],infest crops and...paraquat on these two

species, principally in lucerne and
grain crops,has resulted in the *evolution* of paraquat resistance at a number ofsites in southern Australia. The *evolution* of paraquat resistance occursafter a prolonged period of use, often up to 20 years...
... will lead to a better understanding of how resistance is spread as wellas the *evolution* of paraquat resistance in field populations....DESCRIPTORS: *evolution*; ......*herbicide* *resistance*; ......*weeds*
...*Medicago* sativa...CABICODES: *Weeds* and Noxious Plants (FF500...

□ 12/K,6/8 (Item 8 from file: 50)

0008751520 CAB Accession Number: 20053008750 *Evolution* and spread of *herbicide* *resistant* barley grass (Hordeumglaucum Steud. and H. leporinum Link.) in South Australia.Book Title: *Weed* management: balancing people, planet, profit. 14thAustralian *Weeds* Conference, Wagga Wagga, New South Wales, Australia,6-9 September 2004: papers and proceedingsPublication Year: 2004 The barley grasses (H. glaucum and H. leporinum (H. murinum subsp.leporinum)) are important *weeds* of crops and pastures in South Australia. Populations of both species have evolved resistance to paraquat, primarily following intensive use of paraquat for winter *weed*
control in lucerne (*Medicago* sativa) crops. In the past few years,agricultural consultants have been reporting an increase in......This research was conducted to determine the relative importance of seedmovement compared with independent *evolution* for paraquat resistance in
□ Hordeum spp. H. glaucum and H. leporinum seeds were collected from...
... by 7 km appeared to be the same genotype. These results suggest thatboth independent *evolution* and seed movement are important in thedistribution of paraquat-resistant Hordeum spp. in South...DESCRIPTORS: *evolution*; ......*herbicide* *resistance*; ......*weeds*
...*Medicago* sativa...CABICODES: *Weeds* and Noxious Plants (FF500

□ 12/K,6/9 (Item 9 from file: 50)DIALOG(R)File 50:(c) 2008 CAB International. All rts. reserv.0008324661 CAB Accession Number: 20023162508
Herbicides in *alfalfa* culture.
Original Title: Herbicidas na cultura da alfafa.
Publication Year: 2002
... the tolerance of lucerne cv. Crioula and the efficiency of

□ pre-emergent herbicides on broadleaved *weed* control, in 2 differentsoils having (a) 0.96% organic matter (OM) and pH of 5.4 and (b) 2.61% OMand pH of 6.1. The *weed* control efficiency of oxyfluorfen and mixture ofdiuron+paraquat was also evaluated one day after...
... 24 and 0.36 of oxyfluorfen. Two controls were added to all experiments,
□ i.e. *weeded* and unweeded. Pre-emergence herbicides were sprayed one dayafter planting in moistened soil. In...
□ ... plants. Oryzalin was selective to the crop, providing a better controlof grasses and broadleaved *weeds* at the 2 highest doses, regardless ofthe amount of OM and soil pH. Acetochlor...
□ ... both contents of OM and soil pH, with excellent control of the broadleaved and grass *weeds*. Flumetsulam and imazaquin may be appliedonly at the lowest dose tested, regardless of OM content in the soil,providing good control of some broadleaved *weeds*, with spraying offluazifop-P-butyl [fluazifop-P] needed in post-emergence. The herbicidesshowed, in average, 10% more control of the *weeds* in soil with 2.61% ofOM and pH of 6.1, in comparison to the *weeds* in the soil with 0.96% ofOM and pH of 5.4. Lucerne budding...
□ .. oxyfluorfen up to 12 days after application; this herbicide presentedgood potential for post-lasting *weed* control and excellent pre-emergencecontrol. Mixture application in tank (diuron+paraquat) just after cutting
... ...DESCRIPTORS: *herbicide* *resistance*; ......*weed* control......*weeds*...*Medicago* sativa

□ 12/K,6/10 (Item 10 from file: 50)DIALOG(R)File 50:(c) 2008 CAB International. All rts. reserv.0009320611 CAB Accession Number: 20073193351

Herbicide-*resistant* crops as *weeds* in North America.
Publication Year: 2007
Growers have rapidly adopted transgenic *herbicide*-*resistant* (HR)

□ crops, such as canola (Brassica napus L.), soyabean [Glycine max (L.) Merr.], maize (Zea...crops and subsequent potential for volunteerism of these crops are assessed. HR volunteers are common *weeds* and the relative *weediness*
□ depends on species, genotype, seed shatter prior to harvest and disbursement of seed at harvest...limited if the crop volunteers are HR.There are generally no marked changes in volunteer *weed* problemsassociated with these crops, except in no-tillage systems when glyphosate(GLY) is used...
...DESCRIPTORS: *Herbicide* *resistance*; ......*Weed*control......*Weeds*;
IDENTIFIERS: *alfalfa*; ......*weedicides*; ......*weedkillers*
...ORGANISM DESCRIPTORS: *Medicago* sativa

12/K,6/11 (Item 11 from file: 50)

0008751696 CAB Accession Number: 20053008458

How profitable are perennial pasture phases in Western Australian cropping systems?
Book Title: *Weed* management: balancing people, planet, profit. 14thAustralian *Weeds* Conference, Wagga Wagga, New South Wales, Australia,6-9 September 2004: papers and proceedings
Publication Year: 2004
... that, in most parts of Western Australia, it is not currentlyprofitable to plant lucerne (*Medicago* sativa) on the scale requiredfor salinity abatement. However, these investigations have not incorporated the long-term benefits that accrue from the use of lucerne toenhance management of *weeds* , especially for those growers facing thethreat or actual presence of *herbicide* *resistance*. This work is an investigation of the economics of lucerne when these various benefits are considered simultaneously. An existing model for analysing *herbicide**resistance* in annual ryegrass (Lolium rigidum) in Western Australia(Ryegrass Resistance and Integrated Management) is extended...
... pasture phase increase long-term profitability, relative to that ofcontinuous cropping, because of improved *weed* management, reduced chemical use and through increasing yields in subsequent cereal crops. Thefirst two benefits help reduce the *evolution* of *herbicide* *resistance* . In addition, the incorporation of lucerne in a rotation can significantly reduce recharge. These results......DESCRIPTORS: *herbicide* *resistance*; ......*herbicide* *resistant*
weeds; ...
...*weed* control......*weeds*...*Medicago* sativa

□ 12/K,6/12 (Item 12 from file: 55)

0019917724 BIOSIS NO.: 200700577465
New annual and short-lived perennial pasture legumes for Australianagriculture - 15 years of revolution
2007
ABSTRACT: Fifteen years ago subterranean clover (Trifolium subterraneum)and annual medics (*Medicago* spp.) dominated annual pasture legumesowings in southern Australia, while limited pasture legume options
existed...
...glanduliferum), arrowleaf (Trifolium vesiculosum), eastern star(Trifolium dasyurttm) and crimson (Trifolium incarnatum) clovers andsphere (*Medicago* sphaerocarpos), button (*Medicago* orbicularis) andhybrid disc (*Medicago* tornata x *Medicago* littoralis) medics have beencommercialised. Improved cultivars have also been developed ofsubterranean (T. subterraneum), balansa (Trifolium michelianum), rose(Trifolium hirtum), Persian (Trifolium resupinatum) and purple (Trifoliumpurpureum) clovers, burr (*Medicago* polymorpha), strand (M. littoralis),snail (*Medicago* scutellata) and barrel (*Medicago* 'truncatula) medicsand yellow serradella (Ornithopus compressus). New tropical legumes for
pasture phases in subtropical...likely to increase due to the increasing cost

of inorganic nitrogen, the need to combat *herbicide*-*resistant* crop
weeds and improved livestock prices. Mixtures of these legumes allows for
more robust pastures buffered against...
12/K,6/13 (Item 13 from file: 50)
DIALOG(R)File 50:(c) 2008 CAB International. All rts. reserv.
0008415606 CAB Accession Number: 20033074295

□ Preharvest glyphosate in *alfalfa* for seed production: control of
□ Canada thistle. Publication Year: 2003 Canada thistle (Cirsium arvense) is increasing in both frequency and
density in Saskatchewan lucerne (*Medicago* sativa) seed fields. Application of preharvest glyphosate is an effective means of controllingCanada thistle...
...DESCRIPTORS: *herbicide* *resistance*; ......*weed* control......*weeds*...*Medicago* sativa

□ 12/K,6/14 (Item 14 from file: 10)DIALOG(R)File 10:(c) format only 2008 Dialog. All rts. reserv.4818901 44029738 Holding Library: AGL
Role and value of including lucerne (*Medicago* sativa L.) phases in croprotations for the management of *herbicide*-*resistant* Lolium rigidum inWestern Australia
2008 URL: http://dx.doi.org/10.1016/j.cropro.2007.07.018Use of lucerne (*Medicago* sativa L.) pastures in crop rotations has been
proposed as a method to enhance *weed* management options for growersfacing *herbicide* *resistance* in Western Australia. An existing model foranalysing *herbicide* *resistance* in the important crop *weed* annualryegrass (Lolium rigidum Gaud.) is consequently extended to include lucerne, used for grazing by...options are analysed, including variouscombinations of lucerne, annual pastures, and crops. Lucerne providesadditional *weed* management benefits across the rotation, but in the region studied these benefits are only sufficient...

□ 12/K,6/15 (Item 15 from file: 50)DIALOG(R)File 50:(c) 2008 CAB International. All rts. reserv.0008983866 CAB Accession Number: 20063055062
□ Sensitivity of selected crops to isoxaflutole in soil and irrigation
□ water. Publication Year: 2005 ... hectarage crops grown in Michigan, USA. The crops evaluated were:
□ adzuki bean (Vigna angularis), lucerne (*Medicago* sativa), carrot (Daucus carota), cucumber (Cucumis sativus), dry bean (navy and blackbeans; Phaseolus vulgaris...of the rates that resulted in injury were substantially less than the rates used for *weed* control in maize.
Carryover from isoxaflutoleapplications in maize production may require plant back restrictions......DESCRIPTORS: *herbicide* *resistance*;...*Medicago* sativa

□ 12/K,6/17 (Item 17 from file: 55)DIALOG(R)File 55:(c) 2008 The Thomson Corporation. All rts. reserv.17533797 BIOSIS NO.: 200300491454 Tolerance of annual forage legumes to herbicides in Alberta.*2003*
...ABSTRACT: under irrigation. Results indicate that recommended rates of
either ethalfluralin or imazethapyr have potential for *weed* control in

alfalfa, berseem clover, balansa clover, fenugreek, pea, and vetches.*alfalfa* (Leguminosae...*herbicide* *tolerance*; ....*weed* controlpotential

□ 12/K,6/18 (Item 18 from file: 50)
DIALOG(R)File 50:(c) 2008 CAB International. All rts. reserv.
□ 0008566544 CAB Accession Number: 20043017840 *Weed* control in lucerne and pastures 2004.Publication Year: 2003 Information to aid the planning of *weed* control in lucerne and pastures in Australia, is presented under the following headings:
identification of...
...establishing pasture legumes; poison warnings on herbicide labels; usingherbicides successfully; using herbicides in pastures; *weed* glossary;time interval needed between herbicide application and rainfall; *weed*control in seedling lucerne - grass *weeds*; *weed* control in seedlinglucerne - broadleaf *weeds*; *weed* control in established lucerne stands(over one-year-old) -broadleaf *weeds*; *weed* control in establishedlucerne stands (over one-year-old) -grass *weeds*; clover and medic pastures -grass *weeds* -for

presowing, seedling and establishment;clover and medic pastures - broadleaf *weeds* - for presowing, seedlingand established pastures; *weed* control in grass pastures only -broadleaf *weeds*; *herbicide* *resistance* management; direct drill andsurface sowing; perennial grass *weed* control; approximate retail pricesof chemicals used on lucerne and pastures; herbicide volatility; winter crop......DESCRIPTORS: *herbicide* *resistance*; ......*weed* control......*weeds* ...*Medicago* sativa

12/K,6/19 (Item 19 from file: 50)DIALOG(R)File 50:(c) 2008 CAB International. All rts. reserv.

0008415608 CAB Accession Number: 20033074293 *Weed* management in irrigated fenugreek grown for forage in rotationwith other annual crops.Publication Year: 2003 ... determine the tolerance of fenugreek (cv. Amber) to several herbicides and their efficacy on various *weeds* (Avena fatua, Setariaviridis and Amaranthus retroflexus) in 1997-99 in Alberta, Canada.Potentially, fenugreek...effect of herbicides, seeding method, and 11 previous crops on fenugreek yield. Without herbicide application, *weeds* contributed 37-86% to total dry matter production. When imazamox/imazethapyr, or combinations of imazamoz/imazethapyr or imazethapyr with ethalfluralin was applied, *weed*contents were 5% of the total dry matter and the herbicides did notreduce fenugreek yield compared to the hand-*weeded* control. Total foragesamples with a low *weed* content had lower fibre content and higherprotein and digestible dry matter content than forages with a high *weed*content. When imazamox/imazethapyr was used for *weed* control, fenugreekyields and *weed* biomass were similar after direct seeding and aftercultivation plus seeding. In addition, the effect...
... and the previous crop by seeding method interaction was not significantfor fenugreek yield and *weed* biomass. Therefore, irrigated fenugreek canbe successfully grown in conservation tillage systems in rotation withseveral crops provided an effective herbicide is used for *weed* control.

...DESCRIPTORS: *herbicide* *resistance*; ......*weed* control...*Medicago*sativa

□ 12/K,6/20 (Item 20 from file: 55)
DIALOG(R)File 55:(c) 2008 The Thomson Corporation. All rts. reserv.
0020265062 BIOSIS NO.: 200800312001
Winter annual *weed* control with herbicides in *alfalfa*-orchardgrass mixtures
2008
4.0 ABSTRACT: *Alfalfa*-orchardgrass hay is popular in the Western UnitedStates because of an expanding horse-hay market. However, *weed* controlin mixed *alfalfa*-orchardgrass stands is problematic, as herbicides mustbe safe for both species. Most growers rely solely on the competitivenessof the crop for *weed* control, which is often insufficient, especiallyin older stands. Field experiments were established in northernCalifornia to determine the efficacy and crop safety of severalherbicides for winter annual *weed* control in established *alfalfa* -orchardgrass. Metribuzin at 560 or 840 g/ha and hexazinone at 420 g/ha applied...
...Paraquat at 560 g/ha applied shortly after crop green-up gave 50 to 82%*weed* control and caused significant injury to orchardgrass, which wasstill noticeable at first cutting....ORGANISMS: *Medicago* sativa {*alfalfa*} (Leguminosae)MISCELLANEOUS TERMS: *herbicide* *tolerance*

1.5 Supplemental Searches

www.scirus.com
Terms:
alfalfa AND glyphosate (40 titles evaluated)

www.scholar.google.com
Terms:
alfalfa AND glyphosate

www.yahoo.com

Terms:

Alfalfa hay
Alfalfa sprouts
Organic alfalfa sprouts
Alfalfa seeds
Alfalfa glyphosate
Feral alfalfa
Wild alfalfa
Alfalfa state extension guidance
Perennial bluegrass
Quackgrass
Red horned poppy
Sprangletop weed
Tall waterhemp
White cockle weed
Butyrac
Butoxone
Benefin
Balan herbicide
Bromoxynil herbicide
Clethodim herbicide
Prism herbicide
Select herbicide
Diuron herbicide
EPTC herbicide
Velpar herbicide
Raptor herbicide
Pursuit herbicide
Sencor herbicide
Solicam herbicide
Paraquat herbicide
Pronamide herbicide
Kerb herbicide
Poast herbicide
Terbacil herbicide
Sinbar herbicide
Trifluralin herbicide
Treflan/TR-10 herbicide

www.google.com

Terms:

alfalfa bloom
alfalfa crop rotation
alfalfa cultivation
alfalfa harvest
alfalfa quality definitions
alfalfa quality standards
alfalfa quality statistics
alfalfa sprouts
alfalfa weeds
dandelion off-taste milk
dairy cows
Eleucine indica
Burdock weed
Certified organic alfalfa seed
Common ragweed
Common ragweed weed problem
Gene flow simulation
GENESYS gene flow
Glyphosate
Glyphosate resistant weeds
Growing regions
Herbicide active ingredients
Horseweed
Lucerne Medicago
Meadow foxtail
Organic alfalfa acres
Organic alfalfa acres USDA
Organic alfalfa certified
Organic alfalfa seeds
Organic alfalfa statistics
Pigweed
Roundup ready label
Tansymustard
Tansyweed
Teuber gene flow alfalfa
Visual definition for alfalfa quality
Weed interference with rhyzobium
Weeds off tasting milk
Weeds taste in milk
Horseweed Italian ryegrass
Italian ryegrass weed
Palmer amaranth
Buckhorn plantain
Goosegrass

Junglerice
Echinochloa junglerice
Burning nettle
Utica uren
Erodium filaree
Purslane weed
Large crabgrass in alfalfa
Bermudagrass weed alfalfa
Large crabgrass weed
Morning glory toxic livestock
Morning glory weed
Nutsedge
Nutsedge toxic livestock
alfalfa stand removal
volunteer alfalfa
alfalfa autotoxicity

Appendix G-3. Weeds in Alfalfa

Table G-9. Weeds in Alfalfa

Common Name	Scientific Name and Synonyms[25]	Type	Season	East Central	North Central	Southeast	Winter Hardy Inter-mountain	Great Plains	PNW	Moderate Inter-mountain	Southwest	Source
African mustard	*Brassica tournefortii* Asian mustard wild turnip	Broadleaf	WA								X	Rogan and Fitzpatrick 2004
Barnyardgrass	*Echinochloa crus-galli,* cockspur grass, Japanese millet watergrass cockspur watergrass	Grass	SA	X	X			X	X	X	X	Rogan and Fitzpatrick 2004
Bermudagrass	*Cynodon spp.*	Grass	P			X		X			X	Rogan and Fitzpatrick 2004
Blessed milk thistle	*Silyburn marianum* blessed milkthistle milk thistle spotted thistle variegated thistle	Dicot	A								X	Canevari et al., 2007
Blue mustard	*Chorispora tenella,* beanpodded mustard chorispora crossflower purple mustard tenella mustard	Broadleaf	WA		X		X					Rogan and Fitzpatrick 2004
Bluegrass (annual)	*Poa annua* walkgrass, annual bluegrass	Grass	WA			X		X			X	Rogan and Fitzpatrick 2004
Bluegrass (perennial)	*Poca* spp. Perennial bluegrass	Broadleaf	P		X							Rogan and Fitzpatrick 2004
Bristly oxtongue*	*Picris echioides*	Dicot	WA								X	Canevari et al., 2007
Bromes	*Bromus* spp.	Grass	WA								X	Rogan and Fitzpatrick 2004
Buckhorn plantain	*Plantago lanceolata*	Broadleaf	P					X		X		Rogan and

[25] Source: http://plants.usda.gov/java/invasiveOne.

Common Name	Scientific Name and Synonyms[25]	Type	Season	East Central	North Central	Southeast	Winter Hardy Inter-mountain	Great Plains	PNW	Moderate Inter-mountain	Southwest	Source
	English plantain buckhorn plantain lanceleaf plantain narrowleaf plantain ribgrass ribwort *Plantago major* broadleaf plantain buckhorn plantain common plantain rippleseed plantain											Fitzpatrick 2004
Buffalobur	*Solanum rostratum* Colorado bur Kansas thistle Mexican thistle Texas thistle Buffalobur nightshade	Broadleaf	SA					X				Rogan and Fitzpatrick 2004
Bulbous bluegrass	*Poa bulbosa*	Grass	P							X		Rogan and Fitzpatrick 2004
Bull thistle	*Cirsium lanceolatum*	Broadleaf	P							X		Rogan and Fitzpatrick 2004
Burcucumber	*Sicyos angulatus* Wall bur cucumber	Broadleaf	SA			X						Rogan and Fitzpatrick 2004
Burning nettle	*Urtica dioica* California nettle slender nettle stinging nettle tall nettle	Broadleaf	A								X	Canevari et al., 2004; Canevari et al., 2006b
Bushy wallflower	*Ersimum repandum* Treacle mustard	Broadleaf	WA					X				Rogan and Fitzpatrick 2004
California burclover	*Medicago polymorpha* burclover	Dicot	WA-P								X	Canevari et al., 2007
Canada thistle	*Cirsium arvense* Californian thistle creeping thistle	Broadleaf	P	X	X		X			X		Rogan and Fitzpatrick 2004

Common Name	Scientific Name and Synonyms[25]	Type	Season	East Central	North Central	Southeast	Winter Hardy Inter-mountain	Great Plains	PNW	Moderate Inter-mountain	Southwest	Source
	field thistle Cirsium thistle											
Canarygrass	*Phalaris arundinacea* canary grass reed canarygrass *Phalaris canariensis* canary grass *Phalaris minor* canarygrass littleseed canarygrass	Grass	WA								X	Rogan and Fitzpatrick 2004
Carolina geranium	*Geranium carolinianum*	Broadleaf	WA			X						Rogan and Fitzpatrick 2004
Cheatgrass	*Bromus tectorum* downy brome early chess military grass thatch bromegrass	Grass	WA	X	X		X	X	X	X	X	Rogan and Fitzpatrick 2004
Cheeseweed	*Malva neglecta* buttonweed cheeseplant little mallow common mallow	Broadleaf	WA-P							X	X	Rogan and Fitzpatrick 2004
Chickweed (common)	*Stellaria media*	Broadleaf	WA	X	X	X		X	X			Rogan and Fitzpatrick 2004
Chicory	*Cichorium intybus* blue sailors chicory coffeeweed succory	Broadleaf	P							X		Rogan and Fitzpatrick 2004
Coastal fiddleneck	*Amsinckia menziesii* var. *intermedia* coast buckthorn coast fiddleneck common fiddleneck fiddleneck	Broadleaf	WA							X		Rogan and Fitzpatrick 2004
Cocklebur (common)	*Xanthium strumarium* cocklebur common cocklebur rough cocklebur	Broadleaf	SA	X	X	X			X			Rogan and Fitzpatrick 2004
Cornflower	*Centaurea cyanus*	Broadleaf	WA			X						Rogan and

Common Name	Scientific Name and Synonyms[25]	Type	Season	East Central	North Central	Southeast	Winter Hardy Inter-mountain	Great Plains	PNW	Moderate Inter-mountain	Southwest	Source
	bachelor's button garden cornflower											Fitzpatrick 2004
Crabgrass	*Digitaria bicornis* Asian crabgrass *Digitaria ciliaris* Henry's crabgrass fingergrass kukaepua'a saulangi smooth crabgrass tropical crabgrass *Digitaria ischaemum* small crabgrass smooth crabgrass *Digitaria Sanguinalis* hairy crabgrass large crabgrass purple crabgrass	Grass	SA	X	X	X		X				Rogan and Fitzpatrick 2004
Creeping swinecress	*Coronopus didymus* lesser swinecress *Coronopus squamatus* creeping wartcress swinecress	Dicot	WA								X	Canevari et al., 2007
Cupgrasses	*Eriochloa gracilis* southwestern cupgrass tapertip Cupgrass *Eriochloa contracta* prairie cupgrass *Eriochloa villosa* woolly cupgrass	Grass	SA					X			X	Rogan and Fitzpatrick 2004
Curly dock	*Rumex crispus* narrowleaf dock sour dock yellow dock Rumex dock	Broadleaf	P	X	X	X		X				Rogan and Fitzpatrick 2004
Cutleaf	*Oenothera*	Broadl	WA					X				Rogan

Common Name	Scientific Name and Synonyms[25]	Type	Season	East Central	North Central	Southeast	Winter Hardy Inter-mountain	Great Plains	PNW	Moderate Inter-mountain	Southwest	Source
eveningprimrose	*laciniata* cut-leaved evening primrose	eaf										and Fitzpatrick 2004
Dallisgrass	*Paspalum dilatatum* dallies grass herbe de miel herbe sirop hiku nua palpalum dilate water grass	Grass	P								X	Canevari et al., 2007
Dandelion (common)	*Taraxacum officinale* blowball common dandelion faceclock	Broadleaf	P	X	X		X	X		X		Rogan and Fitzpatrick 2004
Dodder	*Cuscuta* 50 common names for species in the genus	Broadleaf	SA					X	X	X	X	Rogan and Fitzpatrick 2004
Fall panicum	*Panicum dichotomiforum* western witchgrass	Grass	SA	X		X						Rogan and Fitzpatrick 2004
Fescue	*Festuca* spp. 66 common names for species in the genus	Grass	P			X				X		Rogan and Fitzpatrick 2004
Fescue (tall)	*Festuca arundinacea* *Festuca pratensis* Alta fescue coarse fescue reed fescue tall fescue	Grass	SA							X		Rogan and Fitzpatrick 2004
Field bindweed	*Convolvulus arvensis* creeping jenny European bindweed morningglory perennial morningglory smallflowered morningglory	Broadleaf	P	X			X					Rogan and Fitzpatrick 2004
Field pepperweed	*Lepidium campestre*	Dicot	WA				X			X		Orloff et al., 1997
Flixweed	*Descurainia sophia*	Broadleaf	WA				X	X		X		Rogan and

Common Name	Scientific Name and Synonyms[25]	Type	Season	East Central	North Central	Southeast	Winter Hardy Inter-mountain	Great Plains	PNW	Moderate Inter-mountain	Southwest	Source
	flixweed pinnate tansymustard											Fitzpatrick 2004
Foxtail (giant)	*Setaria faberi* Chinese foxtail Chinese millet giant bristlegrass giant foxtail nodding foxtail	Grass	SA	X	X	X		X	X			Rogan and Fitzpatrick 2004
Foxtail (green)	*Setaria viridis* bottle grass green bristlegrass green foxtail green millet pigeongrass wild millet	Grass	SA	X	X	X	X	X	X	X		Rogan and Fitzpatrick 2004
Foxtail (yellow)	*Setaria glauca* pearl millet pigeongrass wild millet yellow bristlegrass yellow foxtail	Grass	SA	X	X	X	X	X	X			Rogan and Fitzpatrick 2004
Foxtail barley	*Hordeum jubatum*	Grass	P				X			X		Rogan and Fitzpatrick 2004
Goosegrass	*Eleusine indica* crowsfoot grass Indian goosegrass manienie ali'I silver crabgrass wiregrass	Grass	SA			X		X				Rogan and Fitzpatrick 2004
Groundsel (common)	*Senecio vulgaris* ragwort old-man-in-the-Spring	Dicot	WA								X	Canevari et al., 2007
Hairy nightshade	*Solanum sarrachoides* hairy nightshade hoe nightshade	Broadleaf	SA							X		Rogan and Fitzpatrick 2004
Hare barley	*Hordeum leporinum* hare barley leporinum barley wild barley	Dicot	WA				X			X	X	Orloff et al., 1997
Henbit	*Lamium amplexicaule* deadnettle	Broadleaf	WA	X	X	X		X		X		Rogan and Fitzpatrick 2004

Common Name	Scientific Name and Synonyms[25]	Type	Season	East Central	North Central	Southeast	Winter Hardy Inter-mountain	Great Plains	PNW	Moderate Inter-mountain	Southwest	Source
Hoary alyssum	*Berteroa incana* hoary false alyssum hoary false madwort	Broadleaf	P		X							Rogan and Fitzpatrick 2004
Hoary alyssum	*Berteroa incana* hoary false alyssum hoary false madwort	Broadleaf	SA	X								Rogan and Fitzpatrick 2004
Horseweed	*Conyza canadeniss* horseweed fleabane mares tail fleabane	Broadleaf	SA/WA					X				Rogan and Fitzpatrick 2004
Japanese brome	*Bromus japonicus* Japanese bromegrass Japanese chess	Grass	WA					X				Rogan and Fitzpatrick 2004
Jimsonweed	*Datura stramonium* Jamestown weed mad apple moonflower stinkwort thorn apple	Broadleaf	SA	X		X						Rogan and Fitzpatrick 2004
Johnsongrass	*Sorghum halepense* aleppo milletgrass herbe de cuba sorgho d' Alep sorgo de alepo zacate johnson	Grass	P			X		X				Rogan and Fitzpatrick 2004
Jointed goatgrass	*Aegilops cylindrical* jointgrass	Grass	P					X				Rogan and Fitzpatrick 2004
Junglerice	*Echinochloa colona* junglerice watergrass	Grass	SA								X	Rogan and Fitzpatrick 2004
Kentucky bluegrass	*Poa prantensis*	Grass	P							X		Rogan and Fitzpatrick 2004
Knawel	*Sclerantus annus* German knotgrass	Broadleaf	WA			X						Rogan and Fitzpatrick 2004
Knotweed	*Polygonum arenastrum*	Broadleaf	SA						X		X	Rogan and

Common Name	Scientific Name and Synonyms[25]	Type	Season	East Central	North Central	Southeast	Winter Hardy Inter-mountain	Great Plains	PNW	Moderate Inter-mountain	Southwest	Source
	common knotweed doorweed matweed ovalleaf knotweed prostrate knotweed											Fitzpatrick 2004
Kochia	*Kochia scoparia* Mexican burningbush Mexican fireweed fireweed mock cypress summer cypress	Broadleaf	SA		X			X	X			Rogan and Fitzpatrick 2004
Lambsquarters (common)	*Chenopodium album* Lambsquarters White goosefoot	Broadleaf	SA	X	X	X	X	X	X	X	X	Rogan and Fitzpatrick 2004
Little barley	*Hordeum pusillum* little wildbarley	Grass	WA					X				Rogan and Fitzpatrick 2004
London rocket	*Sisymbrium irio*	Grass	WA								X	Rogan and Fitzpatrick 2004
Meadow foxtail*	*Alopecurus pratensis*	Grass	P							X		Rogan and Fitzpatrick 2004
Mexican sprangletop	*Leptochloa uninervia*	Grass	SA								X	Rogan and Fitzpatrick 2004
Mexican tea	*Chenopodium ambrosioides*	Dicot	P								X	Canevari et al., 2007
Miner's lettuce	*Claytonia perfoliata*	Dicot	WA-P								X	Canevari et al., 2007
Morningglory	*Ipomoea* spp.	Broadleaf	SA			X						Rogan and Fitzpatrick 2004
Muhly	*Muhlenbergia frondosa* wirestern muhly *Muhlenbergia racemosa* green muhly marsh muhly	Grass	P							X		Rogan and Fitzpatrick 2004
Musk thistle	*Caruus nutans*	Broadl	WA					X				Rogan

Common Name	Scientific Name and Synonyms[25]	Type	Season	East Central	North Central	Southeast	Winter Hardy Inter-mountain	Great Plains	PNW	Moderate Inter-mountain	Southwest	Source
	Nodding plumeless thistle chardon penche nodding thistle plumeless thistle	eaf										and Fitzpatrick 2004
Mustards	*Brassica* spp.	Broadleaf	WA			X	X					Rogan and Fitzpatrick 2004
Mustards	*Brassica* spp.	Broadleaf	SA			X						Rogan and Fitzpatrick 2004
Nettleleaf goosefoot	*Chenopodium murale*	Broadleaf	SA								X	Rogan and Fitzpatrick 2004
Night-flowering catchfly	*Silene noctiflora* nightflowering silene sticky cockle	Broadleaf	WA		X							Rogan and Fitzpatrick 2004
Nightshade	*Solanum sarrachoides* hairy nightshade hoe nightshade	Broadleaf	SA			X			X			Rogan and Fitzpatrick 2004
Nightshade (E. black)	*Solanum ptychanthum* Eastern black nightshade black nightshade	Broadleaf	SA	X	X							Rogan and Fitzpatrick 2004
Nutsedge (yellow)	*Cyperus esculentus* yellow nutgrass yellow nutsedge	Grass	P	X								Rogan and Fitzpatrick 2004
Nutsedges	*Cyperus esculentus* yellow nutgrass yellow nutsedge *Cyperus rotundus* chaguan humatag cocograss kili'o'opu nutgrass pakopako purple nutsedge	Grass	P								X	Rogan and Fitzpatrick 2004
Palmer amaranth	*Amaranthus palmeri* carelessweed (type of pigweed)	Broadleaf	SA					X				Rogan and Fitzpatrick 2004
Pennycress	*Thlaspi arvense* Frenchweed	Broadleaf	WA	X	X				X			Rogan and

Common Name	Scientific Name and Synonyms[25]	Type	Season	East Central	North Central	Southeast	Winter Hardy Inter-mountain	Great Plains	PNW	Moderate Inter-mountain	Southwest	Source
	Fanweed field pennycress pennycress stinkweed											Fitzpatrick 2004
Pepperweeds	*Lepidium densiflorum* common pepperweed greenflower pepperweed peppergrass	Broadleaf	WA					X		X		Rogan and Fitzpatrick 2004
Persian speedwell	*Veronica persica* birdeye speedwell winter speedwell	Broadleaf	WA							X		Rogan and Fitzpatrick 2004
Pigweed spp.	*Amaranthus* spp. redroot pigweed smooth pigweed Powell amaranth spiny amaranth tumble pigweed prostrate pigweed common waterhemp tall waterhemp Palmer amaranth	Broadleaf	SA	X	X	X	X	X	X	X	X	Rogan and Fitzpatrick 2004
Plains coreopsis	*Coreopsis tinctoria* golden tickseed	Broadleaf	WA					X				Rogan and Fitzpatrick 2004
Plantains	*Plantago major* common plantain broadleaf plantain buckhorn plantain rippleseed plantain	Broadleaf	P			X		X				Rogan and Fitzpatrick 2004
Poverty sumpweed	*Iva axillaris* Iva poverty weed Lesser marshelder mouseear povertyweed poverty sumpweed poverty weed smallflowered marshelder	Broadleaf	P							X		Rogan and Fitzpatrick 2004
Prickly lettuce	*Lactuca serriola* China lettuce	Broadleaf	WA					X	X	X		Rogan and

Common Name	Scientific Name and Synonyms[25]	Type	Season	East Central	North Central	Southeast	Winter Hardy Inter-mountain	Great Plains	PNW	Moderate Inter-mountain	Southwest	Source
	wild lettuce											Fitzpatrick 2004
Purslane	*Portulaca oleracea* akulikuli-kula common purslance duckweed parsley pusley wild portulaca	Broadleaf	SA						X			Rogan and Fitzpatrick 2004
Quackgrass	*Elytrigia repens* couchgrass quackgrass quickgrass quitch scutch twitch *Elymus repens* couchgrass dog grass	Grass	P	X	X				X	X		Rogan and Fitzpatrick 2004
Rabbitsfoot grass	*Polypogon monspelienisis* rabbitfoot polypogon rabbitfootgrass	Grass	WA								X	Rogan and Fitzpatrick 2004
Ragweed (common)	*Ambrosia artemisiifolia* Roman wormwood annual ragweed common ragweed low ragweed short ragweed small ragweed	Broadleaf	SA	X	X	X		X				Rogan and Fitzpatrick 2004
Red horned poppy*	*Glausium carniculatum*	Broadleaf	WA					X				Rogan and Fitzpatrick 2004
Red sprangletop*	*Leptochloa filiformis*	Grass	SA								X	Rogan and Fitzpatrick 2004
Redstem filaree	*Erodium cicutarium* redstem stork's bill alfilaree filaree stork's bill	Broadleaf	WA							X		Rogan and Fitzpatrick 2004
Rescuegrass	*Bromus catharticus* rescue brome	Grass	WA					X				Rogan and Fitzpatrick

Common Name	Scientific Name and Synonyms[25]	Type	Season	East Central	North Central	Southeast	Winter Hardy Inter-mountain	Great Plains	PNW	Moderate Inter-mountain	Southwest	Source
												2004
Roughseed buttercup*	*Ranunculus muricatus*	Dicot	WA-P								X	Canevari et al., 2007
Russian thistle	*Salsola kali* tumbleweed *Salsola iberica* prickly Russian thistle tumbleweed tumbling thistle	Broadl eaf	SA		X			X	X	X		Rogan and Fitzpatrick 2004
Ryegrass	*Lolium multiforum* Italian ryegrass annual ryegrass	Grass	WA			X				X		Rogan and Fitzpatrick 2004
Ryegrass (perennial)	*Lolium perenne* Perennial ryegrass	Grass	WA							X		Rogan and Fitzpatrick 2004
Sandbur	*Cenchrus echinatus* burgrass common sandbur field sandbur konpeito-gusa se mbulabula vao tui tui	Grass	SA					X	X			Rogan and Fitzpatrick 2004
Shepardspurse	*Capsella bursa-pastoris* Shephardspurse	Broadl eaf	WA	X	X	X	X	X	X	X	X	Rogan and Fitzpatrick 2004
Silversheath knotweed*	*Polygonum argyrocoleon*	Broadl eaf	WA								X	Rogan and Fitzpatrick 2004
Smartweed	*Polygonum persicaria* lady's thumb ladysthumb smartweed	Broadl eaf	SA	X	X	X						Rogan and Fitzpatrick 2004
Sowthistle	*Sonchus* spp. (5 species)	Broadl eaf	P						X			Rogan and Fitzpatrick 2004
Spiny sowthistle	*Sonchus asper* perennial sowthistle prickly sowthistle	Broadl eag	WA					X				Rogan and Fitzpatrick 2004
Sprangletops	*Leptochloa fascicularis* bearded sprangletop	Grass	SA					X				Rogan and Fitzpatrick 2004

Common Name	Scientific Name and Synonyms[25]	Type	Season	East Central	North Central	Southeast	Winter Hardy Inter-mountain	Great Plains	PNW	Moderate Inter-mountain	Southwest	Source
	Also other *leptochloa*											
Squirreltail*	*Sitanion hystrix*	Grass	P							X		Rogan and Fitzpatrick 2004
Stinkgrass	*Eragrostis cilianensis* candy grass lovegrass strongscented lovegrass	Grass	SA							X		Rogan and Fitzpatrick 2004
Sunflower (common)	*Helianthus annuus* annual sunflower common sunflower sunflower wild sunflower	Broadl eaf	SA				X		X	X		Rogan and Fitzpatrick 2004
Swamp knotweed*	*Polygonum coccineum*	Broadl eaf	P							X		Rogan and Fitzpatrick 2004
Tall waterhemp	*Amaranthus tuberculatus* roughfruit amaranth tall waterhemp	Broadl eaf	SA		X			X				Rogan and Fitzpatrick 2004
Tansy mustard	*Descurainia pinnata* green tansymustard tansymustard	Broadl eaf	SA		X			X	X	X		Rogan and Fitzpatrick 2004
Toad rush	*Juncus bufonius*	Grass	WA								X	Canevari et al., 2007
Tumble mustard	*Sisymbrium altissimum* Jim hill mustard tall mustard tumble mustard tumbleweed mustard	Broadl eaf	SA						X	X	X	Rogan and Fitzpatrick 2004
Velvetleaf	*Abutilon theophrasti* Indian mallow butterprint buttonweed	Broadl eaf	SA	X	X	X						Rogan and Fitzpatrick 2004
Virginia pepperweed	*Lepidium virginicum* Virginia Pepperweed Virginia	Broadl eaf	WA			X						Rogan and Fitzpatrick 2004

Common Name	Scientific Name and Synonyms[25]	Type	Season	East Central	North Central	Southeast	Winter Hardy Inter-mountain	Great Plains	PNW	Moderate Inter-mountain	Southwest	Source
	peppercress peppergrass poorman's pepper											
Volunteer grains		Grass	WA-SA	X		X		X	X	X		Rogan and Fitzpatrick 2004
White cockle	*Silene latifolia* bladder campion evening lychnis white campion	Broadleaf	P		X							Rogan and Fitzpatrick 2004
Wild celery*	*Apium graveolens*	Dicot	SA-P								X	Canevari et al., 2007
Wild mustard	*Brassica arvensis* wild mustard *Brassica kaber* canola charlock mustard kaber mustard rapeseed wild mustard	Broadleaf	SA	X	X				X			Rogan and Fitzpatrick 2004
Wild oats	*Avena fatua* flaxgrass oatgrass wheat oats	Grass	SA-WA		X				X	X	X	Rogan and Fitzpatrick 2004
Wild radish	*Raphanus raphanistrum*	Broadleaf	SA	X	X	X						Rogan and Fitzpatrick 2004
Windmillgrass	*Chloris verticillata* tumble windmill grass windmillgrass	Grass	P					X				Rogan and Fitzpatrick 2004
Witchgrass	*Panicum capillare* panicgrass ticklegrass tumble panic tumbleweed grass witches hair	Grass	SA	X						X		Rogan and Fitzpatrick 2004
Yellow rocket	*Barbarea vulgaris* garden yellow rocket winter cress	Broadleaf	P	X	X							Rogan and Fitzpatrick 2004
Yellow starthistle	*Cantaurea solstitialis*	Dicot	WA				X			X		Canevari et al., 2007

Common Name	Scientific Name and Synonyms[25]	Type	Season	East Central	North Central	Southeast	Winter Hardy Inter-mountain	Great Plains	PNW	Moderate Inter-mountain	Southwest	Source
Yellowflower pepperweed	*Lepidium perfoliatum* clasping pepperweed	Dicot	WA				X			X		Orloff et al., 1997

Appendix F

Selected Comments to Draft Environmental Impact Statement form Farmers Using Roundup Ready Alfalfa

APHIS-2007-0044-0320

Name: Daniel M. Luckwaldt
Address: Woodville, WI

Submitter's Representative: Daniel Luckwaldt
Organization: Luckwaldt Agriculture Inc.

I am a dairy farmer who planted 100 acres of round-up ready alfalfa when it was available. I seemed to work very good. Additionally it allowed me to plant my alfalfa in a no-till manner (which leaves a smaller carbon footprint) and not worry about weeds. Seemed like it was the best alfalfa I ever grew and was very easy/simple to manage.

APHIS-2007-0044-0516.1

Name: Gene Robben
Address: Dixon, CA

Organization: Robben Ranch

Robben Ranch is a large farming operation located near the town of Dixon, California. This farming operation normally raises approximately 4,000 acres of alfalfa each year. The hay that is produced on this ranch supplies several dairy and cattle operations in the southern part of the Sacramento valley and the northern part of the San Joaquin valley. Each fall this ranch tries to replace older stands of alfalfa and replaces fields of alfalfa that are of poor quality. These fall plantings can range from 800 to 1,000 acres. Fall planting of alfalfa has been the most successful for Robben Ranch.

Three years ago, Robben Ranch planted 600 acres of Roundup Ready Alfalfa to see how this new variety would produce and what type of quality it would have. This fall was the third year of production for the new Roundup Ready variety. It was found from production records that the Roundup Read Alfalfa equaled other varieties in production per acre, and had outstanding tests in T.D.N. (total digestible nutrients). The other factor that was a concern was how resistant was this alfalfa to Roundup Herbicide. After a few Roundup sprays, there was no apparent loss of plants or stands over the three year period.

Many farmers know that with our standard varieties of alfalfa, w can spend form $50 - $100 per acre annually for weed control. With Roundup Ready Alfalfa, expenses range from $10 - $30 per acre per year, which is a considerable savings over standard weed control. It was also noticeable that in the Roundup Ready Alfalfa fields almost 100% weed control was obtained.

Robben Ranch hopes the government will release Roundup Ready Alfalfa seed for the 2010 planting season. If so, this ranch will probable plant 1,000 acres of Roundup Ready Alfalfa this coming fall season. I feel that the government regulators fully analyze the benefit that Roundup Ready Alfalfa has for the American farmer and the environment they will release the seed for sale.

From an environmental standpoint, one can only hope that the regulators will find that with the release of Roundup Ready Alfalfa seed, several million pounds of current herbicides will be greatly decrease or eliminated. Velpar, Sincor, Direx, Gramoxone, and Treflan TR-10 granules are just a few examples of these current herbicides being used. With the reduction of these herbicides, our streams and waterways will be much safer for our environment and us.

Document: APHIS-2007-0044-0813

Name: Kurt Robert Brink
Address: Richview, IL

Biotechnology-based breeding methods safely enhance and extend a crop's yield potential, feed value, adaptation, pest tolerance, environmental benefits, crop management and utilization options, as other biotech crops have demonstrated. The Roundup Ready alfalfa system provides dependable, cost-effective control of broadleaf and grassy weeds for the life of the alfalfa stand.
I have had a plot of RR Alfalfa now for at least 3 years and it has proven to be a major plus for our Dairy business in that we usually are able to maintain at least a RFV of 155 or better in each of 5 cuttings/year. With the ability to control weed growth, it is one of, if not the best stand I have among the 4 fields I do have in alfalfa.
It is imperative in these tough economic times that we are not deprived of whatever advantage we can glean from the seed technology this variety provides.Roundup Ready alfalfa can lead to more consistent, high-quality, weed-free hay, resulting in an increased supply of dairy-quality hay. The forage produced from Roundup Ready alfalfa is comparable in composition, nutritional value and safety to that produced from conventional alfalfa varieties, resulting in proven feed safety. Dairy farmers can benefit from increased milk production per ton of feed and fewer animals sickened by weeds in their feed.
I urge the USDA to consider biotechnology's long history of success and allow alfalfa growers to join other American farmers in the benefits and new opportunities offered by biotechnology.

Kurt Brink
B&B Dairy Farms
Illinois

Document: APHIS-2007-0044-1094
Comment from John Maddox

Name: John Maddox
Address: Burrell, CA

I am a dairyman and alfalfa grower. I currently grow 2,400acs of conventional alfalfa and I would like to have the ability to purchase and grow Roundup Ready alfalfa. I did grow 40acs of Roundup Ready alfalfa when it was first avialable and was extremely satisfied with it.
The Roundup Ready system is extremely effective in controlling some of our toughest weeds that we have in our hay fields especially nutgrass which is a big problem for us to control with the currently avialable products that we have.
It eliminates summer grasses in the alfalfa which gives me greater flexibility in my winter spray applications.
I firmly believe that if I am able to grow Roundup Ready alfalfa, I am going to be able to better protect my workers because they will not have to be exposed to the more toxic herbicides that I currently have to use to control my weeds. This is a huge issue for us in California especially

with the many worker safety regulations that we put in place to provide a safe work environment for our employees.

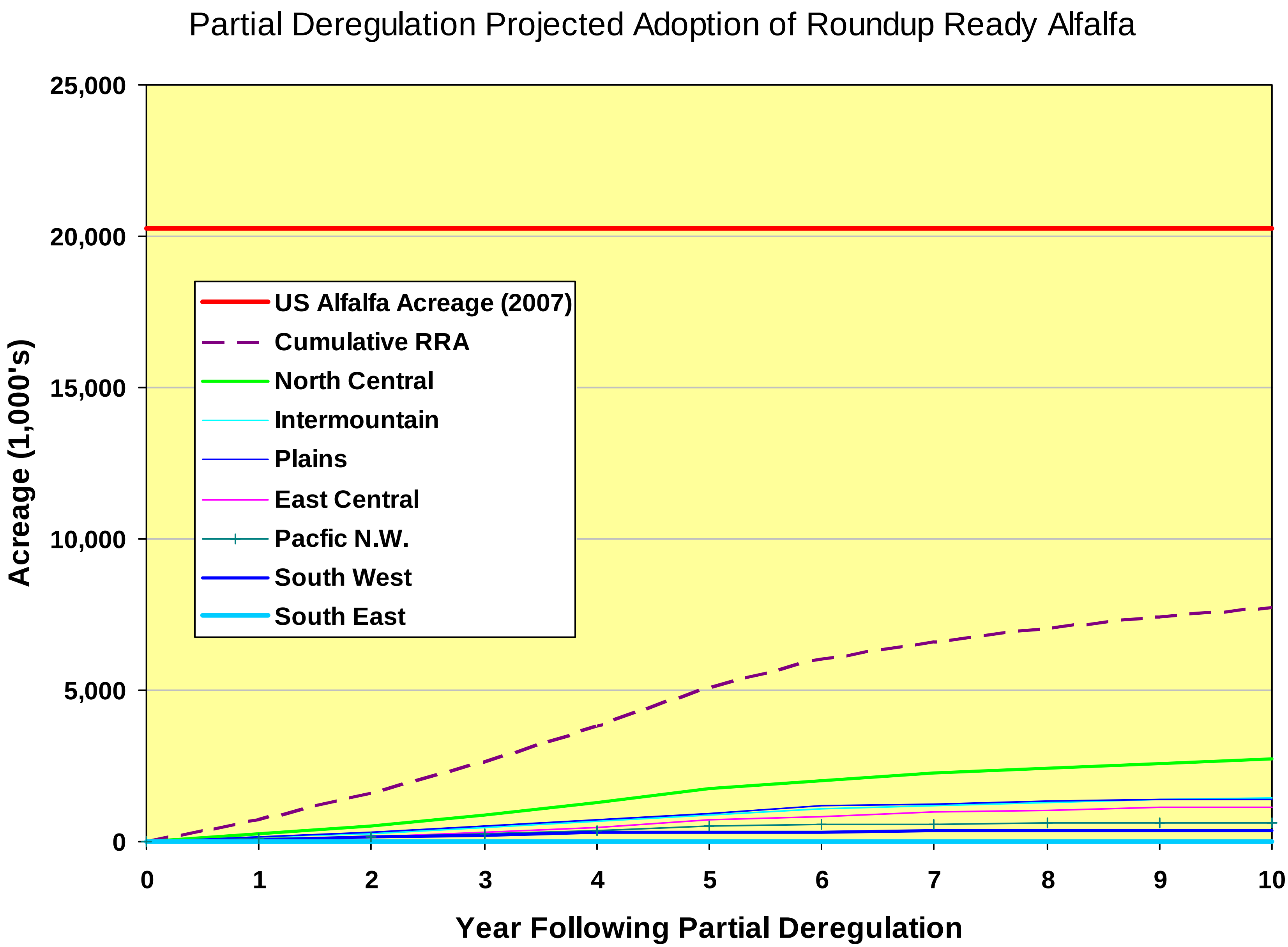
For our dairy, it is of high importance to us to provide the highest quality feed that we can find for our milk cows so that we can maximize their production of high quality milk and butterfat. By growing Roundup Ready alfalfa, I found that my alfalfa was higher in quality and tonnage per acre due to the fact that it was much cleaner than my conventional fields. My 40acres of Roundup Ready alfalfa was the first field that ever produced 10 tons/acre for the year. We have never been able to do that with our conventional varities. This higher production per acre allows me to use less alfalfa acres to provide me the same amount of hay that I currently get from my conventional fields. This frees up some ground for me to rotate into other crops.

Third, because herbicide resistance is a heritable trait, it takes multiple growing seasons for herbicide tolerant weeds to emerge and become the predominant biotype in a specific area (Cole, 2010a, p. 4). Researchers have concluded that even if growers completely relied on only one herbicide, it is likely to take at least five years for an herbicide-resistant weed population to develop (Kniss, 2010a, p4; Beckie 2006, Neve, 2008; Werth et al., 2008). This is a reason why crop monitoring and follow up by University and industry weed scientists in cases of suspected resistance are important parts of all herbicide resistance stewardship programs.

The practice of repeated, in-season mowing combined with alfalfa's perennial nature reduce the likelihood of glyphosate-resistant weed development in >99 percent of the crop's acreage. The ability for alfalfa to fix nitrogen encourages the decision to follow alfalfa in the rotation with a crop that requires additional nitrogen, such as the annual grasses of corn and various cereal crops. These subsequently rotated crops can tolerate a spectrum of herbicides substantially different from the herbicides used in alfalfa. This encourages rotation of crops and herbicides, both of which are highly recommended for reducing the probability of developing herbicide resistant weeds (Orloff et al., 2009; USDA APHIS, 2009, P. 109).

Appendix G

Chart of Anticipated Adoption of RRA Under Partial Deregulation, Prepared by Monsanto/FGI (August 4, 2010)



Partial Deregulation Projected Adoption of Roundup Ready Alfalfa
25,000
20,000
15,000
10,000
5,000
0
Acreage (1,000's)
US Alfalfa Acreage (2007)
Cumulative RRA
North Central
Intermountain
Plains
East Central
Pacfic N.W.
South West
South East
0
1
2
3
4
5
6
7
8
9
10
Year Following Partial Deregulation

Appendix
H

Roundup Ready Alfalfa Satisfaction Study
(Study #091 113 1108)
Prepared by Market Probe, Inc., December 2008

ROUNDUP READY ALFALFA SATISFACTION STUDY

(Study #091 113 1108)

Prepared By:

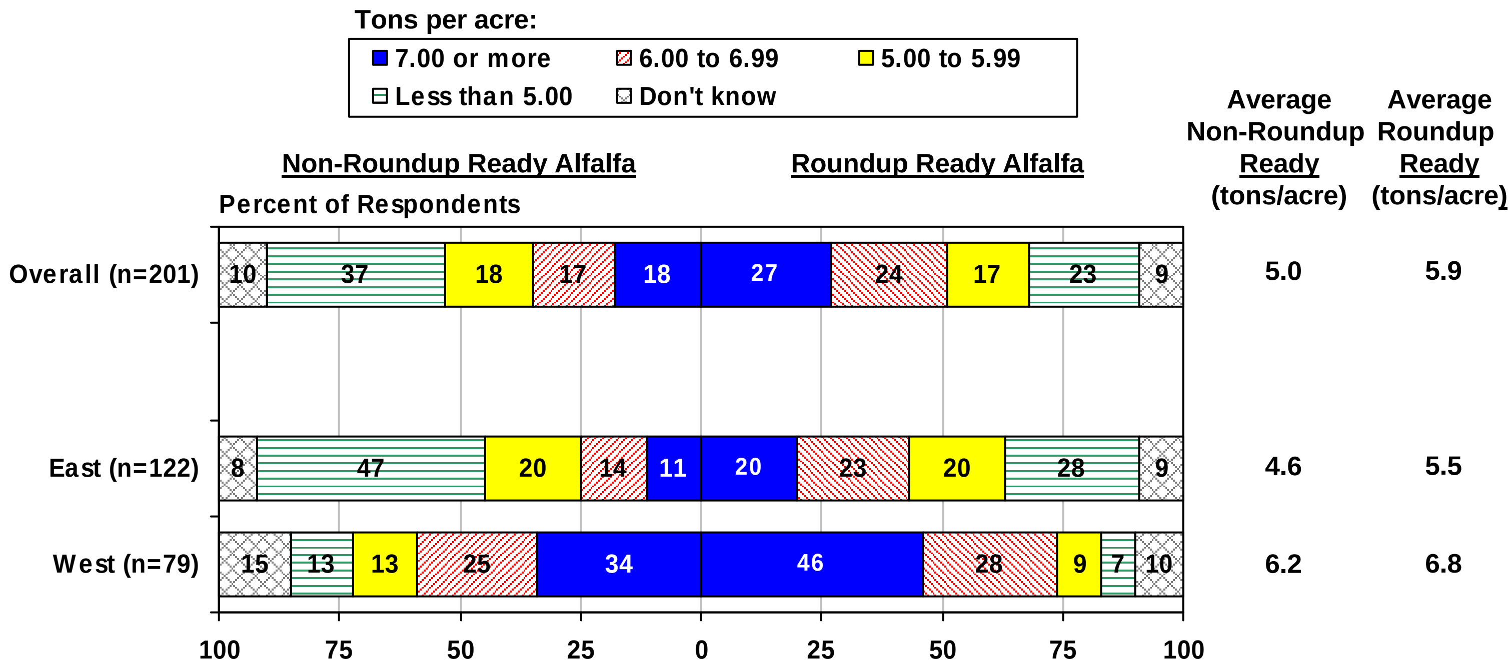
MARKET PROBE, INC.

St. Louis, Missouri

December 2008

Yields On Established Roundup Ready Acres Compared To Established Or Past Non-Roundup Ready Acres

[Base=All respondents]



Q.8b In terms of tons per acre, what was the annual yield on [Established Roundup Ready alfalfa acres][Established non-Roundup Ready alfalfa acres]?

Appendix
I

Putnam, D. and D. Undersander. 2009. Understanding Roundup Ready Alfalfa (Full Version). Originally Posted on the Hay and Forage Grower Magazine Web Site at: http://hayandforage.com/understanding_roundup_ready_alfalfa_revised.pdf (January 1, 2009)

Appendix I
Putnam and Undersander (2009)

Pages 1-3 of Appendix I:

Magazine Version

Holin, F. 2009. Roundup Ready Reality? (Partial version of Putnam and Undersander. 2009. Available at: http://license.icopyright.net/user/viewFreeUse.act?fuid=OTQxOTg4Mg%3D%3D (August 3, 2010)

Pages 4-6 of Appendix I:

Full Version

Putnam, D. and D. Undersander. 2009. Understanding Roundup Ready Alfalfa (full version). Originally posted on the Hay and Forage Grower Magazine web site at: http://hayandforage.com/understanding_roundup_ready_alfalfa_revised.pdf (January 1, 2009).

Hay & Forage Grower

January 1, 2009

Roundup Ready Reality?

by Fae Holin

Is emotion trumping science in debates over the release of Roundup Ready alfalfa? Two forage specialists think so. They've put together a paper debunking what they call misinformation presented at annual conferences around the country.

"We want to dispel some of those myths," says Dan Undersander, University of Wisconsin extension forage specialist. Undersander and his colleague at University of California-Davis, Dan Putnam, offer "a scientific perspective" for alfalfa growers and industry representatives as they evaluate Roundup Ready (RR) alfalfa.

RR alfalfa, legalized in 2005, lost that designation with a court injunction just about two years later. A USDA environmental impact statement, required by the court, is nearing completion with a public comment period expected in the next month. A decision on whether the transgenic crop should again be made available to growers is expected to follow several months later.

In the meantime, the forage specialists want to make sure the alfalfa industry is well-informed. They've offered *Hay & Forage Grower* a preview of their paper, which will be published in its entirety at hayandforage.com [http://hayandforage.com/understanding_roundup_ready_alfalfa_revised.pdf].

Here's a synopsis of their concerns:

1. Once you release this gene, you can't call it back.

Undersander and Putnam respond that the gene is already out - more than 300,000 acres of RR alfalfa have been planted for hay and a limited amount planted for seed. The real question, they write, is whether growers can continue to plant conventional seed. Their answer: Only non-RR alfalfa is being planted now and, if concerned about contamination, growers can test it for the RR gene.

2. Won't contamination from neighboring fields result in all seed being Roundup Ready eventually?

"No," they emphasize, citing that seed production methods and isolation distances will keep the presence of the gene "at a very low level for seed" and that "non-genetically enhanced (non-GE) seed will always be available."

3. Won't my neighbor's RR hayfields contaminate my non-GE alfalfa hay production through pollen and gene flow?

"No," they write. "There is an extremely low probability of gene flow among hayfields. For this to happen, fields must flower at the same time, pollinators must be present to move pollen (it does not blow in wind), plants must remain in fields four to six weeks after flowering for viable seed production, seed must shatter to fall to the ground and establish on the soil surface, seedlings must overcome autotoxicity to germinate and seedlings must overcome competition from existing plants."

Pollen can only be carried by pollinators such as bees, and honey bees don't like to pollinate alfalfa, they add. The specialists discuss the difficulties of the seed germinating, concluding that if growers take care to plant non-RR seed, it's unlikely their hayfields will become contaminated with the gene.

4. Will the seed companies be able to keep seed from being contaminated?

"Yes. The greatest real potential for pollen flow and contamination is during seed production," Undersander and Putnam write. They cite ways the seed industry has agreed to keep track of transgenic seed and reasons why it's in the companies' best interests to do so.

5. Won't feral alfalfa be a source of contamination?

"Feral (wild growing) alfalfa can act as a bridge for moving genes from one seed field to another, and thus should be controlled to prevent gene flow in any area where seed production occurs, whether GE or not. Feral alfalfa is primarily an issue in portions of Western states because little occurs elsewhere," write the forage specialists. They discuss reasons why feral seed would have low production and suggest that removing plants from ditches and roads is a good idea to prevent gene flow.

6. Won't hard seed be a source of contamination?

"Hard seed of alfalfa generally does not persist for more than one year in moist soils, much less after years of hay production," they respond. "To guard against hard seed carryover, seed growers take steps to eliminate residual alfalfa volunteers prior to planting. State seed certification standards already require that the alfalfa seed field's history include a two-year exclusion period before planting alfalfa for seed."

7. Much of the hay in my area is cut late with mature seed - we have good farmers but weather and equipment problems force late cuttings.

"This occasionally happens," Putnam and Undersander answer. "However, plants must remain in a field for four to six weeks after pollination of flowers for viable seed to form and longer for seed to shatter." Delayed cutting will cause little to no seed production in hayfields, and hay harvest should remove seed.

The last seven concerns have to do with **8)** growing organic hay; **9)** export markets; **10)** whether seed companies bias the research on RR alfalfa; **11)** possible effects it may have on insects, animals or the environment; **12)** whether farmers can or will follow stewardship protocols; **13)** weed resistance to Roundup and **14)** whether the risks of RR alfalfa outweigh the rewards.

"There is also a risk with NOT moving ahead with a technology," Under-sander and Putnam contend. RR alfalfa will control tough weeds, they write. "Further, if this breeding methodology is permanently banned, it would mean fewer genetic advancements for alfalfa in the future.

"It is important that alfalfa growers and the industry understand how to use this important new genetic tool, while at the same time, protecting those farmers who don't wish to adopt it."

Authors: Dan Putnam, University of California, and Dan Undersander, Univeristy of Wisconsin
January 2009

Understanding Roundup Ready Alfalfa

A number of concerns have been raised about the release of Roundup Ready (RR) alfalfa, the first biotech trait in alfalfa. Many of these concerns have been fueled by misinformation. In this article, we provide a scientific perspective on these concerns that we hope will inform.

Concern 1. Once you release this gene – you can't call it back.

Over 300,000 acres of RR alfalfa have been planted for hay over the past 2 to 3 years, with a limited amount planted for seed. The real question is whether you can continue to plant conventional alfalfa seed and the answer is a resounding 'yes' – all of the seed currently for sale is 'conventional' – and you only need to test it (or ask the seed company to test it) with inexpensive test strips to make sure it does not contain the gene if you don't want it. Conventional alfalfa seed will continue to be available after Roundup Ready alfalfa is released.

Concern 2. Won't contamination from neighboring fields result in all seed being Roundup Ready, eventually?

No. Seed production methods and isolation distances currently recommended by seed companies should keep adventitious presence at a very low level for seed. A gene will increase in a population only if the new gene gives the plant an advantage over other plants and the conditions creating the advantage are consistently present. Conversely, if plants are grown in an environment where the gene provides no advantage, the gene is more likely to remain in the population at very low levels or to be lost from the population. The formulas for computing these changes in gene frequency can be found in most books on population or quantitative genetics, such as Falconer and MacKay, 1996, Introduction to Quantitative Genetics, Longman Press. Thus non-GE seed will always be available.

Concern 3. Won't my neighbor's Roundup Ready hay fields contaminate my conventional or organic alfalfa hay production through pollen and gene flow?

No. There is almost zero probability of gene flow among hay fields. For this to happen <u>all the following must occur</u>:

- fields must flower at same time.
- pollinators must be present to move pollen (it does not blow in wind).
- plants must remain in field 4 to 6 weeks after flowering for viable seed production.
- seed must shatter, to fall to ground and establish on soil surface.
- seedlings must to overcome autotoxicity to germinate.
- seedlings must to overcome competition from existing plants.

Pollen moves among alfalfa plants only when carried by pollinators such as bees, and honey bees do not like to pollinate alfalfa. Alfalfa seed takes many weeks after flowering to mature sufficiently to germinate and longer to shatter and fall onto the ground. Alfalfa seed does not readily spread. Alfalfa does not germinate well on the soil surface. Germination will be further reduced by alfalfa autotoxicity from existing planting in the hay field (this is why interseeding alfalfa to thicken a stand generally fails). Germinating seeds must compete with established plants for water, nutrients and sunlight. Data has shown that interseeded plants generally die during the first growing season. Thus, if a grower takes care to plant conventional seed, it is very unlikely that the Roundup Ready gene will move to their hay fields. (See Gene Flow in Alfalfa: Biology, Mitigation, and Potential Impact on Production, Special Publication of the Council for Agricultural Science and Technology (CAST) at http://www.cast-science.org/displayProductDetails.asp?idProduct=157)

Concern 4. Will the seed companies be able to keep seed from being contaminated?

Yes, the greatest real potential for pollen flow and contamination is during seed production. The seed industry has agreed on a field tagging technique in areas where RR alfalfa seed will be grown so neighbors and other seed companies will know where RR seed is being produced. The bulk of non-GE alfalfa seed is produced for export by seed production companies and it is in their own best interest to control seed production to continue to produce the 30% or more of total production as non-biotech for export. This large volume of export seed production is much more significant economically than the less than 1% of total seed market for organic seed production. However, concerns and methodology for exported seed will allow organic seed production indefinitely, making non-biotech seed available to growers.

Concern 5. Won't feral alfalfa be a source of contamination?

Feral (wild growing) alfalfa can act as a bridge for moving genes from one seed field to another, and thus should be controlled to prevent gene flow in any area where seed production occurs, whether biotech or not. Feral alfalfa is primarily an issue in portions of Western states because little occurs elsewhere. Feral alfalfa will have low seed production for the reasons described in #3 plus damage from lygus bug and infection from seed-borne fungi when seed develops under damp conditions. Seed from any feral plants will contribute to new plants only over a very short term, but removing feral alfalfa from ditches and roads is a good idea for organic and export growers to prevent gene flow. If feral alfalfa is deemed a problem in a specific area, then it must be controlled as off types of alfalfa and other problem weeds are currently controlled using cultural and other herbicide methods.

Concern 6. Won't hard seed be a source of contamination?

Hard seed of alfalfa generally does not persist for more than one year in moist soils (Albrecht et al. 2008 Forage and Grazinglands), much less after years of hay production. To guard against hard seed carryover, seed growers take steps to eliminate residual alfalfa volunteers prior to planting. State Seed Certification Standards already require that the alfalfa seed field's history include a 2-year exclusion period before planting alfalfa for seed.

Concern 7. Much of hay in my area is cut late with mature seed – we have good farmers but weather, equipment problems force late cuttings.

Although late cuttings occasionally happen viable seed development is unlikely. However, plants must remain in field for 4 to 6 weeks after pollination of flowers for viable seed to form and longer for seed to shatter. Delaying harvest 1 to 2 weeks due to weather, equipment problems and other issues will cause little to no seed production in hay fields (see item #3). Furthermore, hay harvest should remove this small amount of seed so that it doesn't become a problem.

Concern 8. Organic producers may have difficulty growing organic hay.

No – there is no reason that organic growers can't continue to successfully grow organic hay. In fact the presence of Roundup Ready alfalfa hay in the marketplace may increase the value of organic hay, for buyers who are sensitive to biotech traits. Current demand for organic hay has been high, in spite of the introduction of Roundup Ready alfalfa. There are a number of growers who currently grow both Roundup Ready alfalfa and organic hay on the same farm without difficulty. Organic growers should 1) select conventional seed that is tested for the trait if their customers have set a standard of no adventitious presence, 2) take simple steps to protect their crop from gene flow and 3) identify hay lots after harvest. Feedstuffs can be tested to ensure low biotech levels desired for these markets. Organic growers currently are certified to show that their crops are not grown with pesticides or non-organic fertilizers, and similar steps can be taken to show that they do not use genetically engineered crops.

Concern 9. Couldn't we lose our entire export market?

No. While export growers and buyers are sensitive to the presence of biotech traits in crops, they have developed market-assurance methods to demonstrate that they are marketing non-biotech alfalfa hay, including testing to assure buyers of the non-biotech status of hay. Japan, Taiwan, and Korea (main U.S. hay market) already use biotech corn and soybeans and have accepted some RR alfalfa hay. The European Union has approved use of certain biotech varieties of corn and soybeans in food and feedstuffs. While significant in some growing regions in the US, exported hay represents less than 1 % of total alfalfa hay production.

Concern 10. Isn't the research biased by the seed companies that stand to gain most?

RR technology at has been evaluated at many universities. This research is independent of the concerned commercial parties. The goal is to independently test a technology for its viability and environmental safety for farmers and for the general public. These studies must be well-designed, accurate and can only be published only after review by anonymous individuals from other institutions selected for impartiality.

Concern 11. Won't the Roundup Ready gene in alfalfa have a negative effect on insects, diseases, other biota, or the environment?

There is currently no evidence that this gene would have a negative effect on insects or animals, or the environment. The Roundup Ready gene has been thoroughly tested as other crops were released (corn, soybeans, cotton) and no impact on any other biota has been found. No toxicology issues have been identified with roundup ready alfalfa fed to animals. In the past ten years, billions of tons of corn, soybeans, cotton and alfalfa have been produced with this gene, and there has been no documented harm to animals, humans or wildlife. In fact the use of Roundup would replace some more toxic pesticides that have been used and found in ground water (e.g. Velpar).

Concern 12. Farmers can't/won't follow stewardship protocols.

All technology requires stewardship by farmers (e.g. fertilizer use, pesticide use, irrigation). Farmers must be educated about stewardship needed and required to use appropriate stewardship for any technology. The possibility of gene flow is no different in scope than controlling pesticide drift, fertilizer contamination from conventional farms, or for that matter, the influence of weeds from organic fields that may contaminate neighbor's fields. Good farmers know how to do this.

Concern 13. Won't there be weed resistance to Roundup from use of RR alfalfa?

Weed resistance and weed shifts are issues with all herbicides. New management programs have always resulted in shifts in weed pressure. For example, no-till crop production has resulted in different weed problems than when crops were grown with conventional tillage. Resistance to glyphosate has occurred in row crop situations. Inclusion of alfalfa might actually slow increase of resistant populations of weeds because an additional mechanical control (frequent hay harvest) is being added to the weed management program. Techniques are readily available to avoid weed shifts or weed resistance using the Roundup Ready system as detailed in a recent article (Orloff et al., 2008).

Concern 14. Risk far outweighs reward/Do we really need this? Are we willing to take this kind of gamble?

There is also a risk with NOT moving ahead with a technology that has clear potential benefits to farmers and the environment. Currently, many animals are killed or hurt each year by weedy alfalfa fields – something that Roundup Ready technology could help address. Also, some of the conventional herbicides have been found in well water – something not true with glyphosate. Additionally, Roundup Ready alfalfa would allow farmers to control tough weeds for which no other good method of control exists (e.g. winter annuals such as chickweed, wild garlic, wild onion, perennials such as dandelion. difficult weeds such as nutsedge and dodder, and poisonous weeds such as groundsel).

Further, if this breeding methodology is permanently banned, it would mean fewer genetic advancements for alfalfa in the future. Some traits currently under development, such as a low lignin gene that could mean higher forage yield and fewer cuttings for farmers, a leaf retention gene to retain leaves through harvesting process, genes which confer pest resistance, or genes to increase bypass protein, would never be available to farmers. It is not reasonable or fair to farmers to restrict a technology from use in alfalfa that is available in other crops.

A series of articles on biotech alfalfa and coexistence of GE and conventional alfalfa seed and hay production is available at http://www.alfalfa.org/CSCoexistenceDocs.html and http://alfalfa.ucdavis.edu/+producing/biotech.aspx.

In summary, it is essential that alfalfa growers and the industry understand how to use this important new genetic tool, while at the same time, protecting those farmers who don't wish to adapt it. Research has proceeded with great deliberation in the development of Roundup Ready alfalfa and shown it to be a good tool that will benefit many farmers. Like every other tool, it must be used with care and appropriate stewardship. It is important for the industry to manage for coexistence of biotech-adapting and non biotech-adapting farmers, since other important biotech traits are being developed which might be much greater benefit to farmers and society.

Dr. Dan Putnam, University of California
Dr. Dan Undersander, University of Wisconsin

Appendix J

Roundup Ready Alfalfa Harvesting Study, Study #3482 (Originally Submitted as Appendix 6 to Monsanto/FGI Comments to Draft EIS)

ROUNDUP READY ALFALFA HARVESTING STUDY

Study #3482

MONSANTO
imagine™

Prepared By:

Market Probe

St. Louis, Missouri

January 2010

METHODOLOGY

- To achieve the objectives set for this study, a total of 200 telephone interviews were completed with growers who had Roundup Ready alfalfa acres in production in 2009 and/or 2010. The interviews were distributed regionally:

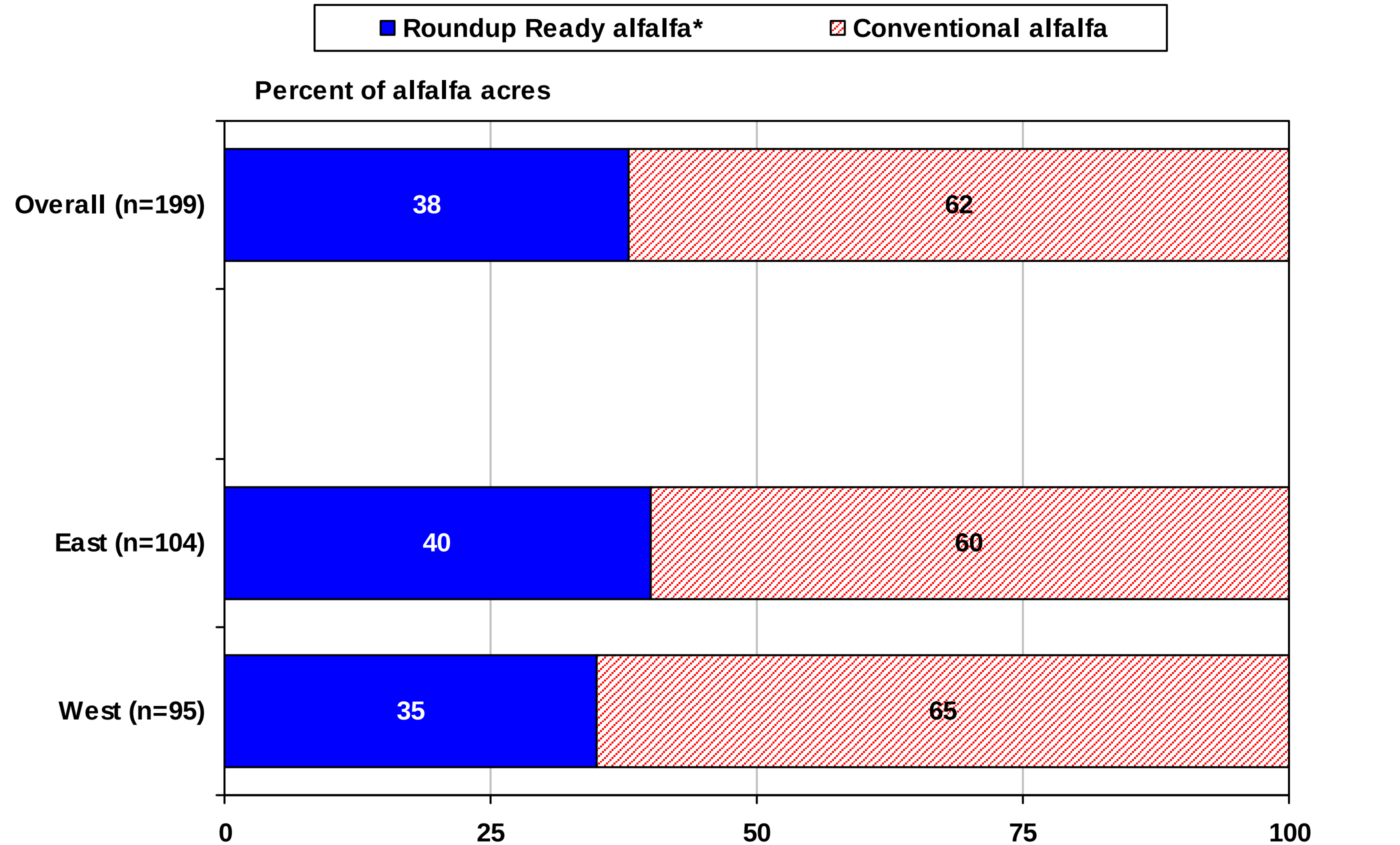
West:	WA/OR/ID/CA/NV/UT/AZ	N=95
East:	All other states, east of the Rockies	N=105

- Participants were screened on the following criteria:
  - Actively involved in farming
  - Primarily responsible for decisions concerning the management practices followed on alfalfa crop
  - Had 30+ acres of Roundup Ready alfalfa in production in 2009 or 2010
  - Not, nor anyone in household, working for a farm chemical manufacturer, distributor, or dealer
  - Not, nor anyone in household, working for a seed company, or as a farmer dealer
  - Not, nor anyone in household, raising alfalfa seed for a seed company

- A monetary honorarium was paid ($40-West and $20-East) to all participants. Interviews were conducted between January 18th and 25th, 2010.

2010 Roundup Ready Alfalfa Penetration

[Base=Respondents able to estimate]



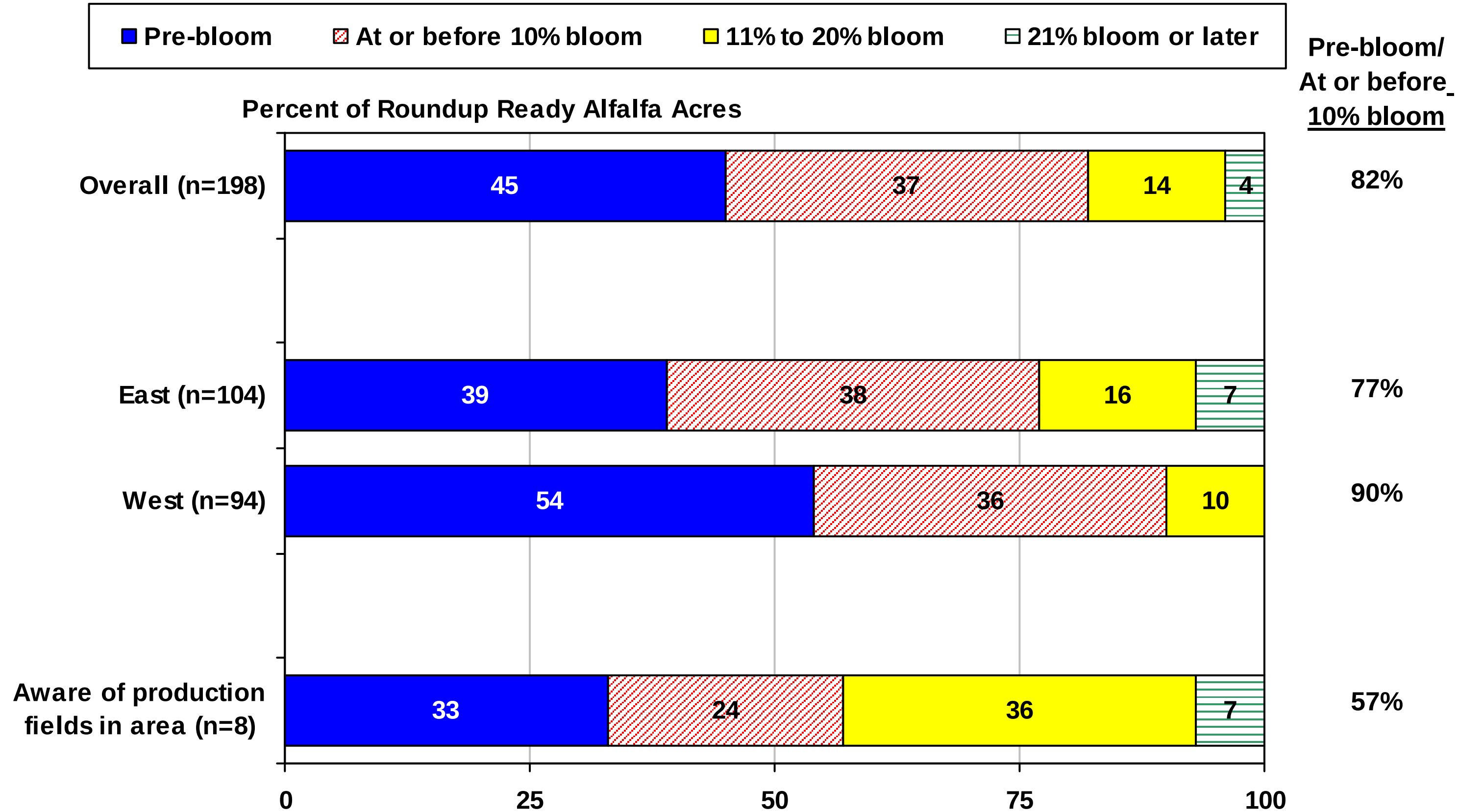
To be included in this study, growers were required to have Roundup Ready alfalfa acres in 2009 and/or 2010

Q.D How many acres of alfalfa, including both established and newly seeded, will you have this year in 2010?

Q.E And, how many, if any, of these [Q.D] acres are Roundup Ready alfalfa, and how many are conventional alfalfa?

Percent Of Roundup Ready Alfalfa Harvested At Specific Stage In 2009

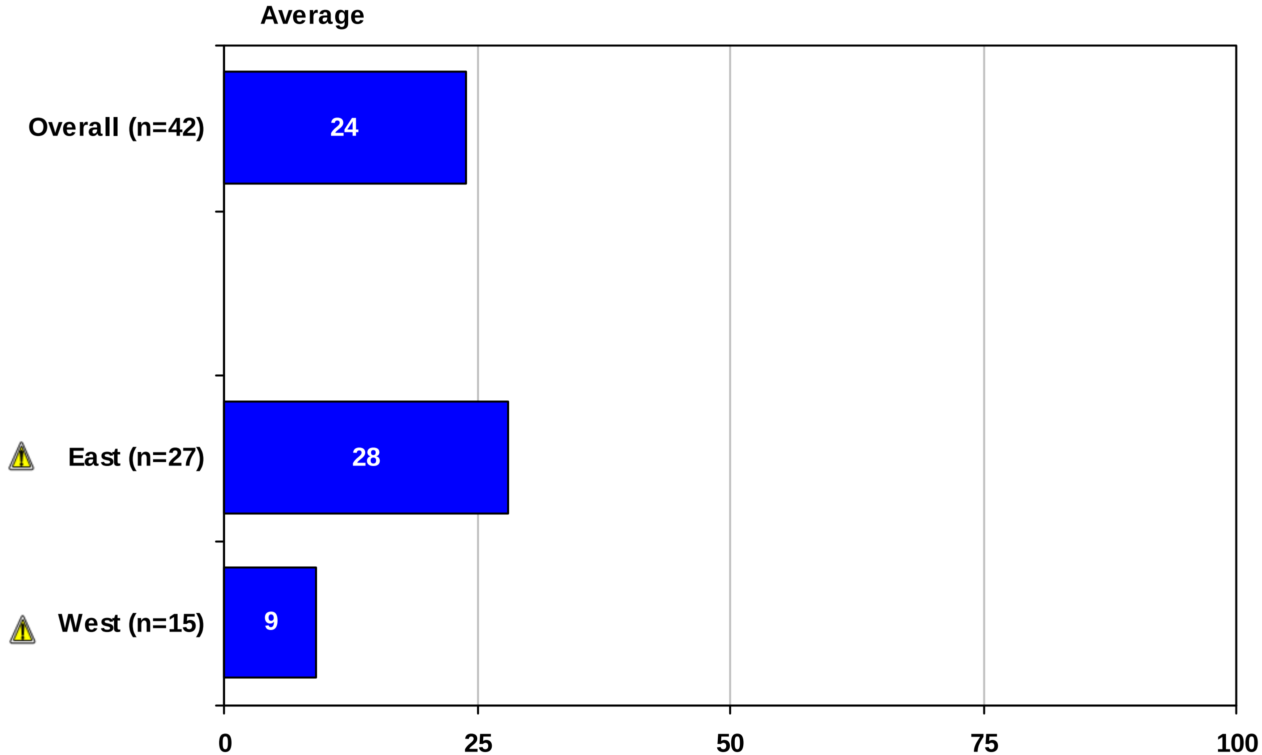
[Base=Respondents harvesting Roundup Ready alfalfa and able to estimate]



Q.3 In 2009, what percent of your total Roundup Ready alfalfa did you harvest:

Of the 18% of Occasions When Harvest Occurred After 10% Bloom, What Percent Were Due To Bad Weather?

[Base=Respondents harvesting at least some Roundup Ready alfalfa after 10% bloom, and able to estimate]



Q.4b What percent of the time was your decision to harvest Roundup Ready alfalfa after 10% bloom due to bad weather?

Appendix
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Fitzpatrick, S. and G. Lowry. 2010. Alfalfa Seed Industry Innovations Enabling Coexistence. Proceedings of the 42^{nd} North American Alfalfa Improvement Conference, Boise, Idaho, July 28-30, 2010

Alfalfa Seed Industry Innovations Enabling Coexistence

S. Fitzpatrick* and G. Lowry**

The alfalfa seed industry has recently implemented two complementary programs that together enable mutual coexistence between conventional and Roundup Ready alfalfa (RRA) seed producers. The 2010 Alfalfa Seed Stewardship Program (ASSP-2010) is an identity preserved process-based certificate offered by state seed certification agencies. It was developed by the Association of Official Seed Certifying Agencies (AOSCA) designed to serve GE-trait sensitive conventional seed producers (e.g., export). In 2008, the Best Management Practices for RRA Seed Production (BMPs) was adopted by the National Alfalfa & Forage Alliance. These BMPs are required coexistence protocols that apply only to RRA seed-producing companies (i.e., no new requirements are imposed upon external conventional seed producers). These market-driven, science-based programs were developed with the involvement of alfalfa industry stakeholders over a 5-year period (2005 to 2010) using all available market and gene flow data. An array of stakeholders were involved that represented diverse segments of the alfalfa seed and hay industries: scientists, seed certifiers, breeders, exporters, marketers, producers, growers and organic. These new programs are independent from and more stringent than AOSCA or OECD Seed Certification Programs. Forage Genetics and Pioneer Hi-Bred International (the only companies producing RRA seed), have collectively reported to inspectors that in 2009 greater than 97% of their conventional seed lots were produced without detection of the RRA trait (>500 lots tested with <0.00% RRA). If detected, AP was less than 0.5% (overall lot average <0.1%).

Seed Program	**No Program (e.g., common seed)**	**USDA National Organic Program Certification**	**Certified Seed**	**Roundup Ready Alfalfa (RRA) Seed**	**AOSCA AASP-2010 Identity Preserved, Certified Seed**
Market	U.S. domestic conventional (baseline)	Organic forage planting	U.S domestic conventional & RRA seed	U.S. domestic RRA seed	U.S. conventional seed for export
Purity Standard or Objective	n/a	No official purity standards; process-based requirements	≤1% off types	≤ 0.5% GE in *neighboring* conventional seed production	Non-detect GE
Spatial isolation from other seed field	n/a	Customized farm plan; not uniform mitigation standard	165 ft	900 ft to 3 mi at RRA seed field planting (pollinator specific)	≥5 miles
Program conforms to:	n/a	USDA-AMS National Organic Program	Federal Seed Act	Industry consensus and RRA seed co. contracts	AOSCA I. P. Program
Program monitored by:	n/a	Local Organic Certifying Agency	State Seed Certifying Agency	State Seed Certifying Agency	State Seed Certifying Agency
Program obligations fulfilled by:	n/a	Organic, conventional grower	Seed company and seed grower	RRA seed company and seed grower	GE-sensitive seed company and conventional seed grower
Growers using the program:	Conventional only	Conventional only	Both, conventional and RRA	All RRA, only	Conventional only

* Forage Genetics International, West Salem, WI **Idaho Crop Improvement Association, Meridian, Idaho