

U.S. Beet Sugar Industry
Submission to the National Academy of Sciences
National Research Council Committee on Genetically Engineered
Crops
September 9, 2015

“Sugarbeets are the best suited crop of any for the adoption of biotechnology.”

Leonard P. Gianessi, National Center for Food & Agricultural Policy, 2002

Background: The U.S. beet sugar industry is a highly-specialized and unique industry that is among the most efficient, low cost producers of white sugar in the world (LMC International¹). The sugarbeet is a vegetable that is 75% water, 20% sugar/molasses, 5% pulp tissue. It is incredibly efficient in turning sunshine, water, nutrients and rich soil into pure natural sucrose. Our industry is a critically important supplier of this important food ingredient that is essential for our nation’s food security. Sugarbeets are grown on approximately 1.2 million acres in 11 states, and are processed in the 22 farmer-owned factories within those growing regions.

Challenges: The U.S. sugar industry has faced threats from predatory trade practices for the past 125 years. The McKinley Tariff Bill of 1890 was the first of many government responses to unfair trading practices that have plagued the world sugar market for more than a century. Since 1970, we have closed 38 beet sugar factories due to low sugar prices, low returns to farmers, and higher production costs. The remaining 22 factories are operating today because thousands of our fellow farmers stepped up and mortgaged their farms to purchase them to avoid further closures, which would have put American consumers at risk of becoming more dependent on unreliable foreign suppliers. Our family farmers are the last owners of the factories, and our future depends on young farmers’ financial strength and stability to invest in our cooperatives.

Problem - Weed Control: Every year, our farmers face a combination of many problems when producing their crop. Pests, a variety of diseases, excess or shortage of water, hail, and frosts (spring and fall) are a given, but weed control has been the single largest production challenge to our industry. Traditionally, we used some combination of 13 different costly herbicides that required exact application timing and conditions, using specialized equipment (band sprayers), multiple cultivations and an expensive and depleting source of hand labor (often with marginal results).

Management time, significant financial investments, and marginal results were not acceptable as ever-increasing cropland was being managed by fewer farmers. We could not be a sustainable industry until we found a solution that would successfully address the weed problem while providing the same high-quality products for our consumers and achieving multiple environmental benefits for our farming communities. Embracing biotechnology (H7-1 Roundup Ready® sugarbeets) was a solution for consumers, the environment and farmers.

¹“Sugar and HFCS Production Costs: Global Benchmarking”: LMC International, Oxford, UK.

Issue 1: Consumer Food and Feed Safety

“The sugar (sucrose) is the same, whether it is derived from conventional or glyphosate tolerant sugarbeets, or from conventional or organic sugar cane.”

Charles Baker, Ph.D.

Sugar and Carbohydrate Specialist, Food Systems, LLC

“America’s sugarbeet growers and farmer-owned processors demand the highest quality standards to assure superior products for our customers.”

Robert Hatch, President, American Society of Sugarbeet Technologists

The safety of GE crops for human health is not in doubt. A 2013 paper by independent researchers noted that 1,783 studies, including many that had been publicly funded, on safety and health issues related to GE crops over the prior 10 years, confirmed the consensus in support of the safety of those crops. A 2011 summary report by the European Commission covering a decade of publicly-funded research, 130 research projects, and 500 research groups similarly concluded that there is no scientific evidence of higher risks of GE crops for food and feed safety, or to the environment.

Nothing is more important to our farmers than the safety of the products they produce for the consuming public. If there were any consumer health or safety issues, the technology developer would not pursue it, the Food and Drug Administration would not allow it, and our farmers would not grow it. It is the scientific complexity of how the traits are constructed for plant use and deconstructed through digestion or processing that leaves people bewildered and causes them to fall prey to anti-biotech activists who misrepresent the science in order to create fear in consumers.

The complete mapping of the sugarbeet genome was announced in a 2013 scientific publication. Each cell of a conventional sugarbeet plant contains 27,421 genes. In the development of glyphosate resistant sugarbeets, only one gene is added to the plant’s genome (27,421 + 1). That one gene provides the instructions for the development of a plant protein (CP4-EPSPS) that allows the sugarbeet to be unaffected when glyphosate herbicide is applied to eradicate weeds that co-exist with the emerging sugarbeet seedlings. Like all biotech crops, if a person were to consume the raw sugarbeet, stomach acid would destroy the structure, and thus the functionality, of the protein. During digestion, the protein would be safely broken down into its rudimentary, non-functional components. Therefore, people could safely eat glyphosate tolerant sugarbeets, but sugarbeets are not produced or sold for direct human consumption. They are commercially produced for the extraction of sugar.

The sugar extracted from the glyphosate tolerant sugarbeet is, at the molecular level, the same as that extracted from conventional sugarbeets or sugar extracted from traditional or organic sugar cane. Since highly specific, state-of-the-art tests do not detect any transgenic DNA or protein, both the sugar and molasses extracted from glyphosate tolerant sugarbeets are approved in all major foreign markets (Canada, Mexico, EU, Russia, Japan, China, South Korea, Singapore, Philippines, Australia, New Zealand and Colombia). The plant tissue, or pulp, from H7-1 Roundup Ready® sugarbeets is highly-desired and valuable cattle feed sold in the U.S. and is readily accepted in Europe and Japan.

The DNA and protein responsible for the glyphosate resistance are separated from the sugar during the refining process. The scientific community knows precisely when, where, and how this is done. Having refined sugar in the U.S. for the past 120 years, we have a long understanding of the process of separating sugar from the accompanying plant protein and DNA molecules.

In 1997, eight years before glyphosate resistant sugarbeets were deregulated in the U.S. and 11 years before their major cultivation in the U.S., German scientists with the Institute of Industrial Genetics, University of Stuttgart, documented and published their research findings entitled, "Nucleic acid and protein elimination during the sugar manufacturing process of conventional and transgenic sugarbeets." It is in the process of clarifying the raw juice extracted from the beet where the proteins are separated from the sucrose solution. A copy of that study is attached for your reference. As part of the deregulation protocol in the USDA/EPA/FDA Coordinated Framework for Regulation of Biotechnology, sugar from transgenic sugarbeets extracted in a laboratory was submitted to the FDA by the technology provider, showing that no transgenic protein or DNA was present.

In addition to the FDA review, sugarbeet farmers insisted on yet another redundant set of testing of a small amount of glyphosate resistant sugarbeets that were grown and segregated as part of an industry demonstration in 2006. Once all of the conventional (not glyphosate tolerant) sugarbeets had been processed through a commercial beet sugar factory, the glyphosate resistant beets were processed. An independent and internationally-respected analytics firm collected and labeled sugar, pulp and molasses at the start, middle and end of each stage of the refining process for subsequent testing in its laboratories. Again, the point at which the transgenic protein and DNA were removed was reaffirmed.

The sugar from these glyphosate resistant sugarbeets was also tested along with sugar refined by all domestic beet and cane sugar refiners, laboratory pure (analytical grade) sucrose, and 44 samples of sugar from around the world. The results: There is no difference in the sugar. Sugar extracted from these GE sugarbeets was made available to any customer who wanted to conduct any further testing before adding it to their products.

In a 2014 comprehensive review of all North American beet sugar factories (22 U.S. factories and the single Canadian factory), 69 samples of refined sugar were collected by the same independent analytic firm to test for any presence of the glyphosate resistant DNA and protein. A polymerase chain reaction (PCR) test specific for the detection of trace amounts of DNA was used for this analysis. Realtime PCR specific for DNA from the glyphosate tolerant H7-1 Roundup Ready® sugarbeet event served as an indicator for the presence of GE DNA in the samples. PCR analyses were performed in parallel with appropriate positive and negative controls. **All sixty-nine samples of commercial sugar tested negative for event H7-1 sugarbeet DNA.**

All samples were further analyzed for the presence of the particular novel protein, CP4-EPSPS, which confers Roundup® tolerance to the H7-1 Roundup Ready® sugarbeet plant. A commercially available protein test kit for CP4-EPSPS (Romer, Union, MO #7000014) was used for this analysis. **None of the sixty-nine samples showed any detectable CP4-EPSPS protein.** All samples from all factories confirmed once again that there is no DNA or protein in the sugar extracted from H7-1 Roundup Ready® sugarbeets.

Sugar extracted from H7-1 Roundup Ready® sugarbeets has been and continues to be of the highest quality and at the molecular level is no different than sugar extracted from conventional sugarbeets or from the sugar extracted from traditional or organic sugar cane. The sugar and molasses from H7-1 Roundup Ready® sugarbeets are the same high quality products that have been provided in the U.S. market for over 125 years.

Even though people do not eat raw sugarbeets, animals do, and all tests conducted on GE sugarbeets have shown the plant material to be as safe and nutritious as the same plant tissues from conventional sugarbeets.

Compositional and quality analysis

To determine whether sugar extracted from H7-1 Roundup Ready® sugarbeets was as nutritious and safe as conventional sugarbeets, a total of 55 statistical comparisons for the leaf and root tissues were made using material collected from five different countries in Europe. Compositional analysis included comparisons of nutritional components such as: dry matter, crude protein, crude fat, crude fiber (both ADF and NDF), crude ash, total carbohydrates, percent sucrose, invert sugar (glucose + fructose), 18 different amino acids, sodium, potassium and alpha-amino nitrogen. In addition, naturally-occurring triterpenoid glycosides, the saponins, which are found in sugarbeets, legumes, potatoes and tea, were assayed. All measures of composition and quality were well within the range of conventionally-grown sugarbeets.

Safety of the new protein

Toxicology studies on the protein encoded by the gene that conveys the glyphosate tolerance trait (5-enolpyruvylshikimate-3-phosphate synthase, or EPSPS, from the CP4 strain of *Agrobacterium* sp.) have shown no adverse effects at dosages that are orders of magnitude greater than the amounts that could be consumed by animals fed sugarbeets. In addition, standard allergenicity assays have shown that the protein has no properties associated with known allergens of any kind, not just food allergens.

For a detailed compilation of the safety assessments conducted on the CP4 EPSPS protein, please see the protein monograph prepared by the ILSI Research Foundation at http://www.cera-gmc.org/files/cera/uploads/ebr_cp4epsps.pdf

Issue 2: Environmental Benefits

“Adopting biotechnology in sugarbeet production has provided numerous environmental benefits to tens of thousands of farms across America.”

Jerry Darnell, President, Beet Sugar Development Foundation
Nebraska/Southern Region Agricultural Manager, Western Sugar Cooperative

Glyphosate resistant sugarbeets provide 25 identifiable environmental benefits that include fewer and safer herbicides, improved soil and water quality and conservation, increased plant health, sequestration of greenhouse gases, less fuel consumption and fewer emissions.

HERBICIDES

- 1) Fewer herbicides (13 vs. 1)
 - a. Conventional Sugarbeet Herbicides: The following array of herbicides have been made available for use with conventional sugarbeets:
 “Select”(Clethodim); “Stinger” (Clopyralid); “Ro-Neet” (Cycloate); “Betanex” (Desmedipham); “Eptam” (EPTC); “Nortron” (Ethofumesate); “Spin Aid” (Phenmedipham); “Pyramin” (Pyrazon); “Assure” (Quizalofop-p-ethyl); “Poast” (Sethoxydim); “Treflan” (Trifluranlin); “Pinnacle or Upbeet” (Triflurosulfuron-methyl), “Outlook” (Dimethenamid-p)
 - b. GE Sugarbeet Herbicides: “Roundup®” (Glyphosate)
- 2) Less toxic herbicides

Of eight herbicides evaluated in the 2002 study by the National Center for Food and Agricultural Policy, glyphosate had the lowest total Environmental Impact Quotient (EIQ), which is used to predict the potential risk of pesticides. Academic trials at eight land grant universities demonstrated outstanding crop safety for the Roundup Ready® sugarbeet system compared to a conventional herbicide program.

A comparative analysis between glyphosate and twelve of the other alternative approved herbicides for sugarbeets shows the numerous environmental benefits of glyphosate. The table below is a summary of the comparisons.

✓ Indicates a potential for reduction in risk category by using Roundup® agricultural herbicides.

Table VII-11. Potential reduction in risk from use of Roundup® agricultural herbicides compared to alternative herbicides used in U.S. sugarbeet production

Active Ingredients ¹	Human Health Risk		Non-Target Species Risks					Groundwater Contamination	Total Number of Areas for Potential Risk Reduction
	Acute	Chronic	Mammals	Fish	Aquatic Invertebrates	Aquatic Plants	Avian		
Clethodim	✓	✓				✓		✓	4
Clopyralid	✓							✓	2
Cycloate	✓							✓	2
Desmedipham	✓	✓		✓		✓	✓	✓	6
EPTC	✓	✓	✓					✓	4
Ethofumesate	✓							✓	2
Phenmedipham	✓			✓	✓	✓			4
Pyrazon	✓					✓		✓	3
Quizalofop-p-ethyl	✓							✓	2
Sethoxydim	✓	✓		✓	✓	✓			5
Trifluralin	✓	✓		✓	✓	✓	✓		6
Triflusulfuron	✓					✓			2

Legend:

¹ Alternative herbicides are compared to glyphosate, using the label from Roundup UltraMAX herbicide.

✓ Indicates a potential for reduction in risk category by using Roundup agricultural herbicides.

- 3) Fewer herbicide applications
On average, conventional sugarbeets require 3-4 herbicide applications per year, and each application typically consists of 3-4 active ingredients. This means that the average U.S. conventional sugarbeet acre receives 12 herbicide acre treatments during the year (2002 study by the National Center for Food and Agricultural Policy). Under the Roundup Ready® sugarbeet system (RRSB), only two-to-three applications of Roundup® (one active ingredient) are needed. Herbicide resistance management recommendations in the Roundup Ready® system include the use of an alternative mode of action such as a residual herbicide applied at planting or early post-emergence, such as metolachlor or acetocholor, for control of small seeded broadleaf and grassy weed species.
- 4) Glyphosate binds tightly to the soil, thus preventing or reducing movement to surface or ground water before it breaks down.
 - a. The Windows-Pesticide Screening Tool (Win-PST), developed by the U.S. Department of Agriculture's Natural Resources Conservation Service, predicts the environmental impact to surface and groundwater based upon pesticide properties and soil type.
 - b. Using this tool, five of the alternative herbicides were predicted to have a higher risk of runoff to surface water and two also were found to have a greater risk for leaching into groundwater.
- 5) Worker/applicator safety in handling and applying less toxic herbicides
- 6) Eliminate hand labor (hard work, low availability, costly, inefficient, less than effective, and reduced exposure to crop protection products)

PLANT HEALTH

- 7) Healthier plants due to less herbicide-induced stress provide early season crop vigor.
- 8) Healthier stronger plants help fight other diseases.
- 9) No plant stress provides one month more of growth (increases yield). Crops are limited by spring and fall low temperatures, so every day of healthy growth is critical.
- 10) Less weed competition for nutrients
- 11) Less weed competition for water
- 12) Less weed competition for sunlight
- 13) Reduced weed seeds in the soil means cleaner fields in future years in other crops.
- 14) Eliminating cultivation removes any disruption to the plant root system.

SOIL CONSERVATION

- 15) Low or no till/cover crops for reduced wind erosion
- 16) Low or no till/cover crops for reduce water erosion
- 17) Fewer weeds mean less movement of weed seed from field-to-field from tillage, harvesting equipment and irrigation.

WATER QUALITY AND CONSERVATION

- 18) Better water absorption in soil (less soil compaction)
- 19) Better water retention (water not lost to evaporation from cultivation)
- 20) Broader application window allows for more optimum application conditions.
- 21) Healthier plants use more nutrients; therefore, there is less nutrient loss to storm water. (As noted in Benefit #4, glyphosate bonds to the soil to avoid surface runoff and groundwater leaching.

REDUCED GREENHOUSE GASSES

- 22) Less soil disturbance (carbon sequestration)
- 23) Less fuel (CO₂ reduction): By reducing trips across the field from 7-10 trips for conventional beets, to 3-4 trips for GE sugarbeets, we reduce fuel usage by 3.25 gallons per acre, which reduces CO₂ emissions by 65 lb. /acre or 76.8 million lbs. per year for the beet sugar industry nationally.
- 24) Healthier plants convert more CO₂ to oxygen.

REDUCED CROP STORAGE LOSSES

- 25) No weeds in storage piles (reduces disease and sugarbeet degradation in storage piles)

Issue 3: Coexistence

“America’s sugarbeet seed and root crop farmers are great people, great farmers and great neighbors.”

Thomas Schwartz, Executive Vice President, American Society of Sugarbeet Technologists and the Beet Sugar Development Foundation

The sugarbeet (*Beta vulgaris* subs. *vulgaris*), table beet (*B. vulgaris* subsp. *vulgaris*-Conditiva-group) and chard (*B. vulgaris* subsp. *cicla*-group and *Flavenscens*-Group) all share the same wild taxon ancestor (the sea beet, *Beta vulgaris* subsp. *maritima*). The sea beet is native to the coasts of Europe, northern Africa and southern Asia. It also lives in the wild along some shores in Great Britain.

Commercial Sugarbeet Production:

Individual farmers routinely incorporate multiple crops and production practices within a single operation. Coexistence is not about health or safety; it is about finding ways to improve working relationships when different production systems are used in close proximity. This is not an issue for commercial sugarbeet production.

The 1.2 million acres of commercial sugarbeet production are harvested in the first year of growth and only rarely will a beet plant grow a seed stalk and produce pollen or seed. If a seed stalk or “bolter” does occur in a field of GE sugarbeets, the producer is obligated under the technology stewardship agreement to physically remove it. This mandated stewardship eliminates the potential for cross-pollination of GE sugarbeets with other commercial *Beta* crops (red table beets and/or Swiss chard). The matter of organic sugarbeets is irrelevant, as no organic sugarbeets are grown commercially.

Additionally, commercial fields of red table beets and Swiss chard, like those of conventional or glyphosate resistant sugarbeets, are harvested in their first year before sending up a seed stalk.

Sugarbeets have a long history of coexistence and safety. Field trials of regulated biotech sugarbeets (H7-1, H77, Liberty Link®) began as early as 1993--11 years before deregulation (2005) of H7-1 Roundup Ready® sugarbeets. For the past 22 years, field trials of glyphosate tolerant sugarbeets have been closely monitored and analyzed without injury to humans or the environment. Eighteen Ph.D. research scientists at 10 universities and five Agricultural Research Service stations have worked closely with H7-1 Roundup Ready® sugarbeets.

Commercial Production: H7-1 Roundup Ready® sugarbeets have been planted commercially for 10 years (2006-2015), totaling approximately 9 million acres in 11 states. There have been no reported incidents of harm or injury.

There is no viable seed produced in commercial production; hence, no seed can be saved and replanted. Thus, there is no risk of patent infringement by the producer. Given the extreme temperatures in all growing areas, the vegetable root in the field dies after harvest, so subsequent year “volunteers” are not an issue. Growers must follow the key requirements in the Technology Use Guide summarized below:

The Monsanto Stewardship Agreement

In order to purchase H7-1 Roundup Ready® sugarbeet seed (RRSB), every grower must sign a Monsanto Technology/Stewardship Agreement, legally binding the grower to take appropriate stewardship actions and to follow the Technology Use Guide which requires:

- 1) A grower cannot buy or receive RRSB from an unlicensed dealer.
- 2) An unlicensed and unauthorized grower cannot sell or transfer RRSB to another grower.
- 3) Any bolting sugarbeets must be rogued or topped.
- 4) Pesticide labels must be followed.
- 5) Recommended use of additional herbicide modes-of-action or mechanical weed control in other RR crops rotated with RR sugarbeets.
- 6) RRSB are not permitted to be planted in any wildlife feed plots.

COMMERCIAL SEED PRODUCTION

BACKGROUND:

Sugarbeet seed production has a 75-year record of safe coexistence with other *Beta* seed crop production due to effective seed grower stewardship.

Location: Sugarbeet seed has been commercially produced in the Willamette Valley (Salem – Eugene) of Oregon since 1940 (75 years). The valley is 100 miles long, covering one million acres. Many seed crops are grown in this valley because of its unique climate. Some smaller amounts of sugarbeet seed are also grown in northeastern Washington State.

How it's grown: 2,500–3,500 acres of sugarbeet seed are produced under contract between transplant nurseries or directly sown in growers' fields in late July, August and early September. Very small sugarbeets, called "stecklings," are produced in nurseries and are transplanted in growers' fields from January through March. In some direct sown fields, male pollinators may not be planted along with the females to allow for later varietal selection. Some male stecklings (some produced in Arizona) are then transplanted next to the females in the spring. The beet plants send up seed stalks that flower and pollinate in May-June. The seed is harvested by a combine in July and August and processed during the fall and winter months for delivery to growers the following spring for root/sugar production.

Who grows: The six sugarbeet seed companies produce approximately 160 seed varieties that are processed by:

- 1) West Coast Beet Seed Company, which processes seed varieties for:
 - a. Syngenta - Longmont, CO; Basel, Switzerland (headquarters)
 - i. Hillehog
 - b. SES Vanderhave – Fargo, ND; Tienen, Belgium (headquarters)
 - i. Seedex, Inc.
 - c. Holly Hybrids – owned by Southern Minnesota Beet Sugar Cooperative
 - d. American Crystal Sugar Company
 - i. Crystal Beet Seed - only American Crystal Sugar Company area
- 2) Betaseed, Inc. (a subsidiary of KWS SAAT SE, Einbeck, Germany) produces and processes seed varieties for:
 - a. Betaseed
 - b. ACH Seeds (outside American Crystal Sugar growing areas)

Varieties: Approximately 160 different beet seed varieties produced every year for six companies. The vast majority of these are biotech varieties for the U.S. and Canadian markets. Varieties are bred for specific regions of the United States and Canada to help address disease, insect, climate and other regional issues.

Pollination: Hybrid sugarbeet seed is produced by wind pollination. Almost all of the biotech traits are on the female plant and pollinated by conventional male pollen.

Isolation distances: Sugarbeet pollen can only successfully pollinate with other *Beta* crops (red table beet and Swiss chard). Sugarbeet pollen is not compatible for production of other species.

- a. Given the unique traits of each sugarbeet variety, sugarbeet seed producers and their competitors do not want cross-pollination of one sugarbeet variety with another sugarbeet variety.
- b. A small amount of other *Beta* species (up to 250 acres of Swiss chard and red beet seed crop production) exists in the Willamette Valley. Sugarbeet seed producers must avoid Swiss chard and red beet seed pollen from crossing with their crop; conversely, conventional or organic Swiss chard and red beet growers do not want any sugarbeet traits in their product. Seed purity is mutually desirable among all growers of sugarbeet, Swiss chard and red beet seed.
- c. Viable sugarbeet pollen is heavy and typically does not move long distances (approximately 2,000 meters). Sugarbeet pollen is viable for a maximum of 24 hours, depending upon environmental conditions, especially moisture (from EIS). For pollen to impact other *Beta* crops there would need to be "pollination synchronization," in which both crops were pollinating and receptive at the same time. If this occurs, each field is filled with its own dense pollen cloud, and pollen from other *Beta* crops would have to travel a long distance and penetrate.
- d. For 75 years, isolation distances for conventional seed production were established at 1.5 miles (or 2,400 meters). Under the Willamette Valley Specialty Seed Association, all *Beta* variety producers in the Willamette Valley found that isolation distance acceptable and successful.
- e. All *Beta* crop acres are identified on an electronic pinning map, which is available on the web and constructed with GPS coordinates to make sure that isolation distances are identified and respected. This process, while now modernized, has been voluntary and practiced for 75 years.
- f. Understanding the sensitivity of biotechnology to the organic red beet and Swiss chard seed industry, the sugarbeet seed industry proactively took two extraordinary stewardship actions to assure the ability to coexist with organic red beet and Swiss chard.
 - i. Isolation distance protocols for all RRSB varieties in proximity to other sugarbeet, red table beet and Swiss chard fields were increased from 1.5 miles (2,400 meters) to 4.0 miles (6,400 meters).

- ii. Seed companies have transitioned to inserting the Roundup Ready® gene into the female plant, so there is no Roundup Ready® gene in the pollen. More than 97% of the seed produced in 2015 had the gene on the female plant.
- g. Subsequent years: Five-year protocols are in place to destroy any stray sugarbeet plants in fields that are produced in fields from seeds not captured at harvest.

2) Seed mixing

- a. No red beet or Swiss chard seed is processed at sugarbeet seed processing facilities. Therefore, there is zero risk of cross-contamination in the facility.
- b. Seed processing equipment has always been thoroughly cleaned between the processing of any sugarbeet seed varieties, conventional or biotech. If mixing did occur, any Roundup Ready® seed in conventional seed would not be an issue. If conventional seed was mixed with Roundup Ready® seed, the conventional seed would be killed by the Roundup herbicide. This issue would be contained between the seed company and the grower. There is no impact on the environment or coexistence. Given the small total volume of sugarbeet seed, it is prepared in smaller processing facilities that are routinely cleaned when changing from one variety to another to protect variety purity.
- c. All Roundup Ready® seeds have a special color coating that identifies the seed as Roundup Ready® to alert all persons who are part of the chain of custody of the seed.
- d. All seed boxes for the customer are also well marked.
- e. No mixing has occurred, thus no injury has occurred.

Issue 4: Seed Company Concentration and Farmer Choice

“Six different seed companies offer our farmers 80 different GE and non-GE varieties of seed to choose from to plant on 400,000 acres. We have plenty of competition and good seed choices.”

Paul Rutherford, President, Red River Valley Sugarbeet Growers Association

Six seed companies produce approximately 160 varieties of sugarbeet seeds. It is a very diverse and competitive market.

Climate, soils and diseases determine what seed varieties are approved for each production area. In order to meet the diversity of grower needs, each sugarbeet cooperative selects and approves only the best varieties for its growers to assure an adequate supply of sugarbeets to process. New varieties typically undergo three years in field test plots to assure grower confidence in seed productivity under a variety of weather and disease conditions. Unlike other general commodities, all acres are contracted by the cooperative and there is no alternative source of sugarbeets for the factory, so seed varieties are critically important to both the farmer and the processor.

Issue 5: Trade

“Even though the U.S. is the world’s second-largest sugar importer, sugar from GE sugarbeets has been approved for import as sugar or in sugar-containing products in all major markets, and our beet pulp is welcomed in Europe and Japan.”

Galen Lee, President, Nyssa (Oregon)/Nampa (Idaho) Beet Growers Association
ASGA Vice President
Chairman, ASGA International Affairs Committee

The U.S. is the second-largest importer of sugar in the world. While we typically do not export sugar, beet sugar is often contained in sugar-containing products that are exported. The sugar from H7-1 Roundup Ready® sugarbeets is the same at the molecular level as that produced from conventional sugarbeets and sugar cane or organic sugar cane. Both sugar and molasses from H7-1 Roundup Ready® sugarbeets are approved in all major foreign markets (Canada, Mexico, EU, Russia, Japan, China, South Korea, Singapore, Philippines, Australia, New Zealand and Colombia). For countries that have mandatory labeling requirements, imports of any human food or animal feed derived from one or more transgenic crops would require a label if the total amount of an ingredient exceeds the mandated level.

The plant tissue, or pulp, from H7-1 Roundup Ready® sugarbeets is highly-desired and valuable cattle feed that is sold in the U.S. and is readily accepted in Europe and Japan.

Issue 6: Farmer Efficiency

“GE technology in sugarbeets saved our industry by putting our farmers on a sustainable path of efficiency and competitiveness so we can pass our farms on to our sons and daughters.”

John Snyder, Farmer, Worland, Wyoming
President, American Sugarbeet Growers Association

American agriculture continues to experience consolidation with fewer farmers working more acres, so we have to work with tools that provide tremendous efficiency. The broad spectrum of input costs has steadily increased while market prices for our crops often remain depressed. We must use the best tools to reduce or contain costs and maximize our production in a more environmentally sustainable way. With the adoption of GE technology in sugarbeets, growers have made major advances in efficiency, many of which also provide environmental benefits.

A list of those efficiencies follows:

- 1) The lack of stress on the plant from herbicides applied on conventional sugarbeets has provided an equivalent of one month's additional growth. This, along with other non-GE trait improvements, cultural practices and new crop protection products, has contributed to a significant increase in yields. In a recent publication by Lee Panella, USDA-ARS, Crop Research Lab, Fort Collins, Colorado (and others), it is cited that an average tonnage harvested in 1909 was 10.1 tons/acre; in 2015 that yield was 29.9 tons/acre, which is a 200 percent increase in yield. During the eight years (2008-2015) of planting Roundup Ready® sugarbeets, yields have increased 19 percent over the average yield produced by conventional seed in the eight years (2000-2007) prior to widespread commercialization of Roundup Ready® sugarbeets. Also in that timeframe, the sucrose content of the beets also increased significantly.
- 2) We have eliminated the use of hand labor to remove weeds, which was an expensive and difficult process due to the challenges in recruiting and retaining good seasonal workers.
- 3) We have virtually eliminated between-the-row cultivations that require special cultivating equipment.
- 4) We have eliminated specialized “band” sprayer equipment used only in sugarbeets.
- 5) We have replaced the use of multiple costly herbicides with one low-cost herbicide that is more environmentally friendly and safer to handle.
- 6) We use less fuel by eliminating several tillage and application operations.
- 7) We reduce the number of operating hours on our tractors by eliminating some land preparation, cultivation, and multiple herbicide applications.
- 8) We have reduced the number of hours of labor to conduct some land preparation, cultivation, and multiple herbicide applications.
- 9) The reduction in weed competition has resulted in more water and nutrients being available for the crop.
- 10) The absence of weeds makes harvesting easier because weed roots and stems are not entering the harvester.
- 11) The reduction in time spent on weed management allows our farmers to increase efficiency and devote more time to other key farm operations.

Issue 7: Herbicide Resistance

“Taking preemptive action against herbicide weed resistance is on every grower’s mind and they have been fully committed to doing it.”

Don Morishita, Ph.D., Superintendent, Professor and Extension Specialist
University of Idaho, Kimberly Research and Education Center, Kimberly, Idaho

Herbicide resistance is not new, nor is it unique to GE crops. In fact, the first case of resistance to an herbicide in the U.S. was recorded in the Pacific Northwest in 1957. This is why the beet sugar industry took proactive actions to make sure intensive grower education occurred prior to the availability of any GE sugarbeet seed. That education continues in regular grower meetings and on-line educational tools. Sugarbeet growers clearly understand that the value of the technology is only fully realized as long as no resistance occurs. The four steps that we have followed are:

- 1) **Education:** Annual grower educational meetings always include reminders on weed resistance. An on-line weed resistance course has been available to growers prior to commercialization in 2006.
- 2) **Label:** Growers must strictly follow the application labels as required by the stewardship agreement with the technology provider.
- 3) **Crop rotation:** Sugarbeets are typically grown on the same land once every three to four years. Other crops (wheat, barley, dry beans, potatoes, and other specialty crops) that use other herbicides are often used within the rotation period.
- 4) **A second herbicide:** If there is any concern about either preceding or following a glyphosate tolerant crop with H7-1 Roundup Ready® sugarbeets, an additional herbicide with a different mode of action can be tank mixed with Roundup® to remove any glyphosate volunteer crops and reduce any threat of weed resistance.

Glyphosate resistant weeds have begun to move into sugarbeet growing areas as a result of continuous use in other crops. Development of other herbicide resistant traits for corn and soybeans is expected to help address this problem in the years ahead.

As a result of the “Weed Summit” at the National Academy of Sciences in November of 2014, the beet sugar industry is pursuing pilot projects in four states over the course of three years to find effective methods to engage entire communities (urban and non-beet growers) in the prevention of weed resistance. This partnership with USDA will identify educational, communication and motivational techniques that would be very helpful in addressing herbicide resistance issues across the broad spectrum of crops.