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Round-Up® Ready Spring Wheat: Its potential short-term impacts on U.S. wheat exports markets and prices*

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> "Currently, the agrochemical industry faces two major challenges…On the one hand, to pay for large development and commercialization costs, investors and firms that have funded GM-related technologies must capture a share of the return on that investment. On the other hand, corporations and regulators must also ensure that the new traits and varieties created do not impose risks or liabilities that offset (or swamp) the value generated. At the farm level, in particular, there is significant risk of profit reduction and for co-mingling of plants with new traits with other crops, creating potential new liabilities."
>
> **-- Smyth, S., G. G. Khachatourians & P.W.B. Phillips,**
> **"Liabilities and economics of transgenic crops,"**
> ***Nature Biotechnology, 20, No. 6, 2002, pp.537-541.***

Abstract

This report examines potential impacts on export markets and prices from commercializing GMO hard red spring wheat in the U.S. within the next two to six years. GMO crop technology offers possible large benefits to consumers in the future, if plant-breeding concepts in the development stage materialize. For the short run, however, there is much evidence suggesting that the majority of foreign consumers have serious reservations about purchasing food products made from GMO wheat. Many foreign consumers see nothing to be gained from buying food produced with these types of wheat. Many have questions about the long-term safety of GMO crops, which may not have scientific validity. With or without scientific validity, consumer attitudes determine buying patterns when GMO food labeling programs are present, as they are in many foreign markets for wheat. Potential accidental co-mingling would put both U.S. durum and other spring wheat exports at risk even if only GMO hard red spring wheat were commercialized. With a substantial loss of export markets, excess U.S. production capacity for durum and other spring wheat would be expected to quickly depress prices for these classes to feed-wheat levels.

* The author wishes to acknowledge reviews of earlier drafts and helpful suggestions from Drs. Neil Harl, Roger Ginder, and Michael Duffy (Distinguished Professor, Professor, and Professor), Economics Department, Iowa State University, Dr. Dan O'Brien, Associate Professor and Kansas State University Agricultural Economist, Dr. George Flaskerud, Professor, North Dakota State University Department of Agricultural Economics, and Dan Hiller, retired commodity specialist from Royal Bank of Canada Dominion Securities, Edmonton, Alberta, Canada. ***Note: In May 2004, Monsanto decided not to commercialize this type of wheat because of foreign consumer resistance.***

GMO Spring Wheat: Its potential short-term impacts on U.S. wheat export markets and prices

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Executive Summary

For the longer term, Biotechnology offers potential large benefits from improved agricultural productivity, consumer health and nutrition, and greater efficiency in grain processing if concepts currently in the planning and research stages materialize. Potential benefits of biotechnology include plants with increased resistance to pests, diseases, drought, extreme temperatures, saline soils, and plant products with improved nutrition, cancer-resistance properties, and ability to reduce the risk of heart disease, as well as pharmaceutical crops for producing medicine.

U.S. farmers have rapidly adopted Genetically Modified (GMO) soybeans and cotton in the last few years, because of their ability to simplify weed control, and to reduce the cost of controlling insect pests in cotton. GMO corn has been much less extensively used, but is an important new technology in areas with serious insect and weed-control problems. GMO canola is widely used in Canada. History and economic analyses indicate that the major gainers from GMO crops in the longer run will be (1) producers of the seed and (2) consumers, through lower food costs and possible increased food quality. If the expected agricultural productivity gains materialize, early adopting producers may experience some temporary economic gains (depending on cost of the seed and speed with which the new technology is adopted), but over time will have declining prices to offset potential reduced costs, as global production increases.

The Marketing Challenge for GMO Wheat

For the short term (two to six years), the spring wheat industry faces a serious GMO marketing challenge that affects not only farmers and the seed industry, but all businesses related to the spring wheat industry as well as rural communities, local governments, foreign food processors, retailers and consumers, and very possibly U.S. producers of other classes of wheat and feed grains. Round-Up® herbicide resistant hard red spring wheat (HRS) has been developed and may be offered for commercial production some time in the next few years. Its developer has applied for de-regulation in the U.S. and Canada, but has indicated it does not expect to immediately begin selling Round-Up® Ready wheat because of uncertainty about export market acceptance. The evidence of a major marketing challenge comes from surveys and other indicators of foreign consumer demand that suggest a large majority of foreign consumers and wheat buyers do not want GMO wheat at this time. Unlike those in the U.S., overseas marketing mechanisms in many countries offer consumers a choice of food products made from GMO vs. non-GMO grain.

Wheat is different in several major respects from corn and soybeans, where substantial U.S. exports continue despite widespread GMO production. Spring wheat is a food grain, with dominant markets being direct human consumption rather than livestock feeding. Processing through livestock or removal of GMO protein by processing into vegetable oils and sweeteners has allowed much of the U.S. corn and soybean production, as well as Canadian canola, to avoid foreign GMO food labeling programs. ***This almost certainly will not be the case for spring wheat since its main use is for direct human consumption.*** Also, the U.S. produces a much smaller percent of the total world wheat crop (eight percent in 2002) and has a much smaller share of world exports than is the case for corn and soybeans. Competing wheat supplies, barring adverse weather, are much more readily available from other countries than for corn and soybeans. At this writing, it appears likely that a number of important wheat exporting countries will continue to produce non-GMO wheat for the next few years. Moreover, wheat exports are a much higher percentage of total demand for spring wheat than for U.S. corn (about 40% vs. 18%), thus creating greater downward price risk. ***As this report was being written, total U.S. wheat exports were already at a very depressed level, the lowest since 1971-72 in the 2002-03 marketing year just ended. In the 2003-04 marketing year, a temporary increase is expected due to unusually severe weather problems in Europe and the former Soviet Union. Another contrast between wheat and corn is that domestic processor demand for corn has been a strong growth market due to rising demand for corn-based fuel ethanol, while domestic demand for spring wheat has grown only slowly in recent years. Thus, domestic demand for wheat cannot be counted on to profitably absorb losses in export markets in the same way as with corn.***

At least 37 countries currently have mandatory labeling programs for food that contains detectable GMO ingredients above prescribed levels. Another 10 to 12 countries very likely will initiate mandatory GMO labeling programs in the next few years. ***The recent ratification of the Cartagena Protocol on Global Biosafety (which became operational on September 11, 2003)*** and prospects for commercialization of a large number of new GMO crops and livestock in the next few years may encourage increased labeling by foreign countries. The up-coming enlargement of the European Union (EU) with at least 10 potential new entrants also will encourage more labeling.

Durum wheat exports would be at risk if GMO HRS wheat is adopted. Durum wheat is grown on farms that produce HRS wheat, and is marketed through the same marketing system as HRS wheat. About two-thirds of U.S. durum wheat exports recently have gone to the EU, where the current threshold for GMO labeling is 1.0% and is expected to decline to 0.9% starting in 2004, for approved GMO crops. In EU, most U.S. durum exports go to Italy, and EU Prospects for government approval of GMO wheat remain uncertain. Even if approved by the EU government, the EU labeling system will allow consumers to determine the demand for such wheat. North Africa is another major market for Durum wheat, and several countries there appear likely to reject GMO wheat. These two regions accounted for nearly 90% of U.S. durum wheat exports in 2001-02.

The EU has had a five-year moratorium on approval of new GMO crops. Unless approved by the EU government, lack of approval of GMO spring wheat would further reduce the EU labeling threshold for GMO spring wheat and durum wheat in consumer products from its current 1%. And with or without EU government approval, a number of foreign buyers might well reduce tolerances for GMO wheat to zero. For example, the CEO of largest wheat milling firm in Italy has indicated strongly that his firm sees no reason to risk customer rejection of its products by buying wheat from areas that produce GMO wheat. The U.K.'s largest milling company also has indicated that it will not buy GMO wheat as long as current consumer attitudes toward the product continue. Other market indicators show strong negative responses in the Far East.

The Issue is Consumer Acceptance, not Food Safety

Much foreign consumer concern centers on questions of food safety and the adequacy of U.S. and foreign government regulatory processes. These concerns may or may not be scientifically valid. ***However, the key issue from a marketing standpoint is not whether the product is safe. It is "Will the final consumer accept GMO wheat?" Right or wrong, consumers are the driving force in countries where market mechanisms allow choice through food labeling. Also note that in countries where food labeling is mandatory, governmental approval of the product does not guarantee consumer acceptance.*** Attitudes toward GMO wheat may change over time, but it is difficult to predict how soon that may occur. Attitude change could be accelerated by a concerted effort to listen to and address consumer concerns, and by the development of GMO products with clear health benefits to consumers.

Dual Marketing Systems for GMO & Non-GMO Wheat

Some analysts indicate that a simple and straightforward solution to the consumer acceptance problem is to create a dual marketing system that provides U.S. GMO wheat to buyers who will accept it, and non-GMO wheat to others who don't want it. So far, after four years of large commercial GMO corn, canola and soybean production, such a system is being used only to a limited extent for non-GMO crops in those industries and has not been adequate to prevent loss of the EU corn, canola, and soybean meal markets. Surveys of firms using a dual marketing system indicate there are substantial costs and major challenges in avoiding accidental co-mingling[1] of GMO and non-GMO products from the seed industry all the way to the final overseas user. In cases where such a system has been used, its costs have been well above those of the existing rapid-receiving, large volume, rapid unloading, handling, and transport system that dominates the current global grain exporting industry. Costs for a dual marketing system are likely to be lower in areas dominated by barge shipments of grain to major ports than in areas such as the Northern Plains where rail shipments are the dominant transportation method.

Several estimates of the cost of a dual marketing system are available. The lowest estimated costs are less than four cents per bushel, while estimates from a U.S. Department of Agriculture survey would put costs into the $0.70 per bushel or higher range when all domestic and overseas marketing and testing costs plus a premium to farmers for crop segregation are included. Costs from a University of Illinois survey of elevators segregating specialty crops, excluding costs further up the marketing system, are between these two extremes. Industry efforts to collect and segregate StarLink® corn from normal marketing channels indicate a price premium to producers is necessary to cause segregation. When additional costs further up the system are included, the Illinois survey would put costs close to USDA numbers.

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[1] The term, adventitious (added extrinsically, occurring sporadically) is often used to describe presence of unwanted GMO products in non-GMO supplies. In this report, the terms "co-mingled" and "contaminated" are used interchangeably to denote the presence of unwanted GMO supplies in non-GMO grain. When the latter term is used, it is intended to denote the concept of reducing the market value of the product in which it is found, with no inferences regarding food safety.

With a dual marketing system where added costs are passed on to final users of the crop, foreign buyers would ask themselves "Why should I pay this premium for U.S. non-GMO wheat if I can get similar non-GMO wheat supplies from another country that does not produce GMO wheat, without having to pay the segregation costs?" Or "Can I pay a fraction of these segregation costs to producers in another country, for example a former Soviet republic, and encourage them to produce more of the wheat my customers want, without paying the full U.S. segregation cost?" Also, foreign food processor and retailer concerns about maintaining the integrity of their products and consumer acceptance would require a high level of assurance that a U.S. dual marketing system would provide a very low risk of GMO contamination. Judging from experiences with corn and soybeans, that assurance is likely to involve substantial cost.

Important costs that must be considered in a dual marketing system include not only the costs of testing but also:

- Investment costs needed for extra dump pits, elevator conveyor, storage, and load-out facilities to avoid accidental contamination and bottlenecks in receiving grain.
- Extra waiting-time costs for farmers, truckers, and elevators at harvest time.
- Extra hauling costs and harvesting delay costs for farmers who are required to transport grain to distant locations that specialize in marketing non-GMO wheat.
- Indirect costs such as possible reduced volumes of grain that can be stored for basis gains in hedging and reduced ability to take advantage of short-term basis movements due to more limited ability to use rapid, large-volume shipments.
- Less than full utilization of elevator storage capacity and storage bins, thus spreading costs of these facilities over fewer bushels.
- Increased use of smaller, inefficient, higher-cost elevators in a dual system.
- Loss of major cost advantages that result from large-volume rail shipments.
- Costs of finding alternative markets and re-routing grain to acceptable markets when a shipment is rejected at a port or other market destination.
- Costs of cleaning out an elevator or processing plant, or recalling retail products when accidental GMO contamination occurs. These costs include downtime for facilities and transportation equipment, as well as other direct costs.
- Premiums paid to wheat growers to cover costs for extra time and management required for record-keeping, testing, avoiding contamination in drills, combines, bins, conveyor systems, and transportation equipment, and to insure that no volunteer or accidental cross-pollination with GMO wheat contaminates non-GMO varieties in seed, commercial, or organic production.

The National Grain and Feed Dealers Association recently estimated that less than five percent of the U.S. grain elevators have the ability to operate such a dual grain marketing system. While segregation of wheat by protein content and segregation from other grains occurs in the current marketing system, indications are that tolerance levels of foreign wheat buyers will be much more rigorous on GMO content than for these market variables. That, in turn, will likely generate much higher segregation costs. The Canadian grain marketing system currently has greater ability to segregate grain than the U.S. system, and could have longer-term competitive advantages in GMO/non-GMO segregation if it continues as presently structured.

Legal Issues

Other major issues related to introduction of GMO wheat are in the legal area. Legal issues focus on who is responsible for costs or reduced crop values if GMO wheat varieties adversely affect non-GMO wheat producers, seed growers, or organic producers' businesses through accidental co-mingling, cross pollination, growth of volunteer GMO wheat, or contamination that requires closing down of processing plants for cleaning and recall of products from retail shelves. This latter issue has occurred in the corn industry, and in the case of StarLink® corn, have led to one of the most expensive food industry problems in U.S. history. Firms and individuals with a potentially important stake in legal issues include non-GMO seed and commercial non-GMO wheat producers, organic wheat producers and marketers, grain elevators, and other processing and food-marketing firms, as well as local governments and businesses whose revenues are dependent on the profitability of wheat production.

Potential Market Impacts

Important market indicators point to a high risk that up to 30 to 50 percent of the foreign market for U.S. HRS wheat and even more of the U.S. durum wheat exports could be lost if HRS GMO wheat is introduced into the U.S. in the next two to six years. Three alternative market scenarios of partial export market loss are examined here. With normal U.S. and foreign average wheat yields, the analysis shows a high risk that U.S. average HRS prices would be forced down to feed-wheat price levels, approximately one-third lower than the average of recent years. Durum wheat exports and prices also would likely face substantial risk. An extensive Canadian study of potential effects from GMO wheat commercialization also finds the potential for substantial negative impacts on Canada's wheat markets.

Negative export and price impacts identified here would be lessened if (1) foreign consumer attitudes toward GMO wheat become positive or (2) ways are found to develop a highly dependable dual marketing system that creates a very low risk of GMO wheat co-mingling with non-GMO supplies, at an economically insignificant cost. Changes in consumer attitudes might well occur with (1) a concerted and serious attempt to listen to and address consumer concerns and/or (2) commercialization of GMO wheat products that offer clearly identified health benefits to consumers.

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GMO spring wheat: Its potential short-run impacts on wheat export markets and prices*

The consumer may be right or wrong, informed or misguided, flippant or serious-minded. Nonetheless, it is consumer choice that drives the entire food system. If significant numbers of consumers register their preferences on a food feature or trait, and that preference is negative (or positive), the results are quickly transmitted through the food chain to the producer.

– Neil E. Harl, Charles F. Curtiss Distinguished Professor of Agriculture and Professor of Economics, Iowa State University (2002)

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As this study is being conducted, a major seed firm has applied for de-regulation and commercial sale of herbicide-resistant GMO (genetically modified organism) hard red spring (HRS) wheat in the U.S. Although the exact timing of its availability is uncertain, this type of wheat is expected to be commercially available to U.S. farmers sometime in the next one to four years. The issues surrounding GMO foods are highly controversial in international markets. Many agriculturalists in U.S. and South America, as well as officials concerned about the future adequacy of world food supplies, see great potential for this technology. Concepts being explored at the think-tank stage include creation of plants that are resistant to drought, salt water, insects, diseases, other pests, and herbicides, or that can supply their own nitrogen needs. Other dimensions of GMO work include research to develop plants with improved milling, health and nutritional qualities, and plants with pharmaceutical properties.

At the other side of the GMO picture, there are strong negative attitudes toward GMO crops and GMO foods in many foreign markets for U.S. wheat. The focus of foreign consumers is on food and environmental safety issues, the extreme difficulty of reversing GMO technology once it becomes widespread, and potential monopolization of the global seed/food industry. (For monopoly concerns, see Harl, 2003). If the rest of the world accepted GMO food products as readily as U.S. consumers do, one could build a strong case for significant economic advantages to U.S. agriculture from widespread commercialization of this type of wheat. However, the economic picture is greatly complicated by foreign consumer concerns about GMO foods. In an export-dependent commodity like wheat, it is essential that an export market assessment be included in any GMO economic feasibility study.

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* *Views expressed here are those of the author and not necessarily those of Iowa State University. Work reported here is from a research contract with the Western Organization of Resource Councils on potential short-run impacts of the introduction of Round-Up Ready® hard red spring wheat on exports and prices of that class of wheat.*

The purposes of this project are to examine (1) potential short-run impacts on hard red spring and durum wheat export markets and prices from the U.S. commercialization of Roundup-Ready® (GMO) spring wheat, and (2) to touch on issues of the organic wheat industry that are related to the introduction of GMO spring wheat. Official standards as well as consumer demand require organic wheat to be non-GMO varieties.

The Industry Setting

Wheat exports are vital to U.S. producers of spring wheat and other classes of wheat because domestic demand is much smaller than potential U.S. production. In 2001-02, the domestic market for hard red spring wheat absorbed only 61% of total U.S. production. U.S. wheat exports have been in a long-term downward trend for many years, with exports in the 2002-03 marketing year dropping to the lowest level since 1971-72. Loss of wheat export markets has been accompanied by:

- a downward trend in wheat prices.
- loss of wheat acreage.
- loss of revenue to industries supplying inputs to wheat producers.
- loss of revenue from sale of wheat production that affects not only farmers but other rural farm-related and non-farm businesses, local and state government tax revenues, and institutions supported by tax revenues.
- diminished economic health of rural communities and state governments in the spring wheat belt.

Impacted non-farm businesses include auto dealers, furniture, appliance, hardware, clothing, health-care, construction and other sectors. Farm incomes have a multiplier affect on local economies as they move through these businesses. With this background, it is clear that economic concerns related to the introduction of GMO wheat affect a much broader segment of the Northern Plains economy than just the farm production sector.

For a number of reasons, consumers in many foreign countries have attitudes toward GMO crops that range from substantial concern to extremely strong negative reactions. ***Indicators of consumer feelings toward GMO crops include the fact that at least thirty-seven countries currently label foods containing GMO ingredients*** (Phillips and McNeill, and Reuter press releases 2001, 2002, and 2003)***. Labeling food that contains GMO ingredients does not prevent U.S. sales in those countries. However, the labeling programs have been implemented because of consumer demand for them.***

Labeling provides a mechanism that consumers can use to reflect the type and intensity of their preferences about GMOs in the market place. In the U.S., no such mechanism is present. In most international markets, many of the products of the two main GMO food-related crops, corn and soybeans, so far have avoided labeling. Two other types of U.S.-produced GMO food crops, insect-resistant potatoes and longer-shelf-life tomatoes, were introduced commercially, but have been economic failures because of widespread rejection by the food industry. GMO Flax was developed in the early 1990s but was not commercialized because of concern about potential lost export markets (Dawson, A., February 27, 2003). A type of GMO sugar beet has been developed, but reportedly is not being used commercially. Sugar companies determine what varieties farmers plant, and have chosen not to offer GMO sugar to consumers. In Canada, GMO canola is a major crop that is used to produce vegetable oil and protein meal for livestock. Consumers in the EU, formerly an important market for this crop, have rejected it (*AGRIWEEK*, July 11, 2003), although Canada continues to export to other countries.

The other major commercial GMO crop, cotton, is not a food crop. It is, however, a source of vegetable oil that competes with corn and soybean oil, and protein meal that competes in livestock feed markets. GMO protein is removed from the cottonseed oil as well as corn and soybean oil and many other consumer products made from corn and soybeans, either through processing or through livestock feeding. Hence, these products have not required GMO labeling. ***This will not be the case for high-quality spring wheat and wheat products, where the protein is expected to remain in almost all consumer products.***

In the next few years, the number of countries labeling GMO foods is almost certain to expand to at least 46 to 48 countries. A major market for U.S. wheat, the European Union (EU), took action in November 2002 to tighten its GMO standards further, by lowering to 0.9% the GMO content threshold at which GMO labeling is required, and by extending labeling to processed food products for which processing has removed the GMO protein (just-food.com, 11/29/02; J. Smith, *Reuters*, 28 Nov 2002). Its Parliament passed legislation in early July 2003 setting the stage for these and other changes in its labeling laws to become operational in 2004 (European Union, July 1 and July 2, 2003, *New York Times*, July 3, 2003). A few more steps are needed to finalize the implementation of these changes.

The new EU legislation calls for development of processes for mandatory labeling of GMO feed ingredients and a system for tracing the source of feed ingredients, similar to one already used for livestock products (*ibid*). Traceability of GMO ingredients is provided for in the U.N. Codex Alimentarius Commission documents (FAO, United Nations, July 9, 2003). The new EU legislation also provides for labeling of previously unlabeled products such as vegetable oils, sweeteners, and livestock feeds.

The EU in late 2002 formalized the processes by which 10 Central and East European nations are expected to be admitted to the EU in next few years. These nations will be required to adopt EU policies related to GMO crop production and foods. Accordingly, the prospective entrants into EU in most cases already are limiting or prohibiting commercial production of GMO crops. At some future time when admitted to the EU, they will become ***both markets for and production sources*** for non-GMO crops. Several East European nations are net grain exporters and have the potential to increase exports in the future.

EU actions, as well as a major consumer survey, indicate the EU's consumer resistance to GMO crops has increased in recent years. In the 1990s, several EU individual country governments initially responded favorably to the commercialization of GMO crops and approved imports of several GMO corn and soybean events. But as consumer concerns increased, the EU has had a de-facto five-year moratorium on approval of any new GMO crops. At this writing, it seems probable that EU consumer resistance will be strong enough to prevent marketing of products from GMO wheat in the EU the short run. Even if GMO wheat receives EU government approval, it is highly doubtful that consumers and the food industry will be willing to buy it during the next two to six years. An example of deeply entrenched attitudes is shown by the following excerpt from the Cabinet Office, British Government, Prime Minister's Strategy Unit, *Scoping Note, COSTS AND BENEFITS OF GM CROPS*. This is a response from the National Federation of Women's Institutes (U.K.), October 2002:

> "In the wake of BSE , FMD, and MMR, the British public is very unwilling to accept government assurances that something is 'safe'. The perceived problems with GM, coupled with the complete lack of any benefits to the consumer of the current GM Maize and Soya crops, will make the introduction of future GMOs very difficult to market."

Other examples:

- The prestigious *British Medical Association* recently indicated, "**There has not yet been a robust and thorough search into the potentially harmful effects of GM foodstuffs on human health.** On the basis of the precautionary principle[2], farm-scale [GMO] trials should not be allowed to continue." (Scottish Parliament's "Health and Community Care Committee, 1st Report 2003", bold added for emphasis).
- A Community-wide 2001 survey of EU consumers by the EU *Eurobarometer*, for the National Consumer Council, indicated 94% of European consumers want the right to choose whether to eat GMO food, and 70.9% do not want to eat this type of food at all. (**RGSB Omnibus Survey for NCC).**
- In the same survey, 79% of consumers indicated they believe meat and other animal products produced with GMO feed should be labeled (op. cit., p. 91).
- **Another *Eurobarometer* survey indicated that between 1996 and 1999, attitudes of EU citizens toward GMO food became more negative (INRA (Europe)-ECOSA). In 1996, 54% of respondents indicated the use of modern biotechnology offered some useful applications in the production of food. By 1999, only 43% of the respondents answered the same question positively. The survey indicated that the most trusted sources of information on GMO food are consumer organizations and the Medical profession (op. cit., p. 91).**

On the other side of the globe, there also is evidence of strong negative consumer attitudes toward GMO food grains. Japan announced in July of 2002 that, beginning in April of 2003, it will require mandatory testing of feed ingredients for unapproved GMO content, in addition to its food-labeling program that has been in effect for two years (*Japan Agrinfo Newsletter*)**.**

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2 The pre-cautionary principle is provided for in the United Nations, Food and Agricultural Organization, Cartagena Protocol on Biosaftety, "Cartagena Protocol on Biosafety About the Protocol", http://www.biodiv.org/biosafety/background.asp

A report from Japan indicates that on December 5, 2002, The Aichi Prefecture, Japan, Department of Agriculture and Forestry announced it will cease its cooperative research with Monsanto in the development of Roundup® herbicide tolerant rice that had been underway since 1996 (Kawata, Masaharu). This report indicated the Aichi Department of Agriculture and Forestry also announced it had decided not to commercialize the herbicide-tolerant rice strain because many Japanese consumers are opposed to it. ***The decision reportedly came in response to a "NO GMO" campaign involving 148 organizations, including consumer groups and organic farmers. Leaders of the campaign presented a petition with more than 580,000 signatures opposing the development and commercialization of the GM rice to the Governor of Aichi Prefecture (ibid.)***. Taiwan and Sri Lanka have just initiated GMO food labeling programs in response to consumer concerns.

The Cartagena Global Biosafety Protocol Agreement, to be implemented by the United Nations, was negotiated in February 2001 by a meeting of 120 nations. It allows countries to label food containing GMOs (Cartagena Protocal on Biosafety, op. cit.). **Ratification by 50 countries is required for the Agreement to be implemented. By June 10, 2003, 50 nations had ratified the agreement, setting the stage for it to be implemented beginning September 11, 2003.** The Agreement was developed to provide an organized global mechanism for dealing with the hundreds of new GMO varieties of crops and livestock that are anticipated to be presented for commercialization in the next few years. One hundred three countries signed the Protocol, indicating they have general support for the agreement and intend to become parties to it. (Ibid.)

USDA Federal Grain Inspection Service non-GMO Wheat Certification

The U.S. Department of Agriculture, Grain Inspection, Packers and Stockyards Administration (GIPSA) administer inspection of U.S. wheat as it is loaded on ships for export. One indicator of foreign buyer concern about GMO wheat is widespread foreign-buyer requests that U.S. certify its wheat as being GMO free. Since September1999, at the request of foreign wheat customers and wheat exporting firms, ***GIPSA has been issuing certification statements indicating that "There are no transgenic wheat varieties for sale or in commercial production in the United States."*** GIPSA indicates countries representing very large U.S. wheat export markets request this statement, including Japan, Mexico, South Korea, Taiwan, the Philippines, and Italy. These markets alone accounted for 54 percent of all U.S. hard red spring wheat exports in 2002-03 and 60 percent of U.S. durum wheat exports in 2001-02. GIPSA estimates that countries representing about half of all U.S. wheat exports (including the other four classes of wheat) request this statement. (USDA, GIPSA, March 20,2003). If there is an interim period during which Round-Up Ready® wheat is de-regulated but not yet offered for commercial production, GIPSA indicates this statement will no longer be possible unless Monsanto meets three specific conditions each year. Those conditions include (USDA, GIPSA, March 20, 2003, op. cit.):

- a signed statement from Monsanto at the beginning of the marketing year and updated during the year if necessary indicating that RR.W is not for sale or in commercial production in the U.S.

- an approved and audited ISO 9001-2001 quality management system to assure that RR.W seed production does not enter commercial channels.
- DNA reference material that can be used for testing and for the auditing procedures.

<u>GMO Challenges Experienced by the U.S. Corn, Soybean, and Food Industries</u>

The U.S. has lost the formerly important EU market for corn because of GMO acceptance problems. In years before 1996, EU corn exports typically were valued at $200 million or more annually. At this writing, the U.S. also has lost most of the formerly important EU soybean meal market. U.S. soybean meal exports to the EU last year recorded a 52% year-to-year decline, and cumulative U.S. soybean meal exports and outstanding unshipped sales to EU for the 2002-03 marketing year through June 26, 2003were 77% below the low level of a year earlier. U.S. sales to the EU so far this marketing year are equivalent to the meal from only 2.8 million bushels of soybeans, and are equivalent to only 2/10% of the EU's estimated annual soybean meal imports. The EU typically has been a large market for U.S. soybean meal, often the largest or second largest U.S. export market for that commodity. It is by far the world's largest import market for soybean meal, accounting for about half of global soybean meal trade (USDA, FAS, 12/10/2002 and 1/30/2003). Brazil has become a major supplier of soybean meal to EU because of its non-GMO soybean production in newly developing agricultural areas in its Center West.

The U.S. has lost nearly all of the South Korean corn market, which only four years ago was the second largest export market for U.S. corn (ibid.). The South Korean market is now being supplied by non-GMO Chinese corn, as are several other Asian markets. In addition, several African countries in late summer of 2002 rejected U.S. food aid shipments of GMO corn even though the net price was extremely low. In early January 2003, India rejected a shipment of food aid U.S. corn and soybeans because it was believed to contain GMO grain.

In other GMO-related developments, the U.S. has had serious and expensive problems related to contamination of commercial corn with corn varieties not approved in all markets. More recently, such problems have occurred with pharmaceutical corn, although the problems were detected in time to avoid serious contamination in the food sector. StarLink® corn was a major problem in 2001, and re-emerged as a problem in U.S. corn shipments to Japan in late December of 2002, even though less than one percent of the nation's corn acreage was planted to StarLink® varieties in 2000 and sale of the seed was banned for 2001 and later years. In Canada, canola farmers have lost the formerly important EU export market because of consumer rejection of GMO canola (***Calgary Herald***).

It is in this setting of major foreign consumer concern about GMO grain and oilseeds that this study examines potential short-term (two to six year) impacts on durum and hard red spring wheat exports and prices from the introduction of commercial hard red spring wheat production in the U.S.

The Organic Food Sector, GMO Wheat, and Legal Issues

The organic food industry has been the most rapidly growing component of the U.S. food sector and also is experiencing rapid demand growth in foreign markets. While the organic food market is much smaller than the rest of the food industry, its size is economically significant. Western Canadian organic farmers reportedly can no longer grow organic canola because of cross-pollination with GMO canola (Belcher et. al., 2002). Concern about cross-pollination of GMO wheat with organic wheat, potential accidental co-mingling of seed supplies, and consumer confidence are critical issues for organic food producers in the Spring Wheat Belt. The impact of introducing GMO wheat is a major concern to organic wheat producers. There fear is that potential GMO contamination will diminish or eliminate their ability to generate additional income through price premiums paid for organic wheat production.

Data on price premiums paid for organic production is sketchy, especially for grains. Some reports indicate they may in many cases be at least 50 percent higher than U.S. cash and futures prices for conventionally-grown spring wheat. The increases in acreage indicate that the premiums and the added income are enough to entice some farmers to switch to organic wheat production. However, organic farmers are concerned over the possible cross contamination with the introduction of GMO wheat that could eliminate their markets (Brasher, July 14, 2003).

Although they are not addressed here, a host of legal liability questions related to seed supplies, production, marketing, transportation, processing and retailing also come to the forefront with the introduction of GMO wheat. These legal issues are extremely important to producers and consumers of organic, conventional and GMO crops as well as the seed, grain, and processing industries. ***Legal issues center around the question of who is liable if unwanted GMO supplies are found in seed, grain to be marketed, grain elevators, the transportation system, processing plants or in finished products on retailer shelves, and cause reduced economic value of products in which they are found.*** Legal issues affect the ability of both U.S. non-GMO and organic producers to service domestic and foreign customers. ***Solutions to the legal issues, while extremely important, are beyond the scope of this report.***

Role of the Final Consumer in Determining Product Choice

When considering the introduction of GMO wheat, a guiding principle should be that the actual market is the consumer, rather than the grower who will produce it and hope the market will accept it several months after the seed has been purchased and planted. ***In virtually all non-agricultural markets, the main focus of product innovation is the needs and desires of the final consumer. Industrial history is full of examples where products failed because they did not meet the desires of the final consumer or were offered in the market before consumers were ready to accept them.*** This same principle applies to agriculture. The consumer is King (Harl, 2002). Negative consumer attitudes toward GMOs in international markets may continue at least until GMO crops with clear consumer benefits are commercially available and/or consumer concerns are addressed more thoroughly through research.

About GMOs

GMO is an inaccurate term commonly used to describe transgenic or biotech crops. Plants have been genetically modified for centuries through traditional plant breeding. ***However, advancements in biotechnology now permit genes from totally unrelated species to be inserted into a plant or animal to provide new characteristics that otherwise would either take many years to develop or would be impossible to develop through conventional breeding.*** Crops or other products produced through these processes are being referred to as Genetically Modified Organisms or GMOs.

In the case of currently available insect-resistant corn, a fungus gene is inserted into the plant to make it resistant to corn borers and/or rootworms. In the development of Round-Up® herbicide-resistant crops, a gene from herbicide-resistant bacteria found at a herbicide factory has been inserted into the plant (Charles, p. 69)**.** Stacked GMO corn events may contain both types of genes. Thus, in contrast to traditional plant breeding, GMO crop varieties are created by inserting genes from totally unrelated organisms into plants that, in a non-biotech environment, would never cross breed. The process of developing GMO crops also typically includes the use of an antibiotic-resistant marker gene and a promoter gene. Cauliflower mosaic virus is a common source of the promoter gene (*ibid).*

U.S. industry voluntary testing procedures have not found food safety problems from this process and its resulting products. The U.S. Food and Drug Administration, which is responsible for food safety, considers currently available commercial GMO crops to be "substantially equivalent"[3] to those developed through conventional plant breeding, and thus not requiring extra testing or labeling for food safety (Belson, op. cit.). Crops are given the "substantially equivalent" designation after companies developing them have run tests of nutritional composition, and tests for known allergens and toxins that show no significant differences from conventional varieties. However, the types of genes being inserted into GMO crops have caused concern in Europe and other areas, and have generated requests for more rigorous research on long-term safety of GMO foods.

As stated earlier, it is not the purpose of this report to address the question of whether these concerns are valid or whether more food safety research is needed. Rather, it is to increase the understanding of why foreign consumers have concerns about the safety of GMO crops, ***and the market implications of those concerns. Consumer concerns and perceptions are driving forces in market demand.***

GMO technology may not be the only way of obtaining some of the benefits of this new crop production technology. New ways of analyzing plant genetic information suggest that at

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[3] The "Substantially Equivalent" concept originated with the Organization for Economic Cooperation and Development (OECD) in 1993 (United Nations, FAO web site)

least some of the potential gains being obtained from GMO crops can also be obtained by working with the plant's own genetic structure without inserting foreign genes (Zhu, 1999).

Rapid Adoption of GMO Soybeans

U.S. soybean growers have adopted GMO technology more rapidly than almost any other new technology in the history of American agriculture. The first GMO soybean seed became widely available to producers in 1997. By 2002, about three-fourths of the U.S. soybean acreage was estimated to be planted to GMO varieties (USDA, NASS). Cotton farmers also have been quick to adopt GMO varieties in their fight against harmful insects and weeds, with 71% of the 2002 U.S. cotton acreage planted to GMO varieties (op. cit.).

While GMO technology is being used in corn production, its adoption by corn growers has been much slower than for soybeans and cotton. About one-third of the nation's corn acreage was planted to GMO varieties in 2002 (op. cit.). Percentages of corn, cotton, and soybean crops that are GMO varieties vary considerably from state to state. For corn in 2002, this percentage ranged from an estimated low of nine percent in Ohio to a high of 66 percent in South Dakota. Midwest corn and soybean states west of the Mississippi river generally grow higher percentages of GMO crops than states further east, in part because of greater insect problems and a greater need to reduce the risk of soil moisture depletion that comes from tillage operations. Round-Up® herbicide is commonly used in no-till and limited tillage farming because it kills most weeds.

Input vs. Output Trait GMO Crops

Current GMO crops can be described as "input trait" technology. The traits inserted into seed through artificial genetic manipulation substitute for other inputs or practices that normally would be used to control insects or weeds. "Output trait" GMO crops would have readily perceivable benefits for consumers and might cause consumers to have more favorable attitudes toward GMO food crops. Although work is underway to develop "output trait" GMO crops, the research has not yet led to commercially available crops with clear benefits to consumers. At this writing, commercial production of "output trait" GMO crops appears likely to be available several years from now.

One such product that received widespread positive publicity in the early 1990s was the "Flavr Savr" tomato, produced by the Calgene Company. It had an increased shelf life that was designed to permit harvesting when the crop was fully ripe. Its main advantage was the potential to provide consumers with a more colorful and flavorful tomato than is available from conventional varieties. However, the "Flavr Savr's" handling characteristics proved inadequate for normal marketing channels, and this tomato is no longer commercially available (Charles, p. 145).

Another widely publicized type of "output trait" GMO crop is "golden rice". It contains more vitamin A than traditional varieties and is being designed to reduce malnutrition and blindness in developing nations. "Golden rice" is still in the development phase and may not be available to rice producers for several years. A number of other types of "output trait" crops are being considered that may provide improved nutrition, vaccines, medication or other potential benefits to some consumers.

Several test plots of pharmaceutical GMO corn have been grown in the Midwest, adding to the complexity of the GMO food safety issue from a consumer and food industry perspective. At least two problem situations with these crops led to government seizure of pharmaceutical-related crops in 2002 (Fox). One case involved the growth of volunteer pharmaceutical corn in a soybean field that previously raised the corn. The corn reportedly was designed to produce a vaccine to prevent diarrhea in pigs (*Rachel's Environment and Health News*, 1/30/03). This problem was discovered after the soybeans were harvested and transferred to a grain elevator, where they were co-mingled with other soybeans.

Such events further weaken foreign consumer confidence in government GMO regulations and the ability of the grain and food industry to prevent co-mingling of GMO and non-GMO grain. Initial response from the U.S. food industry was a statement indicating that food crops should not be used for production of pharmaceuticals and that the integrity of the food system and food safety must be of highest priority (Fabi, 02/07/03). This, in turn, brought concerns from farmers and farm-state legislators that their states and regions might be deprived of potential economic benefits from production of pharmaceutical crops (Fox, January 2003).

Macro Economic Effects: Do Farmers Gain Economically from GMOs?

Research indicates the current insect-resistant GMO technology has a yield-increasing impact on corn, especially in years and regions where insects are a serious problem (Duffy). Increased crop yields nationally have a negative affect on prices, provided other market factors remain constant. For soybeans, evidence indicates the current GMO technology may have a slight yield-depressing impact (Duffy, 2001). However, the attractiveness of herbicide-resistant GMO soybeans comes from the fact that they offer greatly simplified weed control. For soybean growers, weed management traditionally has been a much greater problem than for other major crops. Simplified weed control allows individual farmers to farm larger acreages, using a one-pass weed control system (Wisner, et. al.) The technology also facilitates no-till cropping on land that previously was unsuitable for soybean production because of limited rainfall and inadequate soil moisture supplies, both in the U.S. and in Argentina. No-till farming conserves soil moisture that would otherwise be lost through tillage operations. This new technology has been a significant factor helping to explain why Argentina's estimated 2003 harvested soybean acreage is 53% above the 1997-2001 average (data are from USDA, FAS). Increased global acreage of soybeans has a negative effect on prices, thus tending to reduce farmers' income from producing the crop. The Farm Security and Rural Investment Act of 2002 provides U.S. soybean growers with two types of price-sensitive government payments that tend to partially offset negative price impacts from GMO soybeans. These mechanisms are (1) Loan Deficiency Payments and (2) Counter-cyclical Payments. When marketing year average prices decline below legislatively-determined thresholds, payments to U.S. farmers increase to partially or completely offset lower prices (Wisner, September 2002). In Argentina and other soybean producing countries, lack of offsetting government payments causes reduced incomes to growers when prices decline. U.S. marketing year soybean prices averaged $6.12/ bushel for the nine-year period ending with the 1997 marketing year. With expanded South American and U.S. production, the average price for the 1998 through 2002 marketing years was $4.80 per bushel, a decline of 22 percent.

Except for these offsetting payments, net long-run economic benefits for crop producers from adopting GMO technology likely will be zero (Moschini, G.). However, early-adopters may gain through cost savings and/or increased production before the aggregate impacts depress prices, depending on prices paid for the seed and the speed with which the technology is adopted.

Net short-term impacts on prices depends both on changes in the supply of the commodity available to the market and on consumer reaction to the new type of commodity. ***Several analyses of economic gains from adoption of GMO technology have assumed (1) there will be no negative crop price impacts through changes in aggregate supply and (2) consumers will readily accept the GMO crops without price discounts. For the short run (one to six years), there is much evidence that this latter assumption is unrealistic for a commodity like wheat, whose major market is products for direct human consumption.***

For the longer term, the first assumption will almost certainly be violated if the cost-saving promises of the biotechnology industry are fulfilled. Economic analysis indicates market impacts from production-increasing or cost-reducing technology will drive prices down to the point where the crop producers' gains from reduced costs and/or increased yields are just offset by lower prices. In this environment, the long-run benefits go to the GMO seed company and to consumers through lower priced food—if there are no offsetting negative effects for consumers.

Foreign Consumer Views

From the viewpoint of many foreign consumers, there is nothing to be gained and may be serious disadvantages from purchasing food containing "input trait" GMO ingredients. For a number of reasons (some noted earlier), surveys indicate a large majority of consumers in these markets are concerned that GMO crops may have negative long-term health and/or environmental effects that have not been adequately researched.

The U.S. government, including foreign embassy offices, and biotech firms have indicated that there is no evidence of serious human health problems stemming from consumption of U.S.-approved GMO corn and soybeans since the beginning of their extensive commercial use in 1999. However, many foreign consumers would say that science made the same conclusion about feeding ruminant-based protein ingredients such as meat meal and tankage to ruminants in the years before bovine spongiform encephalopathy (BSE) or Mad Cow Disease problems developed. Consumer groups also call attention to scientific assessments of the safety of the DDT insecticide and the diethylstilboestrol growth stimulant for cattle as they were introduced into the market, for a number of years afterward, and the contrast with recent research showing harmful effects (Cohn, B.A., et. al., June 28, 2003). Science, in the early years of these products, indicated they posed no health risks. **Experience with these and other products, and serious food safety problems in Europe and the Far East have caused foreign consumers to view science as *continually evolving*.** This view (confirmed by history) says there is a potential for current scientific views to change over time with new information.

Examples of this viewpoint, while not necessarily reflective of exact foreign consumer views, were articulated as follows in a 2000 report from the U.S. Food and Drug Administration on focus group studies of consumer attitudes toward GMO foods:

> "In each case, participants saw a technological innovation that was introduced mainly for the sake of producers/distributors, with little apparent benefit to the consumer. Such innovations are seen as being approved by scientists and regulators, but later found to have unanticipated long-term health effects. It is this hazard model, drawn from recent experience with technological innovation that underlies participants' views about the wisdom of food biotechnology.
> This hazard model includes roles for various actors such as producers, industry, government regulators, scientists and consumers. It is marked by skepticism that the interests of consumers are sufficiently taken into account by the other actors. Some participants complained consumers are being used as "guinea pigs" and many were doubtful that government regulators and scientists have the ability to counteract the powerful profit motives of industry and producers." (Levy, A. S. and Derby, B.M., 2000)

Numerous publications have appeared in Europe, both in the popular press and in technical journals, raising questions that relate to internal behavior of cells after receiving genes from unrelated species, including bacteria or fungi. Implications of antibiotic-resistant marker genes, use of the cauliflower mosaic virus promoter gene, and various other questions related to food safety are concerns (for example, see Charles). Foreign consumers also express concern about a lack of peer-reviewed studies of food safety in the U.S. government approval process for GMO crops, and a close relationship between the regulators and regulated firms. They point out that the U.S. GMO food safety assessment procedures do not focus on long-term health affects on humans, and do not require the U.S. Food and Drug Administration to test GMO crops for food safety if nutritional, toxicology, and allergenic information indicates they are "substantially equivalent" to crops produced through conventional breeding.

Other concerns retarding the acceptance of GMO crops in foreign markets include

- The extreme difficulty of reversing the GMO technology once it becomes widely adopted in a country—because of cross-pollination, growth of volunteer plants in non-GMO fields, and co-mingling of seed supplies.
- The concentrated ownership of GMO patents of the five major food and feed crops (wheat, rice, corn, canola, and soybeans) in a small number of global firms.

- Environmental concerns, including impacts on wildlife, native species of the plants and closely related plants, soil microbes, and potential for creating insects or weeds that are resistant to conventional and GMO control methods.

Economic concentration in the seed industry and a possible monopoly in global seed production become a concern because patents for basic seed stock of major food and feed crops are being held by a very small and shrinking number of firms (Harl, 2003). For limited-resource farmers in developing countries who do not have money to purchase patented GMO seed and typically save part of their crop for seed, there is concern that widespread use of GMO varieties and the requirement of annual purchases of new seed would lead to a plantation structure of agriculture, displacing many small farms and farm families.

One reflection of foreign consumers' concerns about the adequacy of the U.S. Food and Drug Administration (FDA) process for examining the safety of new GMO crops is indicated below. The following note is from a media briefing presentation by Michael Hansen, at Brussels, Belgium, January 10, 2003 for Consumers International entitled "Government lack of safety standards for GM crops revealed" (Hansen). Dr. Hansen is a Senior Policy Research Associate for the Consumers' Policy Institute, a division of the Consumers Union, the largest consumer organization in the U.S. His references to GE/GM refer to what is commonly referred to as GMO crops in the U.S.

Dr. Hansen reported that, despite indications to the contrary by U.S. Ambassadors in Europe and other nations, the U.S. has not used rigorous standards for food safety assessment of GM crops and has not formally approved GM corn varieties grown in the U.S. He indicated that for GE/GM plants that produce a pesticide, it is the responsibility of the Environmental Protection Agency (EPA) to approve the safety of the pesticide. Other dimensions of safety of the new GE/GM plant are under the jurisdiction of the U.S. Food and Drug Administration (FDA) and the USDA.

In a more detailed statement, in which we have added bold font for emphasis on some items, Dr. Hansen said:

> "The fact that FDA does not approve GE/GM crops can be seen in the letter FDA sends to the company after completion of a "safety consultation." For example, the letter sent to Monsanto on September 25, 1996 about its MON810 Bt maize states, 'Based on the safety and nutritional assessment **you have conducted, it is our understanding that Monsanto has concluded** that corn grain and forage derived from the new variety are not materially different in composition, safety, or other relevant parameters from corn grain and forage currently on the market, **and that they do not raise issues that would require premarket review or approval by FDA"** (complete letter is available at www.cfsan.fda.gov/~acrobat2/bnfL034.pdf). **Note that FDA does not state its own opinion about the safety of this crop; it only states what the company believes.** The letters for all 52 'safety consultations' done since the Flavr Savr tomato contain basically the

> same language. FDA has recently admitted that it should require mandatory notification of GE/GM food marketing, but has not issued such a regulation." (Ibid.)

We note that the above quotation from Dr. Hansen deviates slightly from the FDA letter in that it specifies "corn grain and forage", whereas the FDA letter uses the term, "corn products", which presumably could include forage.

In a prepared statement that may have implications for recent U.S. action to bring EU GMO policies to the World Trade Organization, Michael Hansen added:

> "Earlier this year [2002], the Codex Alimentarius Ad Hoc Task Force on Foods Derived from Biotechnology reached agreement on a "Draft guideline for the conduct of food safety assessment of foods derived from recombinant-DNA plants" (ALINORM 03/34, Appendix V, pp. 61-73). This document is at Step 8 of the Codex procedure, which means that all 35 countries, including the U.S., at the meeting in Yokahama, Japan agreed on this document and recommended that it be adopted by the full Codex Alimentarius Commission." (Ibid.**).**

Details of these recommendations are being finalized in mid-2003 (Ingham, June 29, 2003, and Agence France Presse English, June 30, 2003)

Hansen noted that if trade disputes over the food safety of GMO crops arise, the World Trade Organization would use the standards or guidelines of Codex Alimentarius to settle the disputes. According to Hansen, "**At present, the U.S. has not subjected GE/GM maize to the complete safety assessment laid out in this document." (Ibid; bold added for emphasis.)** Hansen's presentation is one of a number of examples illustrating the background behind foreign consumers' mistrust of the U.S. approval system for GMO crops.

The purpose of this report is not to determine whether these and other safety concerns are scientifically valid, but to note that they are major influences on foreign consumer attitudes toward GMO food and are major potential influences on foreign demand for GMO wheat. Many of these concerns have been sensitized by foreign food safety issues that are unrelated to GMO issues, and by GMO problems in the U.S. corn industry—including StarLink® and pharmaceutical corn. ***These concerns will have direct influence on the short-term consumer acceptance of GMO wheat in major export markets and resulting price impacts.***

U.S. corn industry problems included the co-mingling of small amounts of StarLink® corn (initially not approved for human food or export, but later approved for export as feed to countries that would accept it) with approved varieties in 2000-01. ***Less than one percent of the U.S. corn acreage in 2000 was planted to StarLink® corn varieties.*** Even so, contamination through co-mingling and cross pollination of corn supplies required domestic food processing plants to be closed and cleaned out, products to be recalled from retail shelves, extra testing of grain and grain products at various points in the U.S. and foreign marketing systems, and extra costs in re-routing supplies to alternative markets. The

StarLink® problem impacted both domestic and foreign markets and was one of the most costly problems in the history of the U.S. food industry, despite the small area planted to these varieties. At this writing, legal actions are still pending that relate to assessment of costs, determining which players are liable, and reimbursement of injured players.

StarLink® and pharmaceutical corn problems illustrate the challenges in developing identity-preserved non-GMO crop production and marketing systems, as well as risks which GMO production places on neighboring producers of non-GMO crops.

Wheat Cross-pollination and Volunteer Wheat Risks

While cross-pollination risks are lower in wheat than in corn, some risk exists. The risks occurs both through cross-pollination along the edges of the fields, with the problem increasing year-by-year if the same field is used repeatedly for wheat production, and through volunteer wheat that germinates the next year and becomes an increasing problem over time, especially if Round-Up® is the herbicide being used for weed control. The extent of cross-pollination varies with varieties (Eastham and Sweet, February 2002, Van Acker, R.C., Brúle-Babel, A.L., and Friesen, L.F., June 2003). With very low tolerances in foreign GMO food labeling programs, these problems are a substantial risk for the U.S. hard red spring and durum wheat exports as well as Canadian exports of the same types of wheat.

GMO Wheat vs. Corn and Soybeans, from a Consumer Perspective

As we have noted previously, it should be emphasized that the key issue from a demand standpoint is not whether consumer safety concerns are scientifically valid. It is consumer perceptions and preferences, not facts that determine market demand. With the background of consumer concerns outlined above, foreign wheat millers and users have been uneasy about talk that the U.S. would soon adopt GMO wheat technology. Many have indicated very directly that they will not buy U.S. wheat if producers are permitted to grow GMO wheat.

Some proponents of GMO wheat may argue that the market will quickly accept the new type of wheat, since U.S. corn and soybeans have continued to find export market outlets despite widespread U.S. production of GMO varieties of these crops. But note that in developed countries where corn and soybeans are sold, the large majority of the food products made from these crops are processed in ways that remove the GMO protein and avoid labeling. Major markets for corn and soybean meal are for livestock and poultry feeds, where the products are processed into meat or dairy products. For corn oil, soybean oil, and corn sweeteners, the processing technology removes the GMO protein. Foreign labeling systems so far have not been required to label these food products as containing GMO ingredients or made from GMO ingredients. Also note that several developing nations have rejected U.S. food aid shipments of GMO corn, even though the cost was extremely low. Even with widespread foreign acceptance of U.S. corn, total U.S. corn exports to all destinations in the

August-September 2002-03 marketing year are expected to be 34 percent below the 1979-80 record high and 28 percent below 1995-96 exports.

Unlike corn and soybeans, hard spring wheat and durum wheat are used mostly for direct human food consumption. In typical products made from these types of wheat, such as bread, cereals, and pasta, the GMO protein almost certainly would not be processed out, and hence the products would be labeled as containing GMO ingredients. For that reason as well as others, it appears likely that negative foreign consumer reaction to GMO wheat will be stronger than for corn and soybeans. Since the U.S. produces about eight percent of the world's wheat, alternative supplies are available elsewhere. As the wheat industry and government officials debate policies related to the adoption of GMO wheat, it is important to note that the U.S. share of world wheat exports has been in a downward trend for decades. U.S. wheat growers face the challenge of how to make their products as attractive as possible to foreign consumers in order to prevent further loss of market share. Another difference between corn and spring wheat is that about 16.5% of the demand for U.S. corn currently comes from exports vs. 40% for spring wheat. Also, corn has a rapidly growing domestic ethanol market to partially compensate for lost export demand. Wheat can be used to produce ethanol, but it would not be competitive as a feed stock, except at prices near those of corn.

Food Labeling Policies of Foreign Countries

In mid-2003, at least thirty-seven nations had mandatory food labeling programs that required food with GMO ingredients exceeding a specified limit to be labeled as containing GMO ingredients. Between ten and 12 other countries are expected to join this group in the next few years as the EU accepts new members from Central and Eastern Europe, and as the Philippines and other nations implement labeling programs. Thresholds for GMO labeling range from zero, for China, to an expected 0.9 percent (down from the current one percent) GMO ingredient content in the EU nations, to five percent in Japan and a number of other countries. Recent actions by individual EU national governments and the EU Parliament are expected to add feed ingredients to the labeling program, and to include products for which processing has removed the GMO protein. This latter category includes vegetable oils and corn sweeteners (European Union, July 2, 2003, op. cit.). ***The trend in many foreign nations has been toward more intensive rather than less intensive regulation of GMOs in recent years***. The list of countries as of June 2003 that label foods containing GMO ingredients above certain threshold levels is shown below. Taiwan and Malaysia are initiating labeling programs in 2003, and several other countries are developing labeling programs.

Foreign Markets for U.S. Hard Red Spring Wheat and Durum Wheat

The initial plans for introducing GMO wheat are focused on hard red spring (HRS) varieties, grown in the northern Great Plains of the U.S. This analysis also includes durum wheat, since many growers of other spring wheat produce durum wheat, and the two classes of wheat move in the same marketing channels. We assume that cross-pollination with HRS wheat, growth of volunteer GMO wheat in durum fields, and other accidental co-mingling in the production and/or marketing system would place durum wheat at risk in export markets.

There is some question of whether exports of white wheat from the Pacific Northwest and hard red winter wheat (HRW) produced in Montana, South Dakota and other northern HRS producing states might also be adversely affected by the introduction of GMO HRS wheat. Some of this wheat moves in the same marketing channels as HRS wheat. Also, foreign market acceptance problems with HRS wheat would very likely cause this class of wheat to be shipped to domestic mills for partial substitution for other classes of wheat, thus bringing it into HRW marketing channels outside the Northern Plains. We discuss possible impacts on these classes of wheat later in the report, but have not attempted to estimate possible negative effects on domestic wheat milling markets.

Our focus here will be to first consider where U.S. spring wheat exports go and the relative size of various foreign markets that label GMO food. Next, this report will discuss available indicators of the degree of risk U.S. exports would be exposed to in the short run if GMO wheat is deregulated and produced commercially. The short run is defined here as two to six years. Figures 1 and 2 show percentage shares of HRS and durum U.S. wheat exports for the June-May 2001-02 marketing year by major destinations that are labeling, or likely will be labeling or prohibiting GMO wheat imports in the next few years. Market shares are based on USDA data (USDA, FAS, *Export Sales,* June 6, 2002). Figure 1 indicates much of the U.S. hard red spring wheat export market will face GMO labeling if GMO varieties of this class of wheat are widely grown in the northern U.S. Figure 2 shows the comparable shares for U.S. durum wheat exports.

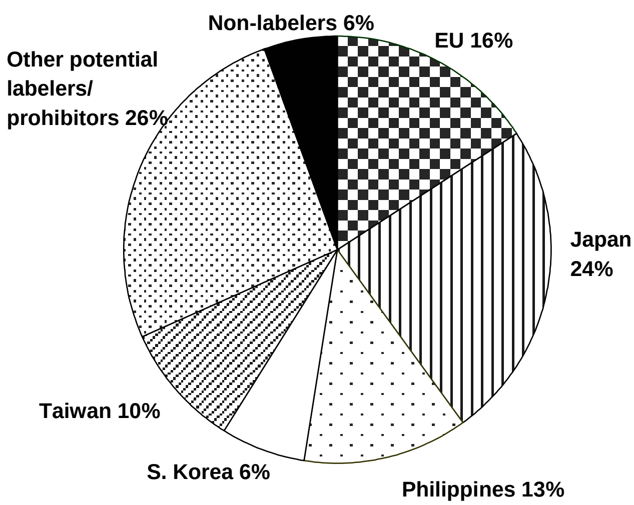
The export market for U.S. durum wheat is heavily dominated by the EU (primarily Italy), Algeria and Tunisia. GMO acceptance has been quite poor in Italy and is highly questionable in these two North African countries. Producers of durum wheat and elevators marketing it need to be aware of the EU's pending 0.9 percent GMO labeling standard. With that standard, the maximum allowable amount of GMO wheat in 10,000 kernels of durum wheat would be approximately 90 kernels. In reality, the effective standard on the U.S. side of the marketing system would probably be almost zero.

Because of foreign buyer insistence (as we noted earlier), the USDA Federal Grain Inspection Service (FGIS) currently provides export loads of U.S. wheat with a certificate stating that the U.S. does not have commercial production of GMO wheat. Many foreign buyers have indicated they will not buy U.S. wheat without this certification. When U.S. de-regulation of HRS wheat occurs, these non-GMO certification letters may not be possible unless stringent conditions are met.

With the risk of small amounts of HRS GMO wheat contamination of durum supplies through volunteer wheat, small amounts in pockets of combines, unloading augers, bottoms of farm bins, elevator dump pits, conveyor systems, and by other means, the chances for foreign buyer rejection of durum wheat supplies from the northern plains of the U.S. is high. Commercialization of GMO HRS wheat may well accelerate durum wheat production in the southwestern U.S., where fears of contamination with GMO supplies would be much lower than in the Northern Plains.

Figure 3 shows total use of U.S. HRS wheat in 2001-02 and the relative amount of total demand represented by exports. Nearly 40 percent of the demand for U.S. HRS wheat originates in export markets. Figure 4 shows the same type of comparison for durum wheat. Durum export markets where the probability of GMO labeling or rejection is low in the next few years accounted for only about six percent of U.S. durum wheat exports in 2001-02. Some individual HRS-producing states export a higher percentage of the crop than the national average and could be affected more by loss of export markets than others.

Figure 1. Shares of U.S. Hard Red Spring Wheat Exports by Destination, 2001-02



<u>Market Acceptance Indicators</u>

As noted earlier, GMO food labeling would not automatically prevent the U.S. from exporting GMO wheat to the various foreign markets. ***Labeling serves as a communication mechanism between the consumers, retailers, processors, and crop producers.*** Market impacts could include the following:

- Partial or total foreign consumer and/or food processor and retailer rejection of all U.S. wheat and wheat products, both GMO and non-GMO.
- Foreign consumer acceptance of non-GMO U.S. wheat produced outside the Northern Plains but rejection of all HRS wheat and wheat products, as well as durum wheat by countries with labeling programs because of substantial co-mingling risks.
- Rejection of HRS and durum wheat and wheat products by a segment of foreign consumers, with widespread acceptance by the remaining consumers in labeling countries, but with a price discount, and with non-labelers continuing to purchase at present levels.

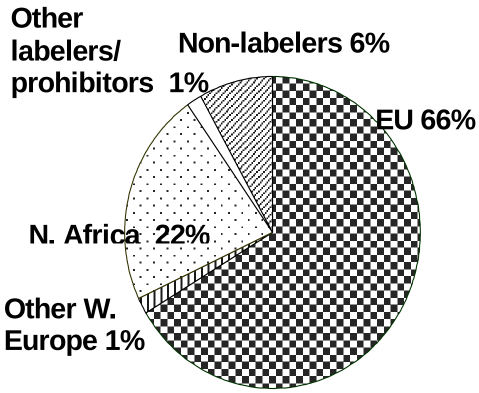
- Rejection of GMO HRS and durum wheat and wheat products by a fraction of foreign consumers in labeling countries who turn to non-U.S. suppliers for their wheat needs, with widespread acceptance by the remaining consumers with no price discount.
- All foreign consumers fully accepting all GMO wheat despite the GMO ingredient labels.

The last scenario has a very low probability of occurring in the short run. At least two of the other scenarios likely would involve substantial expense to develop identity preserved production and marketing systems, in order to avoid cross-pollination at the farm and seed production levels, and co-mingling in the marketing system.

Foreign food retailers and processors will also have a strong potential impact on market acceptance. Retailers or processors who believed the image and reputation of their firms would be harmed by marketing GMO food might avoid such ingredients entirely. This has happened in the EU, with a number of large retail chains avoiding GMO ingredients in store brands in response to consumer concerns about health or environmental safety of the GMO. Other evidence about EU acceptance of GMO wheat comes from the CEO of Italy's largest wheat miller, Grandi Molini Italiani, who in August 2002 indicated his firm would immediately cease buying U.S. wheat if the U.S. allows commercial production of GMO wheat varieties. Its CEO, Antonio Costato, is quoted as saying "We will not only avoid buying GM wheat but we will probably be forced to completely avoid importing from those countries/regions where it is known that GM wheat is grown…**As president of GMI, I do not see any reason to expose the company to the risks implied by accidental contamination with GM whe**at, added Costato, whose company has six Italian mills and uses about 1.4 million tons of grain [52 million bushels] annually." (Reuters News Service, 2/03/2003; bold added for emphasis). ***GMI's purchases alone are equivalent to 2/3 of the 2002 Montana HRS wheat production or nearly 1/3 of last year's North Dakota HRS crop.*** The U.K.'s largest flour miller, Rank Hovis, also indicated it would have to stop purchasing North American wheat if GMO wheat is commercialized in the U.S. or Canada and attitudes of British consumers continue as at present. Hovis's annual purchases of North American wheat reportedly have been about 18 million bushels and is used for higher quality bread (Harding, 06/03/03). A Nebraska trade mission to Japan in June 2003 indicated that "Olsen (President of Nebraska Farm Bureau) accompanied Gov. Mike Johanns on a Nebraska trade mission to Japan last month. Olsen said Japanese officials didn't mince words about genetically modified wheat. 'They made it pretty clear they don't want (genetically modified crops) for food consumption', he said." (Clayton, C., July 14, 2003).

Further evidence of potential serious consumer acceptance problems in the short run comes from a survey of Asian buyers by the US Wheat Associates in August 2002 (U.S. Wheat Associates, 9/30/02). U.S Wheat Associates stresses that this survey was not structured to give estimates of volumes of exports that might be affected by the introduction of GMO wheat. It did not take into account the volume of purchases represented by individual buyers or other details that would be needed to give a precise reading on potential consumer demand. Also, it represents consumer and buyer reactions at a point in time. Buyer attitudes

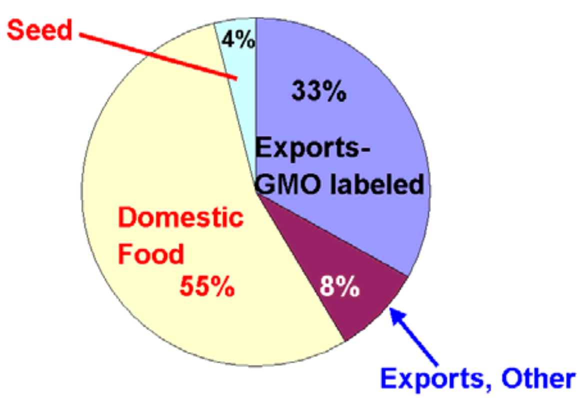
Figure 2. Shares of U.S. Durum Wheat Exports by Destination, 2001-02



may or may not change over time as more GMO products become available and as more research becomes available on questions of concern to consumers.

The survey of wheat buyers, millers and users found that ***"there is currently an overwhelming rejection of Monsanto's biotech "Roundup Ready®" wheat*** (*Reuters News Service*, 10/10/2002). The report indicated that all Chinese, Korean and Japanese wheat buyer representatives surveyed said they would not buy or use Roundup Ready wheat, while 82% of the Taiwanese buyers and 78% of the South Asian buyers would not buy GMO wheat.

Figure 3. U.S. Hard Red Spring Wheat Use By Type, 2001-02 Marketing Year

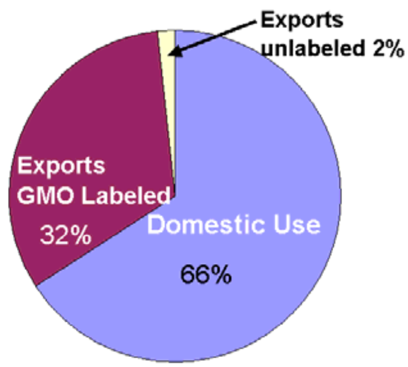


The Japanese users unanimously indicated they would not buy GMO wheat, regardless of U.S. and Japanese government regulations. Asian wheat buyers also said they would not buy wheat with even small amounts of adventitious presence of GMO wheat, according to U.S. Wheat Associates official, Dawn Forsythe (Ibid.). U.S. Wheat Associates indicated the survey represented very large Japanese and Korean organizations. Taiwanese buyers, while concerned, were less concerned than others about GMO wheat. About one-fourth of the Taiwanese buyers indicated they would require GMO-free certification of all classes of U.S. wheat if HRS GMO wheat is commercialized (Ibid.). The Canadian Wheat Board indicates more than 80% of its customers have said they will refuse to buy genetically modified wheat. It also indicates that assurances from the Canadian government are extremely unlikely to change foreign consumer attitudes toward such wheat (*Canadian Press*, 01/13/03).

<u>Assumed Two-to-Six-Year Export Scenarios for Analysis</u>

To estimate potential export and price impacts from commercializing GMO wheat, we used the following three types of short-run export market responses to a U.S. commercialization of

Figure 4. U.S. Durum Wheat Use by Type, 2001-02



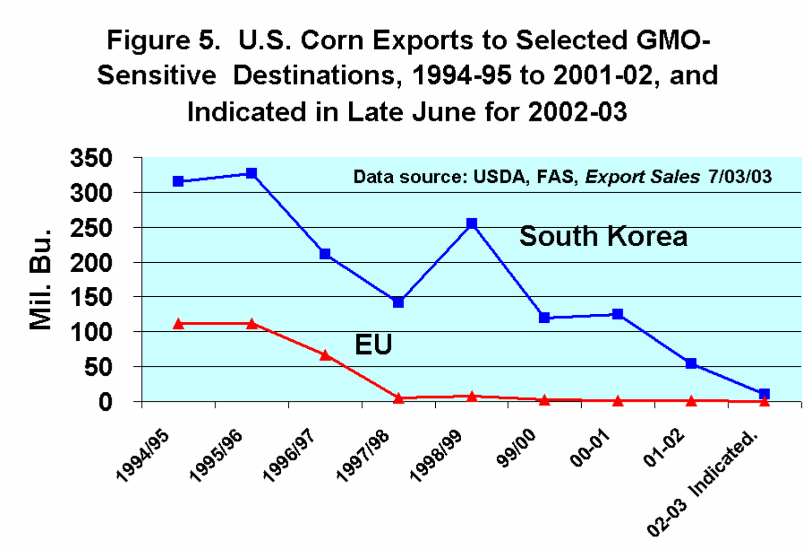
RoundUp®-Ready hard red spring wheat, assuming that such wheat is commercialized sometime in the next two to six years:

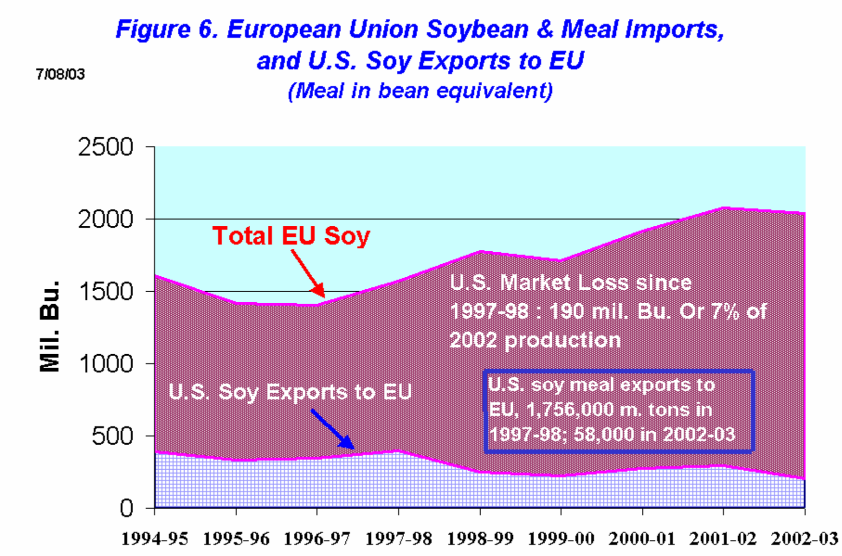
- **Scenario I**: Loss of the entire EU spring wheat and durum wheat export markets plus 40% of the other GMO labeling and prospective labeling markets shown in Figures 1 and 2 above, with no loss of non-labeling markets.
- **Scenario II:** Loss of the entire EU spring wheat and durum wheat export markets plus 25% of the other GMO labeling and prospective labeling markets with no loss of non-labeling markets.
- **Scenario III:** The U.S. develops a certified non-GMO marketing system to provide guaranteed non-GMO wheat to all GMO-labeling and prospective labeling export markets, at an added cost of $0.45 per bushel. The entire EU market is lost, along with 50% of the non-EU labeling and prospective labeling markets, and 20% of these non-EU markets utilize the non-GMO certification system. The remaining 30% of the labeling and prospective labeling markets and 100% of the non-labeling export markets buy GMO wheat at no discount. Final users of the non-GMO wheat pay all of the certification costs, and farmers receive an $0.18 per bushel premium as an incentive for producing and marketing non-GMO wheat.

<u>Is It Realistic to Assume the EU Wheat Market Will Be Lost?</u>

There is no way of answering this question with 100% certainty. In assuming the EU market would be lost with U.S. commercialization of GMO HRS wheat, we draw on:

- The U.S. corn and soybean meal market loss experience.
- The Canadian EU canola market loss.
- Reactions noted earlier from two large European wheat millers.
- Surveys of EU consumers.
- Forthcoming modifications in the EU labeling and traceability systems.
- EU Food retailer responses to GMO products.
- Other evidences of strong negative EU consumer reactions to GMO foods.





As further evidence of risk of market acceptance of GMO products in the EU, note Figure 5 which shows recent exports of corn to the EU and South Korea, and Figure 6 which shows U.S. soybean and soybean meal exports to EU.

As this report is being written, available indicators suggest the risk is very high that U.S. adoption of GMO wheat in the next two to six years would cause loss of the entire EU HRS and durum wheat markets. Segments of other foreign markets likely would be lost since consumer attitudes toward GMOs are negative there and alternative wheat supplies are readily available elsewhere, assuming normal weather in major wheat growing regions. Risks in the non-EU markets are sizeable, although precise quantification is not possible. At this writing, the U.S. has initiated a protest of the EU GMO regulations through WTO processes, charging that EU GMO policies are non-tariff trade barriers. Judging from previous WTO appeals and the complexity of the GMO issue, it may take at least a year or two for a decision to be made. Even then, in case of a decision against EU policies, consumer and food industry behavior would determine whether the EU would import HRS and durum U.S. wheat.

<u>What Does It Cost to Segregate Grain?</u>

Segregation and certification costs are affected by such variables as the amount and type of testing required, number of certification-verification points involved, the volume handled, loss of efficiency in elevator operations and transportation, cost of added waiting time for farmers, premiums paid to provide incentive for producers to apply the additional management needed to insure non-co-mingling at the farm and seed production levels, and the number of loads failing to meet contract standards at the ports and overseas. In our assumed costs for this system, we utilize work from the University of Illinois on recent actual costs of segregating non-GMO and other specialty grain and oilseeds at elevators from supplies of other grain in conventional marketing channels, plus other costs further upstream in the marketing system that are not included in the University of Illinois study.

Costs from the University of Illinois study are as shown in Figure **7**. Note that these costs included only those in moving the grain through local elevators. Additional costs of testing and certification would be involved at port elevators and in the foreign marketing system. Economies of scale in barge transportation used by some elevators in the survey likely are much smaller than for rail transportation used predominantly in the spring wheat areas. Also note that much of the grain handled by these elevators was specialty grains that would have less exact contract tolerances than will likely be required by most foreign buyers of non-GMO wheat.

Figure 7. University of Illinois Survey of Grain Segregation Costs, 1998

By K. Bender, L. Hill, B. Wenzel, and R. Hornbaker

Added Cost, Specialty corn, through Elevators

• Handling/Segregation	$ .03/bu.	
• Risk management	.01	
• Transportation	.01	
• Analysis/testing	.01	
• Purchasing premium	.18	
Total	$ .24	($9.45/m.ton)

9% of elevator volume was specialty crops

The additional $0.21 per bushel segregation and certification costs that are assumed in our study reflect:

1) Additional testing of grain for GMOs and accompanying certification records at each point in the U.S. and international marketing system.
2) Added costs of diverting shipments to alternative markets that fail the non-GMO testing procedures at ports. These costs could range up to 30 to 40 cents per rejected bushel, when costs of transportation to distant feed markets are included.
3) Loss of large-volume rail transportation discounts that can easily amount to $0.10 to $0.15 per bushel.*
4) Possible costs of cleaning port elevator facilities that have been accidentally contaminated with GMO wheat.
5) Partial loss of country elevator efficiencies and economies of scale.

As one example of economies of scale in transportation, 110 car shuttle trains are the latest rail transport system in the Corn Belt, and provide freight cost reductions of up to 20 cents per bushel for an 800 mile shipment, vs. 100 car rates to the same location.*

The $0.21 per bushel additional cost is an assumed cost that appears to be within a realistic range when the above factors are considered and under some conditions could be quite conservative. It is based in part on non-GMO soybean segregation cost estimates developed by USDA from a survey of 84 elevators that placed non-GMO segregation costs at $0.22 and $0.54 per bushel respectively for corn and soybeans (Lin, et. al. 2000). These costs do not include premiums paid to farmers or added overseas testing costs, and will vary from one elevator to another with variations in facilities and the volume handled. (For additional discussion of segregation or other dual marketing system costs, see Smyth, et. al., 2003, and Herrman, et. al., 1999.)

A recent North Dakota State University study provides estimates of some handling and testing costs at country elevators for a dual marketing system where non-GMO tolerances are moderate and elevators apparently already have existing dual dump pit, conveyor, and load-out systems to avoid contamination and clean-out expenses or the system is achieved by multi-location firms designating individual facilities for handling only non-GMO grain (Wilson & Dahl, October 2002). The authors estimated total segregation costs with an optimal strategy at 3.36 cents per bushel, testing every fifth load of incoming grain.

Under this system, in addition to costs identified by the authors, a number of significant additional costs and "hidden costs" almost certainly would be involved. These include farmer expenses for added waiting time and hauling the crop longer distances than at the present time, and likely loss of economies of scale in grain elevator and transportation costs through lower handling volumes and storage bins not being fully utilized (Maltsbarger, et. al., 2000). Lin, et. al. also cites National Grain and Feed Association estimates that, at a 1-percent or lower tolerance level for biotech content, roughly 5 percent of the nation's elevators can achieve segregation without major new investments.

Canadian researchers find cross-pollination and volunteer wheat to be a substantial co-mingling problem when the same field and adjoining fields raise wheat over a multi-year period, particularly when the crop is herbicide-resistant and non-GMO market tolerances are low. A low level of contamination may occur initially along the edges of fields that border GMO wheat fields. This wheat, in turn produces volunteer wheat that contaminates a larger area of the field the next year. Over a series of years, the researchers find that contamination is potentially a serious problem. The Canadian researchers also indicate it is a potentially serious problem for seed producers in that it may cause GMO wheat contamination of non-GMO seed wheat, thus compounding segregation challenges (Brûlé-Babel1). This problem becomes more serious with the

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* Personal communication with Dr. C. Phillip Baumel, Distinguished Professor of Agriculture, Professor of Economics, and agricultural transportation specialist at Iowa State University.

recognition that many wheat growers save seed from current production for planting the next year. That is a practice that non-GMO wheat producers would expect to continue to use if GMO wheat is commercialized. Experience with soybeans, another self-pollinating plant, also indicates this risk is not insignificant and may well be due to accidental low-level co-mingling at seed processing plants and/or growth of volunteer herbicide-resistant soybeans in seed fields. Seed plants typically have extensive conveyor systems and other mechanisms where low-level contamination may be a risk. Because of these problems, major seed companies indicate they cannot guarantee that U.S. corn and soybean seed sold as non-GMO varieties is 100 % non-GMO.

Experiences with StarLink® corn, organic soybeans, and pharmaceutical corn in Iowa and Nebraska, all of which represented much less than one percent of total crop acreage, suggest the challenges of meeting foreign buyer non-GMO wheat contract specifications are likely to require a stringent market segregation system. Other costs that likely would be involved in such a system include additional expenses to clean-out legs and conveyor systems, waiting time for producers as the elevator shifts from receiving loads of GMO wheat to receiving non-GMO wheat, possible investment costs at elevators for additional dump pits and separate conveyor systems to insure non-co-mingling, added segregation costs at U.S. port elevators, and added testing and segregation costs beyond the receiving port elevators in the country receiving and using the non-GMO grain. For additional work on costs of segregating or identity preservation of non-GMO grain, see (Lin et. al., 2000; Gosnell, 2001).

Non-GMO Premiums on the Tokyo Grain Exchange Show Large Segregation Costs

A further indication that when all costs from producer to end user are included, GMO wheat segregation costs to prevent low-level GMO contamination are likely to be several times the level indicated in the low-cost study cited above comes from price premiums of the non-GMO soybean futures contract on the Tokyo Grain Exchange (TGE) vs. the GMO soybean futures contract. Both contracts specify No. 2 yellow soybeans produced in Ohio, Michigan, and Indiana as the deliverable commodity, but also provide for soybeans from Iowa, Illinois, and Wisconsin to be delivered. The delivery points are designated warehouses in Tokyo, Kanagawa, Chiba, and Saitama, with no discount for Iowa, Illinois, or Wisconsin soybeans. (Tokyo Grain Exchange [TGE] Web site: http://www.tge.or.jp/).

The TGE non-GMO soybean futures contracts began trading on May 18, 2000. GMO soybeans have been commercially available in large quantities in the U.S. for the past four years. The average premium of all TGE non-GMO soybean futures (for all delivery months combined) over TGE GMO soybean futures contracts during the month of December of 2002 was $1.033 per bushel. Premiums vary over time with changing market conditions, and influences such as the availability of Brazilian non-GMO soybeans to meet user needs and length of time to the delivery period. ***Economic theory indicates that with efficient, competitive markets, if a dual marketing system capable of meeting Japanese buyer needs had been possible at costs of only a few cents per bushel, the market would have had sufficient time to force non-GMO vs. GMO soybean futures price differentials down to that cost level by late 2002.*** Other empirical evidence of substantial cost involved in developing a dual marketing system comes from the Canada's loss of the EU canola market, and the U.S. loss of the EU corn market. ***In both cases, if a dual marketing system had been available to meet the low tolerances of foreign buyers at low cost, it should have emerged in the years after these crops were introduced commercially in the U.S. and Canada.***

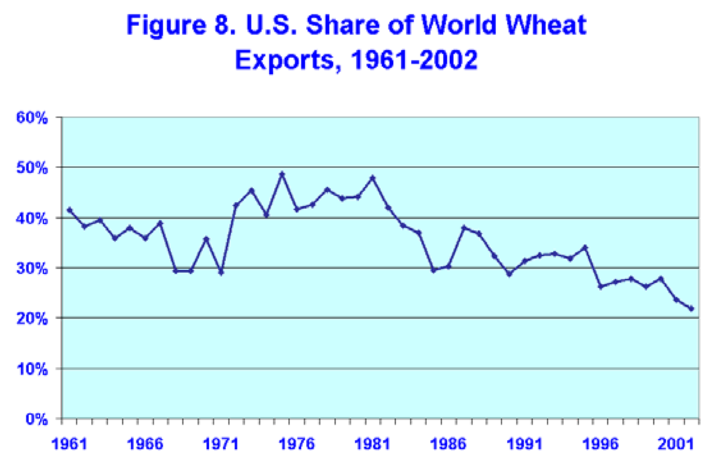
Summary Comments About Segregation Costs

There is uncertainty about the precise cost of a dual marketing system, whether it will work effectively with stringent foreign buyer requirements, or whether an identity preservation system would be required to reduce to near zero the chance of accidental GMO contamination. A key point to keep in mind is that if even modest additional costs are involved in marketing non-GMO U.S. wheat, foreign buyers will have incentive to look for alternative suppliers who do not produce GMO wheat. That tendency will be reinforced by foreign food processors, who do not want to risk alienating customers with possible accidental co-mingling of GMO and non-GMO wheat in their products.

In considering segregated or identity-preserved marketing systems, it is important to consider the challenges of low foreign GMO tolerance. In China's labeling system, the tolerance level is zero. In the EU, it currently is one percent and is expected to soon be lowered to 0.9 percent. A 0.9% tolerance level would be reached with only 90 kernels of wheat in 10,000 kernels. For unapproved GMO varieties, the official EU labeling tolerance is expected to remain at 0.5%, although buyers might well require a lower tolerance level. A segregated or identity-preserved marketing system would need adequate precision to prevent contamination of non-GMO wheat with GMO varieties above these levels. Without a segregated handling system, a small amount of wheat left in an elevator leg or dump pit after unloading GMO wheat could easily cause rejection of a shipment of grain, an entire bin at an elevator, or could shut-down a processing plant, even if tests of samples from incoming loads were confirmed to be non-GMO wheat. ***Even with the best of systems, such rejection is almost certain to occur at times and must be considered in the costs of segregation, unless there are completely segregated dual handling systems. Dual systems likely would require duplication of some investments and loss of economies of scale.***

Long-Term Trend in U.S. Share of World Wheat Exports

In considering the potential impact of GMO wheat commercialization on the U.S. competitive position in world markets, it is important to note the long-term trend in the U.S. world market share, as shown in Figure 8. Competition in world wheat markets intensified in the 1980s and 1990s and remains highly competitive. The U.S. share of the world wheat export market has fallen from the 40 to 49 percent range in the 1970s and early 1980s to the low 20 percent range in the past year. Current trends indicate competition in this market may increase in the years ahead as Eastern Europe and the former Soviet Union continue



their transitions to market economies and increased wheat exports. The 2003-04 marketing year may be a temporary exception to this trend because of the worst winter-kill damage in nearly a century and severe drought in parts of the former Soviet Union.

Competitiveness in international markets has several dimensions, including price, dependability of supplies, and quality. The quality dimension clearly will include non-GMO vs. GMO when GMO wheat is commercialized. Since wheat is produced in many parts of the world, non-GMO supplies are likely to be readily available to foreign buyers in the next two to six years, at highly competitive prices. For the U.S. to maintain or enhance its share of world wheat exports, it will be important to provide consumers with the quality of wheat they desire at competitive prices.

If the U.S. attempts to supply world markets with both GMO and non-GMO wheat from the same producing regions, foreign consumers will be faced with the following question. ***"Should I buy non-GMO U.S. wheat at a premium price that includes the costs of segregation and certification, or can I get similar wheat from other suppliers without paying segregation costs?"*** A segregation premium and/or lack of non-GMO supplies in the U.S. would create foreign incentives to increase investment in over-seas wheat producing areas to create alternative sources of supply, in a pattern similar to the one that occurred in Brazil in recent decades (Warnken, P.F., 1999). Several former Soviet republics have expanded grain production rapidly in the last five years, and are modernizing their marketing systems, including large new investments for exporting facilities on the Black Sea. Some estimates indicate that as much as 37 to 73 million more acres of good cropland could be brought into production in these countries in the next few years. Much of this land is likely to be used for wheat production. Farm level production costs in parts of this region are estimated to be as low as $0.98 to $1.22 per bushel (McKee, August 2002, p. 37).

Potential Export Market & Price Impacts on Hard Red Spring and Durum Wheat

Our market-loss scenarios are based on the assumption that in the short-run (2 to 6 years), alternative non-GMO supplies will be readily available in other countries, without the need for segregation expenses. At this writing, this appears to be a valid assumption for the short run, although it may not be valid in a longer-run time frame. Table 1 shows the estimated millions of bushels of negative impacts on U.S. hard red spring wheat exports, total demand for this class of wheat, and potential price impacts for the three scenarios previously outlined.

In each case, loss of export markets forces excess wheat supplies into the domestic feed market in competition with corn and other feed grains. Large feedlots are not present in most of the northern Great Plains of the U.S. Feed wheat prices likely would also be depressed by the cost of shipping excess wheat to intensive livestock feeding areas further south. These costs could be partially offset by the higher feeding value of wheat than corn. But it should also be noted that the Northern Plains region would face intense competition from emerging innovations in very large, low-cost shuttle-train corn shipments noted earlier that are being used to move corn into these same feeding areas. The 110-car shuttle trains haul almost half-a-million bushels at a time, and must be loaded and ready to move out from the originating elevator in 17 hours. Additional competition would come from competitively priced distiller's grain and solubles (DGS) from more than two dozen new ethanol plants under construction and/or just coming into operation, along with more plants that will be built in the next few years. The distiller's grain has about twice the protein content (dry matter basis) that is contained in ordinary protein hard red wheat, as well as considerable energy. This product is priced at about the same price per ton as corn.

Table 2 shows potential export and price impact comparisons for durum wheat. The EU and non-Egyptian North African markets are especially important to U.S. durum wheat producers since they accounted for about 88% of U.S. durum wheat exports in 2001-02. Strong negative reactions to GMO wheat appear likely in both of these markets. Judging from the StarLink® experience where co-mingling with other types of corn caused widespread market rejections, this analysis is based on the premise that similar problems would be likely to occur with durum wheat. While the GMO wheat is not expected to have the allergenic concerns that were associated with StarLink® corn, buyer preferences in these two durum market areas appear strong enough to produce similar rejection, and the StarLink® experience shows the high risk of contamination of non-GMO supplies with GMO grain.

In this part of the analysis we assume U.S. commercial GMO varieties are restricted to spring wheat, that U.S. consumer attitudes toward GMO wheat are positive, and that foreign buyers will continue to buy other classes of U.S. wheat produced outside of the Northern Plains. Later in the report, we examine export market destinations and risk exposure for other classes of wheat. U.S. consumer acceptance would encourage some substitution of hard red spring wheat for other classes of wheat in the domestic milling market, thereby slightly tempering the impact on spring wheat prices but lowering the price of other types of wheat. At the same time, such substitution would risk co-mingling of HRS wheat with other classes in the marketing system, and might increase the risk loss of foreign markets for other classes of U.S. wheat.

Table 1. Estimated Hard Red Spring Wheat Short-Run Export and Price Impacts from Commercialization of GMO Spring Wheat in the U.S.

	Mil. Bu. Export Loss	Percent of 2001-02 U.S. HRS Exports Lost	Percent of 2001-02 U.S. HRS Total Demand Lost	Estimated Farm Price Impact on HRS Wheat *
Scenario I	88	43%	16.5%	-33%
Scenario II	67	33%	12.6%	-32%
Scenario III	110	52%	20.7%	-35%

* In the short run, Hard Red Spring Wheat is priced as feed wheat because of surplus volume from lost exports being forced into domestic markets.

Table 2. Estimated Durum Wheat Short-Run Export and Price Impacts from Commercialization of GMO Spring Wheat in the U.S.

	Mil. Bu. Export Loss	Percent of 2001-02 U.S. Exports	Percent of 2001-02 U.S. Total Demand	Estimated Farm Price Impact, Durum Wheat
Scenario I	32	82%	26%	-32%
Scenario II	28	71%	23%	-32%
Scenario III	34	87%	28%	-32%

Inelastic Demand

Demand for most farm products is highly inelastic. For this analysis of short-run impacts, we used a domestic food wheat price elasticity of demand of –0.3 for other hard red spring wheat and –0.2 for durum wheat. An inelastic demand in domestic markets means that as supplies are increased by forcing normal exports back into domestic markets, the price goes down by a greater percentage than the increase in domestically available supply. In other words, a large decrease in price is needed for the domestic market to absorb supplies that normally would be marketed outside of the U.S.

Under all three scenarios, price elasticities of demand for domestic food use for both classes of wheat would have lowered prices well below those for corn and other feed grains in an unsuccessful effort to generate enough increased U.S. milling demand to use the supply formerly going to export markets. In the process, these types of wheat would be expected to become attractive to livestock feeders. Thus, feed markets would be expected to set the price of both durum and hard red spring wheat and would absorb the excess supply. As other evidence of potential large negative effects on wheat prices, an extensive Canadian study of GMO commercialization and various export market scenarios for different qualities of Canadian wheat found a potential 58 percent decline in revenue for the highest quality of Canadian wheat (Kuntz, 2001).

Impact on Other Crops

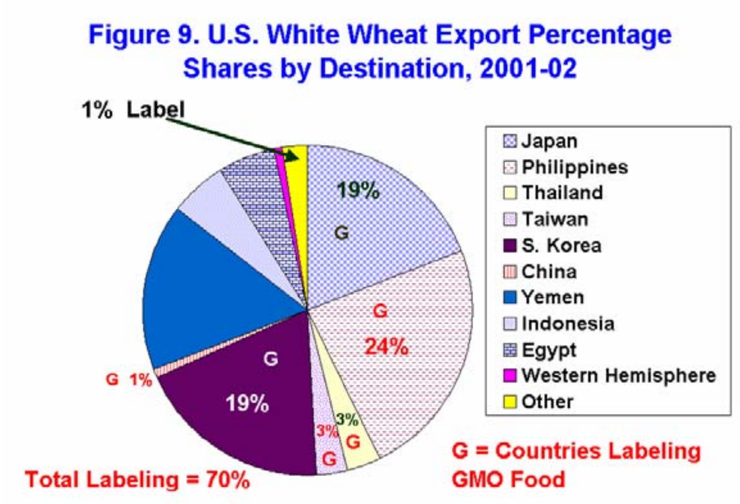
Loss of export markets and forcing of increased supplies of U.S. durum and other spring wheat into feed markets in the short-run would likely have small negative impacts on prices of corn, feed barley, and other feed grains—provided foreign buyers continue to accept other classes of U.S. wheat. The potential volumes of lost spring wheat exports are small in comparison with the total quantity of corn (the dominant feed grain) fed in the U.S. Our estimates show potential negative corn price impacts of around two to three percent or about four to six cents per bushel in the short run, ***provided foreign buyers continue to purchase other classes of U.S. wheat in the same quantities as currently.***

Government Program Impacts

The Farm Security and Rural Investment Act of 2002 provides crop producers with three types of income safety-net mechanisms. Price levels do not influence one type, Direct Payments. The other two, Loan Deficiency Payments (LDPs) and Counter-Cyclical Payments (CCPs), are triggered by low spot and marketing-year average prices, respectively. Current legislation provides for this system to be in effect through the 2007 crop year. In the case of wheat, CCPs are based on the marketing year average price of all wheat, not on prices for individual classes of wheat. If most of the weakness in wheat prices stemming from commercialization of GMO wheat is in the HRS and durum markets, the national average price for all wheat would be less depressed than that for HRS. HRS wheat makes up approximately one-fourth of total U.S. wheat production. As a result, HRS and durum wheat growers might receive only partial compensation for a GMO-induced price decline through increased government payments.

Risk of Export Losses for Other Classes of Wheat

Along with hard red spring and durum wheat, there are three other major classes of U.S. wheat: white, hard red winter, and soft red winter wheat. ***White wheat producers are substantially more dependent on export demand than producers of the other two types of wheat, although exports are very important to all three classes of wheat. In the 2001-02 marketing year ending May 31, 2002, exports accounted for an estimated 61 percent of total use of U.S. white wheat (WW).*** That compares with 43 percent for hard red winter wheat (HRW) and 44 percent for soft red winter wheat (SRW). For the 2002-03 marketing year, the percentage accounted for by exports was about unchanged for WW and

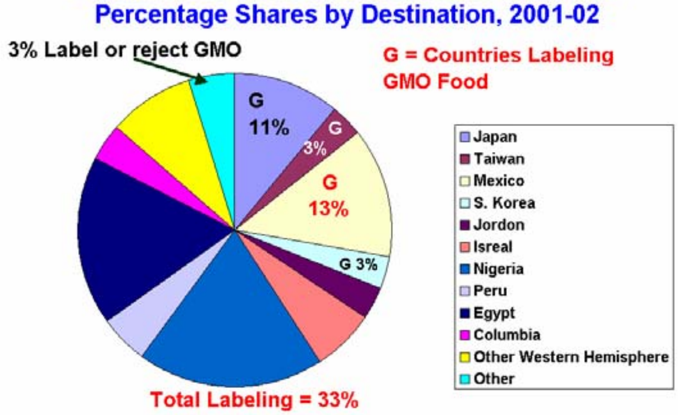


HRW, but was down sharply for SRW. Impacts of de-regulation and commercialization of GMO hard red spring wheat on hard and soft red winter wheat are more uncertain than for HRS because of differing market destinations, fewer exports to countries that label foods containing GMO ingredients, and possible differences in intensity of foreign consumer reactions to GMO wheat in the relevant markets. ***It is not the purpose of this report to provide detailed projections of precise impacts on the other classes of wheat, but to provide a general idea of the risk exposure that may exist for these crops, assuming that Round-Up® Ready HRS wheat is commercialized in the next few years.*** Export risk exposure will also depend on the ability of the U.S. marketing system to avoid co-mingling of GMO HRS wheat with the other classes. Prices also will be affected by attitudes of domestic millers toward use of GMO wheat in their plants. If domestic millers use GMO wheat in their plants, risk of co-mingling GMO HRS supplies with other classes of wheat will be increased. Control of co-mingling probably will be more difficult with white wheat than with hard and soft red winter wheat because white wheat uses the same export marketing system as much of the HRS wheat. However, HRW wheat would be at some risk of co-mingling and hence rejection by foreign buyers that desire to avoid GMO wheat. The co-mingling risk is present because of production in southern areas of the Northern Plains that may move through the same marketing system as spring wheat. Also, if domestic millers readily accept GMO wheat, risk of co-mingling could occur as millers bring spring wheat to their plants through the marketing system used for HRW wheat.

Major export market destinations vary considerably from one type of wheat to another because of the different types of products that are made from them, as shown in Figures 9, 10, and 11. White wheat export markets are primarily in Asia, with almost no exports to Europe, and very few to the Western Hemisphere and Africa. Consumer response to GMO wheat in Yemen, Indonesia, Egypt, and the Western Hemisphere appears likely to be much less negative than in other major export destinations. These countries (most of which do not label GMO foods) accounted for about 30 percent of U.S. white wheat exports in 2001-02 or about 21 percent of combined domestic and foreign use of that type of U.S. wheat.

Hard red winter wheat exports go to a wide range of non-European destinations on four continents. Soft red winter wheat typically is the lowest priced U.S. wheat and goes primarily to developing nations in Africa, Latin America, and Oceania, along with a modest amount to EU. For both WW and HRW exports, one should note that some Arab nations have prohibited the sale of GMO food in their countries, and Saudi Arabia labels food products containing GMOs. That fact adds uncertainty to foreign market acceptance of GMO wheat. ***We are assuming that the***

Figure 10. U.S. Hard Red Winter Wheat Export Percentage Shares by Destination, 2001-02



Arab countries identified here will readily accept these classes of wheat, despite risk of co-mingling with GMO wheat.

Of these three types of wheat, white wheat appears to be at greatest risk of market losses if Round-Up Ready® hard red spring wheat is de-regulated and commercialized. About seventy percent of its exports go to countries that label food containing GMO ingredients, and over 60 percent of the demand for this type of wheat comes from export markets. U.S. Wheat Associates survey data indicate buyers in most of these destinations are opposed to use of GMO wheat in their plants (U.S. Wheat Associates, op. cit.).

The class of U.S. wheat with least risk of market loss from commercialization of GMO HRS wheat appears to be soft red wheat. Only about 28% of U.S. exports of this class of wheat go to markets currently labeling or soon expecting to label food containing GMO ingredients. Even so, this is a significant part of total demand for this type of wheat. Also lowering the risk for SRW wheat exports is the fact that it is produced mainly in the eastern Corn Belt, South Central, and South Eastern U.S. Wheat produced in these regions typically does not move through the same marketing system as HRS wheat. Accordingly, risks of co-mingling SRW and HRS wheat in the marketing system are relatively low. One unknown in assessing risks of market loss for both HRW and SRW is whether developing nations in Africa would accept SRW wheat if HRS is commercialized in the U.S. in the next few years. Several African countries rejected U.S. GMO corn food aid shipments in 2002. According to some sources, the rejection was because the countries feared GMO corn would be used for seed and would contaminate domestic production, part of which is exported to EU.

Figure 11. U.S. Soft Red Wheat Export Percentage Shares by Destination, 2001-02

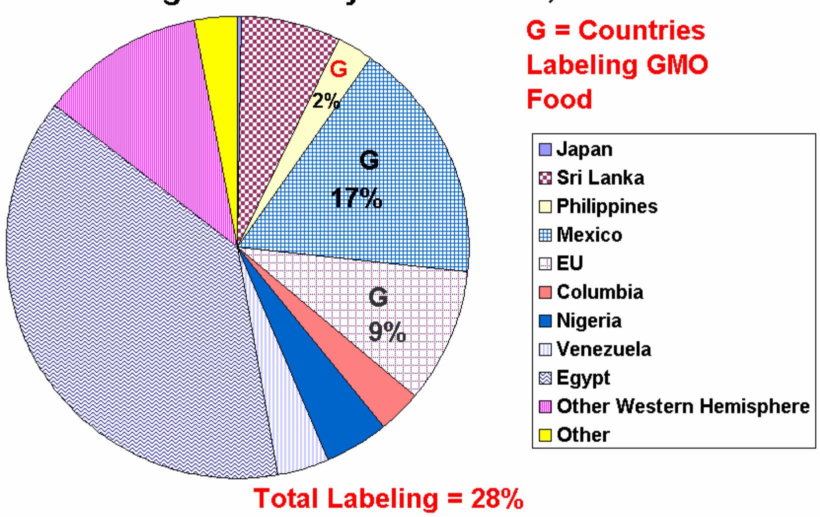


Table 3 shows potential bushel losses of export demand and percentages of total demand for white wheat, using the same assumptions as were used earlier about market acceptance for HRS and Durum wheat, and using the same domestic food elasticity of demand as for HRS wheat. A parallel assumption is that with commercialization of GMO HRS wheat, foreign buyers would view U.S. WW as being very susceptible to co-mingling at low levels with HRS wheat, and thus at risk of containing some GMO wheat. Indicators that this may be a realistic assumption include (1) the fact that WW moves mainly through the same Pacific Northwest U.S. grain marketing system as does a substantial amount of HRS U.S. wheat, and (2) trade reports recently indicated that current U.S. wheat exports contain some fragments of

Table 3. Possible White Wheat Short-Run Export and Price Impacts from Commercialization of GMO Spring Wheat in the U.S.

	Mil. Bu. Export Loss	Percent of 2001-02 U.S. WW Exports Lost	Percent of 2001-02 U.S. WW Total Demand Lost	Estimated Farm Price Impact on HRS Wheat
Scenario I	32	28%	13.4%	-26% *
Scenario II	20	17%	8.4%	-26% *
Scenario III	44	37%	18.1%	-26% *

* In the short run, White Wheat is priced as feed wheat because of surplus volume in domestic markets from lost exports.

Table 4. Possible Hard Red Winter Wheat Short-Run Export and Price Impacts from Commercialization of GMO Spring Wheat in the U.S.

	Mil. Bu. Export Loss	Percent of 2001-02 U.S. HRW Exports Lost	Percent of 2001-02 U.S. WW Total Demand Lost	Estimated Farm Price Impact on HRW Wheat
Scenario I	44	14%	5.4%	-18% #
Scenario II	27	9%	3.4%	-11% #
Scenario III	55	17%	6.7%	-22% *

Because of the potential blending of HRS wheat with this class of wheat in domestic milling operations, the actual decline in prices could be greater than shown here.

* In the short run, Hard Red Winter Wheat is priced as feed wheat because of surplus volume from lost exports.

Table 5. Possible Soft Red Winter Wheat Short-Run Export and Price Impacts from Commercialization of GMO Spring Wheat in the U.S.

	Mil. Bu. Export Loss	Percent of 2001-02 U.S. SRW Exports Lost	Percent of 2001-02 U.S. SRW Total Demand Lost	Estimated Farm Price Impact on SRW Wheat
Scenario I	21	11%	4.6%	-15% *
Scenario II	20	10%	4.4%	-15% *
Scenario III	39	20%	8.5%	-18% *

* In the short run, Soft Red Wheat is priced as feed wheat because of surplus volume from lost exports. ***Note, however, that a low-cost or no-cost dual marketing system may be more workable for this class of wheat than others because of the different geographic location of its production. If that is the case, these negative price impacts for SRW wheat could be moderately over-stated.***

GMO corn and soybeans because they move through the same marketing system (Reuters, June 3, 2003, op. cit.). GMO corn and soybeans can be removed from the wheat because of different sizes, shapes, and density of kernels. But GMO HRS wheat would be very difficult to remove from WW.

U.S. Wheat Product Exports

American wheat product export volumes are very small when compared to un-processed wheat exports. For the 2002-03 marketing year ending May 31, 2003, U.S. firms exported a total of 35,400 tons of these products. While small relative to the size of the total wheat market, these exports may be more significant for some individual firms. Approximately 70 percent of the U.S. wheat product exports went to Mexico last year, with most of the remainder going to other Latin American countries. In the last two years, Western Hemisphere destinations accounted for 84 to 90 percent of U.S. wheat product exports. Due to the small volume of exports and the destinations to which they are shipped, one should not expect risk of foreign buyer rejection of U.S. wheat product exports to create significant risk in wheat prices.

Summary of Implications for other Classes of Wheat and for Feed Grains

This analysis suggests that in the next one to six years, white wheat would be at substantial risk of economically significant export market losses and negative price impacts if GMO HRS wheat is soon commercialized in the U.S. The risk comes in large part from possible co-mingling with HRS wheat at port elevators in the Pacific Northwest. All three market scenarios imply that there is considerable risk of U.S. white wheat prices falling to feed-wheat levels with commercialization of GMO hard red spring wheat. For hard red winter wheat, Scenario III with relatively high segregation costs of a dual marketing system tends to create an incentive to invest in increased foreign wheat production, in a manner similar to that which began in Brazilian soybeans in the 1970s with ill-fated U.S. grain export embargoes **(**Warnken, op. cit.**).** That, in turn pushes HRW prices down to feed wheat levels. For this class of wheat, it is possible that a regional segregation system might be used to reduce the risk of export market loss. Under such a system, wheat from the Southern Plains might be shipped to export markets that prefer non-GMO wheat, while wheat from areas adjoining the spring wheat Belt where co-mingling with GMO wheat is more likely might be shipped to countries where GMO wheat is acceptable.

For SRW, assuming that foreign buyers believe there is considerable risk of co-mingling with HRS wheat, there would be some risk that prices for this class of wheat would drop to feed wheat levels. This possibility is shown by the three scenarios in Table 5. However, the export market risk for this class of wheat may be reduced by the fact that SRW wheat is produced and marketed in regions of the U.S. where spring wheat is not grown.

Total bushels of export demand at risk for all classes of wheat, as indicated in the scenarios shown here, ranges from approximately160 to 280 million bushels. In the short run, this wheat supply likely would be diverted into feed markets, competing with corn, grain sorghum, and feed barley. Our estimates indicate that based on 2001-02 market

conditions, the extra feed supply would have the potential to weaken corn prices by approximately $0.06 to $0.10 per bushel in the short run vs. levels that would be expected to occur without the reduced U.S. wheat exports.

For the world wheat market, these potential reductions in U.S. exports of all wheat are equivalent to 4.4 to 7.7 percent of USDA's July 11, 2003 projections of 2003-04 world wheat exports. They represent a potential loss of 16 to 29 percent of USDA's July 11, 2003 projected U.S. wheat exports for 2003-04. That, in turn, would have the potential to lower the U.S. share of global wheat exports to around 16 to 19 percent, down from 22.9 percent in the marketing year just ended. The bottom end of this range would be equivalent to 62 percent of the percentage decline in the U.S. share of world wheat exports occurred from 1995-96 to 2002-03. ***From another perspective, foreign wheat production would need to increase by a modest 0.8 to 1.5 percent beyond growth in foreign demand to offset this estimated loss of U.S. wheat exports. If classes of U.S. durum and other spring wheat are the only ones impacted by commercialization of Round-Up® resistant spring wheat, the estimated impacts would be only 50 to 60 percent as large as these numbers indicate .***

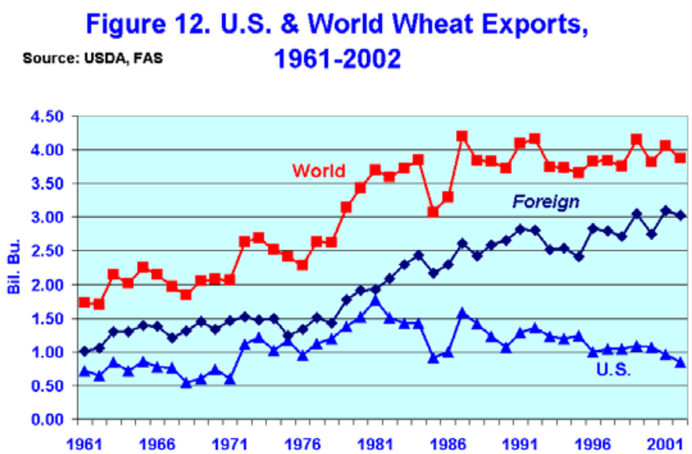
Longer-term U.S. Wheat Production Sector Adjustments to GMO Wheat

The model used here to assess short-term potential price impacts from export market losses is not adequate to analyze longer-term adjustments of the wheat sector to the introduction of Round-Up® Ready wheat, and long-term analysis is beyond the scope of this study. However, the probable direction of longer-term adjustments, provided foreign consumer resistance to that type of wheat persists for several years, is outlined here. An important element in the longer-term setting is that in many U.S. wheat export market destinations, USDA analysts indicate wheat is an inferior good. That means for industrialized and newly industrializing countries, as incomes rise, consumers tend to consume fewer products produced directly from wheat, and more meat, poultry, and sea food. There are exceptions to this pattern, especially in low-income developing nations that consume wheat products as a staple food. Many of these countries tend to rely on classes of wheat other than HRS or durum wheat.

Another element in the long-term global wheat market setting is that for many countries, wheat yields and production technology have laged substantially behind that of the U.S. Also, farmers in former Centrally Planned nations have a learning curve in experiencing how to operate their businesses in a market-directed economy. These two factors suggest that foreign wheat production is likely to continue growing more rapidly than that of the U.S. in the longer run. When short-term reluctance of foreign consumers to embrace GMO wheat is added to the picture, it suggests that U.S. commercialization of GMO wheat may risk accelerating long-term trends that have been in place in the U.S. wheat industry for many years unless changes in foreign consumer attitudes occur. Those trends include:

- a declining U.S. share of global wheat exports.
- downward-trending absolute levels of U.S. wheat exports.

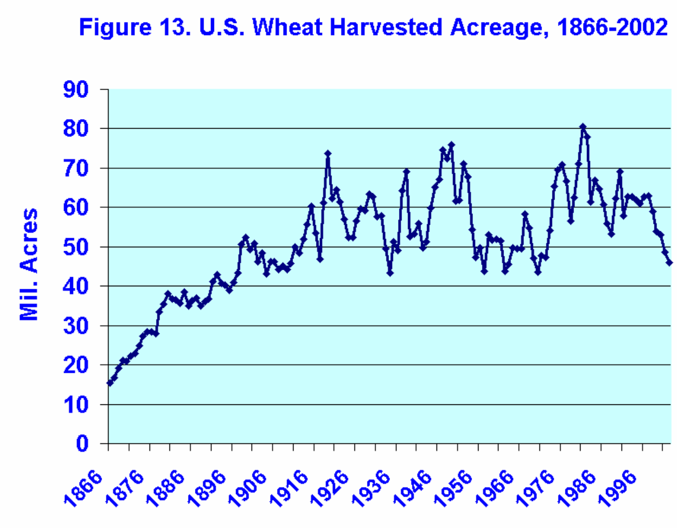
- shifts of U.S. wheat cropland to other uses including the U.S. Conservation Reserve and Wetland Reserve Programs, forage, pasture, soybeans, canola, and feed grains.
- downward trending wheat prices, both in inflation-adjusted terms and in current dollars.
- declining revenue available from wheat to support rural economies and government institutions in major wheat-growing areas



U.S. wheat exports peaked in 1981-82, and have trended downward since that time (see Wisner, Baumel, et. al., 2003 for more detail) as shown in Figure 12. Harvested U.S. wheat acreage peaked in 1981 at 80.6 million acres, and declined to 46 million acres last year, as shown in Figure 13. U.S. harvested wheat acreage in 2002 was the smallest since 1970, and the 6th smallest since 1909.

Downward pressure on wheat prices stemming from lost export demand would likely make wheat an unprofitable crop in some marginal producing areas of the U.S., with prices dropping below variable costs of production.[4]

Government programs, including Loan Deficiency Payments and subsidized crop insurance likely would slightly temper this tendency. But the market signal to producers would be to produce less wheat. Over time as wheat growers would find other alternatives for land currently producing wheat, prices for wheat would likely increase from the initial levels occurred in response to de-regulation and commercialization of Round-Up® resistant hard red spring wheat. Gross revenue to the industry would be expected to decline because of fewer



[4] Variable costs are costs that would not be incurred if the crop were not planted. Opportunity costs on owned land, farm operator labor, depreciation, and some other costs are incurred whether or not the land is planted. These costs are called fixed costs.

acres being planted. That in turn would reduce revenue to local businesses and government institutions in major spring wheat producing areas, unless alternative uses for the land that were equally favorable with wheat prior to GMO commercialization could be found.

Implications for Wheat Futures Markets and Hedging

Merchandising margins per bushel are very small in grain handling and exporting businesses because of strong global competition. With typically volatile wheat prices, a small change in the wheat market could shift a merchandiser's or exporter's wheat purchase or sale from a profitable transaction to a substantial loss unless appropriate risk-management procedures are used. To prevent that from happening, it is standard business practice for buyers of wheat to use the futures market to "hedge" purchases as well as sales to processors, exporters, and other users of wheat, or to use contractual arrangements that are based on futures markets.

Hedging is a process for protecting merchandising or processing profits from market fluctuations. It involves taking opposite positions in two wheat markets such as a cash or spot market for the physical wheat represented by a purchase from a wheat producer, and a sale of a standardized futures market contract for future delivery of the wheat. In nearly all cases, selling the wheat to a buyer at a later time and buying back the futures contract through a paper transaction completes the hedge. The threat of physical delivery on futures contracts (though actual delivery is not used to a large extent) forces the futures price to reflect realities of the cash or spot market. The futures transaction thus serves as a temporary substitute for a later transaction in the physical wheat market. This process provides price protection because a loss in one market is offset by a gain in the other.

For the hedge to be effective in protecting against price risk, the two markets must reflect a value for the same commodity. Otherwise, a decline in the spot commodity price would not be offset by an opposite gain in the futures transaction, or vice versa if the spot commodity price would rise. Accordingly, it is essential to the grain industry, for effective hedging, that the cash or spot market and the futures contract both represent the same type of wheat. For this reason, the Minneapolis grain exchange has allowed buyers of spring wheat futures contracts, if they so desire, to specify that non-GMO wheat be delivered on their contract **(Minneapolis Grain Exchange, News Alert, May 9, 2003).** When GMO wheat is commercialized, this provision may cause some uncertainty in the wheat price discovery process and wheat basis (spot-to-futures price differential) since spring wheat futures sellers may not know at the time of the initial transaction whether their contract will be priced as GMO or as non-GMO wheat.

The other two U.S. wheat futures markets, the Kansas City Board of Trade and the Chicago Board of Trade also may need to make decisions regarding eligibility of GMO vs. non-GMO wheat for delivery (Reuters, May 27, 2003). The former of these two markets offers contracts for HRW wheat, while the latter offers contracts for SRW wheat. If the risk of co-mingling HRW with HRS is perceived to be low, the Kansas City exchange may decide to retain contracts as currently specified. The Chicago Board of Trade wheat contracts at this writing allow delivery of hard red spring wheat (CBOT.com/contract specifications), so the question of whether to allow delivery of GMO wheat may be an issue for that exchange. As noted earlier, soft red wheat--which is the main type of wheat reflected in CBOT wheat futures prices—has the lowest risk of export market losses of any major class of U.S. wheat. The low risk comes from its producing region being isolated from the Northern Plains and from many of its major export markets being less sensitive to GMO issues than those for other classes of wheat.

<u>Foreign Wheat Competitors and GMO Wheat</u>

As of mid-year, 2003, the question of whether major competing wheat exporting countries will soon commercialize GMO wheat is not known for certain. Opposition to commercialization of GMO wheat is strong in Canada. The Canadian Wheat Board has strongly encouraged Monsanto not to commercialize the wheat there because of high risk of loss of export markets (just food.com, June 19, 2003). The Canadian wheat industry has developed a detailed list of requirements that would be necessary to safeguard the industry from economic losses if it is commercialized. In Australia, some provinces have established moratoriums on the sale of GMO wheat. Information about possible production of Round-UP® Ready wheat in other major wheat producing countries is limited at this time, but we are not aware of any movement toward immediate commercialization of GMO wheat by other countries. Risk of export loss is likely to be greatest for the first country to commercialize such wheat.

Conclusions

This report examines probable short run (two to six year) impacts on U.S. spring wheat export markets and prices from the commercialization of GMO hard red spring wheat. GMO crop technology offers possible large benefits to consumers in the future, if plant-breeding concepts currently in the development stage materialize. At this point, however, GMO crops are "input trait" crops. The inserted gene from an unrelated organism is substituted for an alternative type of input such as an insecticide or different weed control technology.

Many foreign consumers see nothing to be gained from purchasing food produced from these types of crops. Moreover, many of them have questions about the long-term safety of GMO crops, which may or may not have scientific foundations. Regardless of their scientific validity, consumer attitudes determine buying patterns when GMO food labeling programs are present, as they are in many foreign markets for U.S. wheat.

Potential export-market impacts from U.S. commercialization of Round-Up Ready® hard red spring wheat (HRS) are extremely important to Northern Plains farmers and ranchers, exporters, millers, other agribusiness firms, rural communities, and state and local government revenues. Exports are a major market for both HRS and durum wheat. Information on consumer attitudes and other patterns reviewed here indicate there is a high probability that Round-Up Ready® hard red spring wheat and U.S. durum wheat from the Northern Plains would be rejected in the short run by a majority of foreign buyers. Without strong exports, excess U.S. production capacity likely would quickly depress prices for these classes of wheat to a level causing excess supplies to be used as livestock feed. Increased government program payments from the Farm Security and Rural Investment Act of 2002 would be expected to only partially offset a drop in spring wheat prices to this level. In the short-run, increased wheat feeding also would have a slight negative impact on markets for feed grains including corn, sorghum, and feed barley.

Some have suggested that the risk of foreign buyer rejection of GMO wheat is low, based on continued U.S. exports of GMO corn and soybeans. However, several differences between these crops and wheat should be noted. First, there are many more alternative suppliers of wheat in world markets than for corn and soybeans, and several of these suppliers have been rapidly expanding exports. The U.S. accounts for only about eight percent of world wheat production versus 40 to 43 percent for corn and soybeans. Secondly, most corn and soybean products so far have avoided labeling in foreign markets, thus avoiding consumer identification. Vegetable oils and corn sweeteners have not been labeled because the GMO protein is removed in processing. Soybean protein is fed largely to livestock and poultry, as is corn. By being processed through meat animals, large percentages of these two crops have avoided GMO labeling. Even so, the U.S. has lost the EU corn export market in the last four years due to commercialization of GMO corn, and also has lost most of the EU Soybean meal market. EU is by far the world's largest importer of soybean meal and in the past frequently has been one of the largest U.S. export markets for soybean meal. The U.S. corn industry also has lost most of the South Korean corn market to non-GMO Chinese corn, although it is difficult to quantify the exact role of GMO issues in the loss. Four years ago, South Korea was the second largest U.S. corn export market. Sales so far (through early July 2003) in 2002-03 total only 10 million bushels, sharply below the 315 million bushels of U.S. exports to that nation in 1994-95. India and a number of African countries also have rejected low-cost GMO corn as food aid. Canada has lost the EU canola market.

GMO wheat products, in contrast to corn and soybeans, likely would almost all be labeled as containing GMOs in the foreign countries that have GMO labeling programs. ***Another difference between corn and wheat is that losses in U.S. corn exports have been partially offset by the rapid growth in domestic demand for ethanol fuel. For example, corn processing use has increased by 488 million bushels since 1998-99, while U.S. corn exports during the same period have declined by 381 million bushels. Growth in the corn processing market is in sharp contrast to the slow growth in U.S. domestic demand for wheat, and the more limited ability of the wheat market to absorb the impact of reduced exports.*** Another important difference between corn and spring wheat is that about 17% of the demand for U.S. corn comes from exports vs. 40% for spring wheat.

Available evidence suggests that one would have to be very optimistic to assume that in the next two to six years, the majority of foreign consumers would readily purchase food products made from GMO wheat. At least 37 nations currently label food that contains GMO ingredients above a prescribed threshold level. Another ten to twelve countries are expected to implement labeling programs in the next few years. Recent ratification of the Global Biosafety Protocol appears likely to encourage additional labeling. Current labeling threshold levels range from zero to five percent of a food's total ingredients, although individual food processors may have more restrictive standards. Labeling does not prevent the U.S. from exporting GMO products to these nations, but it does provide a mechanism that consumers can use to communicate their desires through the market. EU surveys of consumers, a 2002 U.S. Wheat Associates, Inc. survey of oriental buyer and consumer attitudes toward GMOs, a Canadian Wheat Board survey, recent developments in EU GMO policies, and problems with U.S. GMO corn and Canadian canola all are indicators of potential very poor response to GMO wheat in many export markets at this time and probably for the next few years.

These indicators strongly suggest there is high risk that, in the short run, U.S. wheat exports would be seriously and negatively impacted by the introduction of GMO wheat. Concerns of foreign consumers center around food and environmental safety questions and perceived inadequacy of U.S. GMO testing and approval processes. There also is concern about the difficulty of reversing GMO technology once it is introduced and the concentrated ownership of GMO patents on the major world crops among a very small and declining number of global firms. Existing and prospective patents cover major components of the world's food supply, namely corn, soybeans, canola, wheat, and rice. It is not the purpose of this report to determine whether these concerns are warranted. ***However, it is essential to recognize that consumer attitudes are the driving force in markets, regardless of whether or not they are scientifically valid.***

Some authors estimate that the current grain marketing system can easily be converted to a dual marketing system where GMO and non-GMO wheat simultaneously move through the same facilities without serious co-mingling problems or foreign buyer rejection. Those who support this view conclude that the current high-volume, rapid receiving, rapid load-out system, and port receiving system could be operated as a dual system at very minimal extra cost, without jeopardizing foreign buyer and consumer acceptance of U.S. wheat. However, there is substantial disagreement on costs and feasibility of transforming the current marketing system in this way. A closely related issue is whether GMO and non-GMO seed production and marketing can be segregated with adequate precision to prevent contamination of non-GMO wheat with GMO supplies. Experiences with other crops and Canadian research on wheat indicate it may be a major challenge to segregate seed supplies with adequate precision to meet the low GMO labeling thresholds of some countries, and to prevent the GMO wheat technology from becoming a non-reversible technology.

As evidence of the difficulties and costs in developing a dual marketing mechanism, we note the failure of such a system to emerge for corn, U.S. soybean meal, and canola on a scale that would have prevented the loss of the EU markets for these crops. The substantial premiums for non-GMO soybean futures in Tokyo, Japan also should be noted. These conditions imply that creation of a minimal-cost dual marketing system capable of meeting buyer non-GMO wheat specifications would be a major challenge and would involve substantial cost.

The U.S. last year produced an estimated eight percent of the world's wheat crop. If costs for a dual marketing system are substantial, foreign buyers will have incentive to originate their wheat in other areas where the remaining 92 percent of the world's wheat is produced, and (in the short run) probably without incurring the full extra costs of a dual marketing system.

Extra costs of segregated non-GMO wheat would provide a price incentive for other countries to expand non-GMO wheat production.

Other critical U.S. and international issues linked to commercialization of GMO wheat involve legal liability questions related to who is responsible in case of economic losses from cross-pollination, accidental contamination of seed, co-mingling of non-GMO and GMO grain in grain or food marketing channels, and at processing plants. Organic wheat producers are very concerned about liability issues involved if their crops are contaminated from neighboring GMO fields and cause loss of markets and income. Their concern, in part, is due to the nearly total loss of western Canada's organic canola production, as well as antidotal reports from organic corn and soybean producers of loss of organic certification and markets due to accidental GMO contamination (Brasher, op. cit.).

Consumer attitudes and segregation costs are key factors pointing to high risk of lost export markets if GMO spring wheat is introduced in the near future. Serious efforts to address consumer concerns and/or provide wheat consumers with products that would offer them noticeable health benefits could lower these risks in the next few years.

Limited analysis of export destinations for other classes of wheat and marketing channel considerations indicate some risk of export loss also would be present for these crops if Round-Up® Ready hard red spring wheat is de-regulated and commercialized. The greatest risk would be for white wheat produced in the Pacific Northwest of the U.S. About 60 percent of the production of this type of wheat is exported, much of it to higher income countries in Eastern Asia that label food containing GMO ingredients. Most U.S. ports handling these exports also handle HRS wheat and would have a risk of low-level contamination with some HRS GMO wheat. The class of wheat at lowest risk of export loss from commercialization of U.S. GMO HRS wheat appears to be soft red winter wheat. This crop is produced primarily in the eastern Corn Belt, South Central, and southeastern U.S. Most of its exports typically do not move through the same ports as HRS wheat. Many of its export destinations are developing nations that do not label GMO foods. Even so, nearly one-fourth of its exports go to GMO labeling countries, where there would be some risk of lost exports if buyers perceived that a risk of co-mingling with GMO wheat existed. Hard red winter wheat falls between white wheat and soft red winter wheat in its level of risk exposure. Some of its exports go to GMO labeling countries, where there would be risk of loss of export markets. However, a large part of its exports go through marketing facilities and ports that do not handle HRS wheat. Risk of market-channel co-mingling HRS and HRW wheat would be increased if domestic millers would blend these two types of wheat in domestic milling operations Thus, its risk of contamination through co-mingling with HRS or durum wheat would be lower than with white wheat, but would not be zero.

There is high risk that introduction of GMO hard red spring wheat initially would sharply reduce prices for HRS, durum, and very possibly white wheat, as well as other classes of wheat. For wheat diverted from exports to domestic markets, the main alternative would be for feed use, at prices competing with corn and other feed grains. Potential short-run volumes of diversion of U.S. hard red spring and durum wheat from export markets to feed use in this study, if Round-Up Ready® wheat is commercialized in the next few years ranged from 95 to 144 million bushels. The added competition from wheat would be expected to reduce corn prices by about four to six cents per bushel, provided all other market factors remain constant. If foreign customers perceive that co-mingling of GMO wheat is likely for all five classes of U.S. wheat, up to 160 to 280 million bushels might be diverted from exports to feed use. Market shifts of this size would tend to reduce the average farm price of U.S. corn by six to ten cents per bushel, if all other market factors remain constant. To offset the potential loss of U.S. hard red spring and durum exports, foreign wheat production would need to increase by a very slight 0.4 to 0.9 percent beyond the growth in foreign demand.

With a time lag, lower wheat prices likely would cause a reduction in U.S. planted wheat acreage, especially in areas where yields are relatively low and production risk is substantial. Over time, reduced U.S. wheat plantings and possibly a gradual increase in foreign consumer acceptance of GMO wheat would tend to move wheat prices to 1999-02 levels, but at the cost of a further down-sizing of the industry. This adjustment would also be expected to cause a shift of wheat acreage to oilseeds, feed grains, forage, pasture, and idling of land in long-term Conservation and Wetland Reserve Programs.

There is an important role for additional work to continue monitoring foreign consumer attitudes toward GMO food. Wheat producer groups have asked the USDA, Foreign Agriculture Service to use its overseas offices to conduct an extensive assessment of foreign consumer attitudes toward such food. The Foreign Agriculture Service has field offices in most foreign countries, and such information could provide a more complete and periodically updated picture of foreign consumer views concerning GMO wheat. Another important role for additional work is in development of lower-cost dual or identity-preserved marketing systems, and in prevention of contamination of non-GMO seed with GMO seed. If the promises of biotechnology materialize and a number of different types of grains emerge that are tailored to specific consumer and/or processor needs, market segregation will be needed even if GMO crops become widely accepted by consumers.

A Key Question

A key question for the entire non-GMO, organic, and potential GMO wheat industry and rural communities dependent on wheat is whether possible gains from reduced wheat production costs are great enough to offset potential acceleration of negative long-term trends in the industry by neglecting important aspects of consumer demand. The long-term trends include declining U.S. exports and U.S. share of world wheat exports, declining current dollar and inflation-adjusted prices for wheat, and declining U.S. wheat acreage. U.S. wheat exports in 2002-03 were the lowest since 1971-72, despite sharp drought-induced reductions in competition from Canada and Australia. This question should be considered very carefully in light of the extreme difficulty of reversing the GMO technology once it has been introduced into the U.S. wheat industry.

These conditions present a major dilemma for the wheat industry and government regulators. On the one hand, firms have made large investments to develop genetically modified wheat, and the technology suggests that greater gains may be available in the future. But to capture those future gains, a return on past investments is needed. The other horn of the dilemma is on the market demand side. When available evidence of foreign consumer reactions to GMO wheat is examined, a logical conclusion is that capturing those returns at this time would create substantial risks for the entire industry, some risk for closely related industries including the feed grain sector, and risks for local communities and governments in the Spring Wheat Belt. These risks may diminish in the future as consumer attitudes change. Attitude change likely could be accelerated by developing products with clear benefits to consumers, and by more seriously listening to and addressing consumer concerns.

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