A Review of the Potential Market Impacts of Commercializing GM Wheat in the U.S.

January 2010

by Dr. E. Neal Blue, Consultant

for the

Western Organization of Resource Councils

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Western Organization of Resource Councils
220 South 27th Street, Suite B
Billings, Montana 59101
www.worc.org.

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[1] President, Neal Blue Consulting, Columbus, OH Views expressed herein are solely the author's.

Executive Summary

In 2009, as this study is being conducted, a coalition of stakeholders in the wheat industry from Australia, Canada, and the U.S. have agreed to pursue the eventual commercialization of Roundup Ready® wheat and other genetically modified (GM) traits as they become available. This stakeholder group includes wheat grower groups, the National Association of Millers, and technology providers. Monsanto tried to bring GM wheat to market several years ago but withdrew its application for commercialization in 2004 because of negative foreign consumer sentiment towards GMOs. The first GM crop ready to be introduced was Roundup Ready® hard red spring wheat.

Several things have motivated this push for GM wheat, including high prices in 2007-2008, and the perception that GM wheat is needed as one of the tools to restore U.S. wheat competitiveness. The U.S. share of the world wheat export market and the U.S. wheat acreage have trended downward for 30 years.

Is the wheat industry ready for GM wheat? A survey of the popular press and industry pronouncements says, "not yet". There is a belief in the industry that GM wheat will not reach the market for another 10 years. The whole industry effort is predicated on foreign consumer acceptance.

A review of current consumer attitudes indicates that the EU and Japan are not ready for GM wheat. In addition, Asian countries such as South Korea and Taiwan are also reticent about importing GM wheat. The major customers of the US, particularly the EU and Japan, have labeling and traceability requirements, which make it difficult to sell GM wheat. In Europe the level of tolerance for an unapproved GMO is zero. The Canadian Wheat Board (CWB) has stated publicly that it will not support the adoption of GM wheat unless key conditions are in place, including assurances that its overseas markets would accept the crop. The CWB also wants to see a greater benefit, such as resistance to fusarium disease or improved yield and quality. In addition, the CWB said that, as the merchandising system currently stands, there is no way to effectively segregate GM wheat from non-GM wheat, another condition the board wants satisfied.

Identity preserved (IP) systems have been proposed as a way to segregate GM and non-GM wheat if the U.S. introduces GM wheat. Estimated IP costs for such systems are 3 to 6 cents per bushel. Current IP systems analyses do not incorporate liability costs and other associated costs arising from IP system failures. Hartley Furtan and Richard Gray of the University of Saskatchewan have pointed out that introducing a perceived inferior product such as GM wheat without an affordable IP segregation system will create a market for "lemons" that will result in the loss of export markets. The existence of this market externality removes any first mover advantage from adopting GM wheat.

U.S. wheat acres and the U.S. world wheat export shares have gone down since 1960. Trends in US wheat exports indicate that hard red spring (HRS) wheat and durum wheat are most "at risk" of export loss if the U.S. approves Roundup Ready® or another variety of genetically modified wheat. Exports to Japan and the EU would likely be curtailed because of foreign consumer concerns. The combined EU and Japanese export losses would likely be 35 and 50 percent for HRS and durum wheat, respectively. The corresponding price drop would be 41 and 57 percent for HRS and durum wheat, respectively. If more countries in addition to the EU and Japan curtail their purchases of HRS and durum wheat, the U.S. export declines would be even higher. The routing of lost export wheat into the feed wheat markets would limit the price drops to the level of the corn market.

If the U.S. loses its HRS and durum wheat export markets due to GM wheat introduction, Russia and the Former Soviet Union (FSU) countries would likely make up the difference – as indicated by their growing world wheat export market share. As the U.S. world wheat export share is going down over time, the Russian/FSU world wheat export share is going up.

A review of the wheat breeding literature suggests that, in addition to the traditional planting breeding and GM transformation techniques, marker assisted selection (MAS) is being used to generate non-GM trait development in wheat. Non-GM trait development has recently focused on wheat varieties resistant to rust, drought, and salt. In addition, mutagenesis has been used to create non-GM herbicide-resistant wheat sold commercially today.

Depending on the trends for labeling and changing consumer sentiment, there is a mixed outlook for the marketing of GM wheat. Currently there are no commercial GM wheat varieties grown in the world. Some promote GM technology as one of the tools that can reverse the decline in the competitiveness of the wheat sector. However, the concerns of major foreign consumers about GM wheat and the lack of affordable identity preserved segregation make the U.S. introduction of GM wheat a risky proposition.

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1.0 Introduction

In 2004, after several years of research and development, Monsanto withdrew its application for Roundup Ready®[2] hard red spring wheat both in Canada and the US. Concerns about the loss of U.S. and Canadian exports and stringent European Union rules on import, traceability, and labeling of GM food products lead to the withdrawal.

In 2009, a coalition of stakeholders in the US wheat industry agreed to go forward to pursue the eventual approval of GM wheat. The stakeholders included the North American Millers' Association, the National Association of Wheat Growers, U.S. Wheat Associates, Grain Growers of Canada, Western Canadian Wheat Growers Association, Alberta Winter Wheat Producers Commission, Grains Council of Australia, Grain Growers Association, and Pastoralists and Graziers Association of Western Australia (*US Wheat*, newsletter of US Wheat Associates, 5-14-09). Several wheat summits were held from 2006 to 2009 to address the state of the wheat sector in the US. Out of these meetings, several reports were put forth addressing the lack of competitiveness of the wheat crop sector vis a vis the corn and soybean sector. A report entitled "The Biotech Case for Wheat" was released by a wheat industry coalition composed of the following groups: National Association of Wheat Growers, U.S. Wheat Associates, North American Millers' Association, Independent Bakers Association, and the Wheat Foods Council. In the U.S., wheat acres have declined for 30 years and the world share of US wheat exports has gone down. The report said that if GM wheat were available as a production tool it could stem the decline in the competitiveness of wheat with other grains.

While there has been consensus among these stakeholders of the wheat industry to go forward on the eventual adoption of GM wheat, other major industry players are reticent about the adoption of GM wheat. The Canadian Wheat Board (CWB) has stated publicly that it will not support the adoption of GM wheat unless key conditions are in place, including assurances that its overseas markets would accept the crop. The CWB also stated that it wanted a greater benefit of any GM trait adopted in wheat, such as resistance to fusarium disease or improved yield and quality. The CWB said that as the merchandising system currently stands, there is no way to effectively segregate GM wheat from non-GM wheat. Effective segregation is another key condition the board wants satisfied (Reuters, 5-15-09). In 2000, the Australian Wheat Board (AWB) expressed concern about GM wheat because of foreign consumer concerns about GM wheat (Reuters, March 17, 2000). However in 2007, the AWB softened its concern. "AWB supports the development of agricultural biotechnology under controlled conditions because of the potential benefits to farmers and the community," the group said in a statement (Australian Wheat Board, June 2007).

In May 2009, a coalition of 15 farm groups from Australia, Canada, and the U.S. released a statement joint statement of opposition to GMO wheat. This followed the statement of the wheat industry stakeholder declaration of support for GMO wheat. Concerns were voiced that farmers would be economically hurt by the introduction of GMO wheat. The groups signing the joint statement included the Network of Concerned Farmers in Australia, National Farmers Union, Canadian Biotechnology Action Network, the Organic Federation of Australia, Biological Farmers of Australia, Greenpeace, and the U.S.-based Organic Consumers Association. (Reuters, June-1-2009). In addition to the loss of foreign markets, other concerns about Roundup Ready® wheat center on the evolution of glyphosate resistant weeds, and the loss of farmer saved seed (Ogg and Jackson 2001; Van Acker et al. 2003).

This report updates the work completed by Dr. Robert Wisner in 2003 and 2006. In light of the recent actions of the stakeholders of the wheat industry in pursuing GM wheat, this report evaluates the current state of the GM wheat debate. This report covers several broad areas: consumer attitudes in the European Union (EU), Japan, Korea, and Taiwan; EU GM traceability and labeling

[2] Roundup Ready® (RR) wheat: GM wheat wherein Monsanto has inserted a gene that allows the plant to tolerate applications of Roundup (Monsanto's trade name for the broad-spectrum herbicide glyphosate).

regulations; grain merchandiser concerns; U.S. wheat production and exports trends; Former Soviet Union wheat exports; effect of GM wheat on US exports; Biotech development of wheat; and impacts on organic wheat production.

2.0 Consumer Preferences in the EU, Japan, Korea and Taiwan.

Currently there are no commercially available GM varieties of wheat or rice, the two largest directly consumed grains in the world - this at a time when other GM field crops such as corn, soybeans, cotton, and canola have been widely adopted. One oft-cited reason for this phenomenon is the fact that the widely adopted GM crops are highly processed before consumption or fed to livestock. Wheat and rice are more directly consumed. For this reason many foreign consumers around the world are reticent about consuming GM wheat and rice.

Based on the regulatory environment of certain importing countries and the responses of importing countries to unintended releases of GMOs, it is expected that many countries will severely reduce or cease imports of US wheat if GM wheat is approved in the U.S. Much of this is driven by foreign consumer sentiment. This section details consumer attitudes toward GM foods and crops in the European Union, Japan, Korea and Taiwan. These are major consumers of U.S. wheat. The determinant of whether GM wheat will be deregulated for food products and crop production is consumer attitudes in a particular country. Consumers from the EU are generally opposed to consuming GMOs. In Asia there is also consumer opposition to the consumption of GMOs, however, the sentiment is not as strong as seen in the EU. Representatives for Chinese, Korean, and Japanese wheat buyers surveyed said they would not buy or use Roundup Ready® wheat. Eighty-two percent of buyers from Taiwan and 78 percent of buyers from South Asia said they would reject the wheat, (Gillam, 2002).

2.1 European Union (EU)

The adoption of GM crops has been dependent on the regulatory and legal environment of a particular country. The adoption of GM crops has proceeded rapidly in Argentina, Brazil, China, and India and South Africa (James, 2008). However, in the European Union (EU), adoption has been so very low. The oft-cited reasons for the low adoption are consumer sentiment, sociological attributes of the citizens of the various countries in the EU (Zechendorf, 1998), and the regulatory environment based on the precautionary principal (Kogan, 2005). Others attribute the slow adoption of GM crops in the EU to trade barriers erected to protect EU agribusiness and producers (Anderson, et al., 2004).

Several surveys taken by the European Union from 1996 to 2007 detail the consumer attitudes of the various countries in the EU. Consumer attitudes toward GM crops and food have changed over time. Support for GM crops in the EU declined from 1996 to 1999. The pattern for public approval of GM food followed a similar trend. After 1999, the majority of the EU countries showed an increase in support of GM food (Eurobarometer, 2002). In spite of these trends, the 2002 Eurobarometer survey indicated that a majority of Europeans did not support GM foods. For the EU, the most persuasive reason for buying GM foods is the health benefit of lower pesticide residues followed by an environmental benefit. In addition, price was the least incentive for buying GM foods. Depending on the country in the EU, 30 to 65 percent of Europeans reject all reasons for buying GM foods.

The 2005 Eurobarometer (Eurobarometer, 2005) survey showed that, overall, Europeans think that GM food should not be encouraged. The fact that a particular GM food is approved by relevant authorities, or may be cheaper than a non-GM food, are not convincing to the public. The EU public, however, had wider support for non-food uses for biotechnology, such as nanotechnology, pharmacogenetics, and gene threrapy. The introduction of new regulations on the commercialization of GM crops and GM food labeling regulations (Directive 2001/18/EC) has done little to allay the European public's anxiety about GM food biotechnology.

In the most recent Eurobarometer survey (2007), 58 percent of Europeans declared that they were opposed to the use of GMOs, while 21 percent supported their use. Nine percent of respondents had never heard of GMOs. An absolute majority of respondents in most countries within the EU were opposed to the use of GMO's. Respondents who feel they lack information on GMOs are significantly more concerned about the use of GMOs in farming than those who do not feel they need additional information.

2.2 Japan

There is broad opposition to GM foods in Japan. Several surveys taken from 2002 to 2007 have detailed Japanese consumer attitudes towards GM foods. In 2002, the Japanese Ministry of Public Management, Home Affairs, Posts and Telecommunications conducted a public opinion poll on GM labeling of food (MPHPT, 2002). The results showed that 80 percent of Japanese consumers demanded stricter GM labeling and that they were unsatisfied with the current GM labeling regulations. In addition, 84 percent of the surveyed consumers said that "…labeling is necessary whatever … amount of GMO has been used in a food."

McCluskey et.al (2003) evaluated the Japanese consumer's willingness to pay for GM food products. Japanese consumers were willing to purchase GM noodles at a 60 percent discount and GM tofu at 62 percent discount. These results suggest that non-GM foods command a premium over GM labeled foods.

In 2003, a Japanese Ministry of Agriculture, Forestry, and Fisheries internet survey of 600 consumers (MAFF, 2003) found that 60 percent of respondents said that they were unwilling to buy GM foods due to safety concerns. 68 percent of the respondents mentioned that they would not purchase GM foods even if they were priced cheaper than non-GM equivalents. It should be noted that internet surveys are not based on a random sample, but merely reflect the views of those who choose to respond.

A survey by the Pew Global Attitudes Project (PEW, 2003), conducted in 2002 and released in June 2003, showed that Western Europeans and Japanese were overwhelmingly opposed to scientifically altered fruits and vegetables because of health and environmental concerns. Japanese women were more opposed to genetically altering foodstuffs than men.

2.3 Korea

Korea is an importer of biotechnology crops and products. GM crops and foodstuffs must undergo a safety assessment for human consumption by the Korean Food and Drug Administration. Major GM crop imports are corn and soybeans – most of which are further processed. Both processed and unprocessed GM food products must be labeled. Most non-GM labeled unprocessed crops must be certified indicating a GM free status (USDA-FAS, 2005).

A 2001 survey of Korean consumers and a 2003 survey of Korean professors revealed that both groups had concerns about GM food products. 52 percent of the professors believed that GM food was safe for consumers. However, only 21 percent of consumers believed GM food to be safe. Just 14 percent of consumers said they would purchase GM food products (USDA-FAS, 2005).

In 2008, the Korea Biosafety Clearing House (Korea BCH, 2008) conducted an opinion poll (1,000 adults) to find out their awareness and attitudes towards live modified organisms (LMOs) and biosafety. 83.3 percent of respondents had heard of or were aware of LMOs. 70.7 percent of respondents reported they felt uneasy about LMOs used in food and agricultural uses. However, relatively fewer people expressed concerns about the use of LMOs in medical, pharmaceutical, environmental purification, industrial biotech and energy sectors.

An awareness survey conducted by the Korean Food Industry Association in October 2008 showed that 42 percent of respondents would likely buy GMO derived food. This result was 5 percentage points higher than the result in a previous survey. Those who would not buy GM food were 30 percent of the respondents. This was a down from the 42 percent result reported in an earlier survey.

A Korean Consumers Union survey of 154 Korean lawmakers and 64 members of the Seoul Municipal Assembly showed that 76 percent felt that food products should be labeled if they contained GM ingredients (Korea BCH, 2008).

2.4 Taiwan

Chern and Rickertsen (2002) performed a study on consumer attitudes of GMOs in Japan, Norway, Taiwan, and the U.S. Students were surveyed for their willingness to pay for non-GM alternatives. In doing the research, Chern and Rickertsen cited increasing concerns by Taiwan consumers over GM foods. They found that while only 6 percent of U.S. students ranked GM foods as "very risky," the percentages were higher in Norway (11%), Japan (10%) and Taiwan (17%). While only 17 percent of Japanese students were "somewhat" or "very willing" to consume GM foods, the figure was 79 percent for Taiwanese students. The students in the four countries were willing to pay premiums ranging from around 60 percent in Norway to about 20 percent in Taiwan for non-GM vegetable oil. The preference against GM foods is reduced when some benefits associated with them are introduced into the questions suggesting that GM foods have a potential to become more popular. Reduced use of pesticides and improved nutritional qualities are perceived as more important potential benefits than reduced price. Health concerns are apparently more important than ethical or religious concerns in explaining the negative attitudes towards GM foods. The support for mandatory labeling is overwhelming in the student as well as public surveys.

Early in this decade, the Taiwanese government was closely monitoring the development of GM food regulation in Japan. Taiwan implemented a GM food law in 2001 stipulating that foods containing more than 5 percent GM ingredients must be labeled as containing GMOs. There is still a concern about GMOs in Taiwan. In 2009, the Taiwan Council of Agriculture (COA) issued a statement that countered an official from the Department of Health about accepting GM rice from the U.S. "The COA will not take the liberalization measure that would allow such rice from the United States to enter Taiwan," COA Minister Chen Wu-hsiung said. "I will step down if imports of U.S. genetically engineered rice are permitted. The COA has `absolutely no plans' to allow such opening," (South China Post, 10-28-09.)

Surveys of consumer attitudes in the EU, Japan, Korea, and Taiwan, all major export markets for US wheat, suggest that foreign consumers have a mistrust of GM crops and foods. Consumer attitudes have changed little since 2004 when Monsanto withdrew its planned introduction of GM wheat. The main driver for this withdrawal was the foreign consumer mistrust of GM foods.

3.0 European GM Regulations, 1990-2009

The EU has the most stringent regulations in the world regarding the labeling and traceability of GM crops, feed, and food. This section details the development of the regulation of GMOs in the EU from 1990 to 2009.

The European Union has regulated GM crops, food, and feed since the time GM crops were introduced in the U.S. in 1996. In the 1990's, the EU promulgated two sets of rules, one for GM crops and one for GM food.

In 1990 EU Directive 90/220/EC established a process for assessment and approval of GM crops and seeds destined for environmental release. Before 1998, 14 GM plants including 11 crops were approved for release. In 1997, the EU adopted a second set of laws (Regulation EC No 258/97) designed to address labeling of novel food products containing GMOs or produced from GMOs. In addition, the regulation created a simplified approval process for products derived from but not containing GMOs such as refined soybean oil or corn syrup. A producer bringing a GM food to market had to show that it was "substantially equivalent" to existing foods. After Regulation 258/97/EC went into effect, a number of GM products entered the EU market.

In the mid-1990s, several food safety scares, including the BSE (bovine spongiform encephalopathy) outbreak and dioxin tainted meat in Belgium, caused an increased wariness of GM foods and crops. In the consumer attitude surveys discussed in the previous, consumers' opinions of GMOs became more negative. The food scares greatly eroded consumer's trust in government regarding food safety regulations. The erosion of trust occurred at same time as GM crops were being introduced into the EU. Consumers began to trust non-government organizations more than governments.

In the late 1990s, several EU member states began to ban the use of approved GM crops. In 1998 many EU member states blocked approval of European Commission approved GM crops unless existing labeling and safety regulations were further tightened. From 1998 to 2004, no new GM foods or crops were approved. This amounted to a defacto moratorium on GMOs. At this time, the EU began to develop EU-wide regulations more acceptable to member states.

In 2001, EC directive 2001/18/EC on the deliberate release into the environment of genetically modified organisms was approved. This is the basic legal act for the authorization of GMOs for marketing throughout the EU, including commercial cultivation. It repealed and replaced Directive 90/220/EEC, aiming at strengthening the control of risks from the deliberate release of GMOs into the environment. The key features of the Directive include a harmonized approach to risk assessment, post-market monitoring, traceability and labeling, consultation with and information to the public, predictability and transparency of decision-making, and time-limited consents.

In 2003, the EU approved a regulation, EC1830/2003, governing approval of GM food and feed commercialization. The new directive expanded labeling requirements, established traceability requirements, and streamlined the approval process for new GM products. Under EC 1830/2003, all food and feed consisting of GMOs or produced from GMOs were required to be labeled. In addition, highly refined products that were, heretofore, not labeled, were also required to be labeled as being produced from GMOs. Labeling was now required if a food product or crop contained more than 0.9 percent adventitious presence of GMOs. In addition, GM feed was also required to be labeled.

Products such as meat, milk, and eggs produced from animals fed GM crops were not required to be GM labeled. Products such as beer and cheese produced with enzymes made from GM microorganisms also do not need to be labeled.

Regulation 1829/2003/EC added traceability requirements for all GM crops and foodstuffs within the EU. Businesses that grow, store, and process GM products are required to track them throughout the supply/logistics chain – from farm to dinner plate. Trace records must be held for 5 years.

Lastly, the EC 1829/2003 directive streamlines the approval process of GM crops and foodstuffs. A developer of GMOs can file a single application for all intended uses of the GMO – cultivation, importation, and processing. The application goes to the member state where the GMO will be marketed. The European Food Safety Agency will conduct a scientific risk assessment. After that, the European Commission will draft a proposal granting or denying authorization. The draft proposal is submitted for approval by a qualified majority of member states within the Committee on the Food Chain and Animal Health. If the committee approves the draft proposal then the European Commission approves the proposal.

In 2008, the EU adopted Directive 2008/27/EC, which empowered the European Commission to adopt the measures necessary for the implementation of Directive 2001/18/EC.

In spite of the EC 1829/2003 directive, many member states banned GM crop varieties that had been previously approved by the European Commission. This was done by invoking the "safeguard clause" which allows a member state to provisionally restrict a GMO.

4.0 Implications of EU Traceability Rules for Exports of GM Wheat

The labeling and traceability rules specified in the EC directives tightly dictate how GM products are sold in the EU. The traceability rules specified within the EC directive allow up to 0.9 percent adventitious GM material in a food product labeled as being non-GM. The adventitious GM must be one that was authorized by the EU. There is zero tolerance for any level of unapproved GM events in food imports. Since GM events in wheat are not currently approved in the EU, no GM wheat could be exported to the EU today.

In order to get around the zero tolerance of unauthorized GMOs in wheat, the US will have to insure that wheat GMOs are approved by the EU. A US export shipment could then get shipped as a non GMO shipment as long as the adventitious GM level stays below 0.9 percent. The upshot of this regulation is that an identity preservation system will have to be implemented that keeps GM and non-GM crops separated. In essence, since the EU is a major importer of food stuffs, it is in effect exporting its traceability regime to the rest of the world.

4.1 Segregation and Identity Preservation (IP) - Innovations and costs

Many who promote GM wheat say that identity preservation regimes within the grain merchandising system can be used to keep GM and non-GM wheat separate. The development of genetically modified crops is challenging the functions of the grain marketing system with many participants arguing for identity preservation systems prior to release of GM varieties (Wilson and Dahl, 2002). The Canadian Wheat Board (CWB) has said that as the merchandising system currently stands, there is no way to effectively segregate GM wheat from non-GM wheat, a condition of CWB acceptance of commercial release of GM wheat (Reuters, 5-15-09). This section reviews identity preservation and developments that would be needed to reduce the risks of comingling GM and non-GM wheat.

What is identity preservation and how can it be used to handle both GM and non-GM wheat? Identity preservation is a system of production and delivery in which grain is segregated, based on intrinsic characteristics such as variety or production process, during all stages of production, storage, and transportation. Grain growers are interested in IP because of niche marketing, technological innovations, customer demand for a specific grain, and organic production.

In the current grain merchandising system, the traditional bulk system has been designed to comingle grain from many different sources. The comingling of grain occurs in four stages: 1) farm to elevator, 2) elevator to rail/barge, 3) rail/barge to terminal, and 4) terminal to ship. The current system of bulk movements of grain engenders large economies of scale in costs of moving grain. IP systems have been evolving as information technology systems, biotech grain testing, and logistics have improved to meet customer demands.

Several innovations have greatly improved IP systems in terms of contamination risk and improved logistics. Containerized shipping, biotech testing, and information technology are components of an evolving IP system that will play a role in GM/non-GM segregation. In a review of Cargill's IP strategies, Michael Boland (2003) detailed what an IP system would entail in terms of logistics and testing. IP marketing channels are more complicated than simply keeping crops segregated throughout all phases of transportation and storage. IP channels also require that producers separate fields to avoid mixing pollen and or seeds during planting and harvesting. Clean equipment and on-farm storage are also a necessity. At the elevator level, the manager has to develop strict standards to maintain identity to the end user. In the transport of IP grain, railcars and trucks would have to be sealed to avoid contamination. Testing and keeping track of the chain of custody add to the cost of moving the grain. The cost would vary depending on the level of tolerances.

Containerized shipping of grain is a small but growing area of grain merchandising. In 2001, one percent of U.S. grain was moved in containers. It is expected that the volume of grain moved by containers will grow over time to meet a growing demand for specialty products (Vachal and Reichert, 2001). Reichert and Vachal (2003) discussed IP using containerized grain shipments in which grain is shipped in a freight container that can be place placed on a semi truck, rail, or ship. A containerized shipping IP system has advantages for grain shipping: 1) grain is handled less, 2) theft problems are reduced, and 3) ease of movement from truck to rail, and from rail to ship. The only disadvantage is higher costs. However, in recent years costs have declined. Richert's calculation shows that container shipping comes in slightly more expensive than train shipping (container $65.23/ton, truck $133.38/ton, single rail car $59.33/ton, and unit train $57.28/ton).

Wilson and Dahl (2002) go into great detail on the costs and risks of an IP system for GM wheat. The authors estimated total segregation costs with an optimal strategy at 3.36 cents per bushel, testing every fifth load of incoming grain. The main assumption of the Wilson and Dahl study is that some sort of tolerance will have to be built into the IP system for it to work.

A paper by Huygen et al. (2003) details the costs of three IP systems including a containerized system at tolerance levels of 5 percent, 3 percent, 1 percent, 0.5 percent, and 0.1 percent. The three IP systems were 1) elevators segregate GM from non-GM wheat at the point of delivery, 2) elevators are designed solely to handle either GM or non-GM wheat, and 3) a container system where shipments are sealed at the farm. Elevator systems 1 and 2 were close in cost estimates with the containerized system costing more.

Table 1. The Cost of Implementing an IP System for GM/non GM Wheat in Canada.

IP System	Tolerance Level (%)				
	5	3	1	0.5	0.1
	Cost/tonne				
Elevator System 1	194.66	194.68	196.39	199.19	201.09
Elevator System 2	194.56	194.57	196.10	198.68	200.37
Container System	216.68	216.69	218.19	220.67	222.09

Taken from Huygen et al, 2003.

The estimated costs of these systems at 1 percent tolerance, which is close to the EU standard for approved GM events of 0.9%, are as follows: 1) elevator system 1, 5.89 cents/bushel; 2) elevator system 2, 5.41 cents/bushel; and 3) container system, 6.01 cents/bushel. The authors in this paper say that these estimates do not include risks and liabilities that might be associated with system failure.

Until now IP systems have been used for specialty grains where the value of the specialty grain is higher than regular grain run through the merchandising system. Furtan et al (2005) say that introducing GM wheat without an affordable IP segregation system is one that can be likened to creating a market for "lemons" that will result in a loss of export markets. In any proposed IP system for GM wheat, GM wheat, a commodity that could be considered inferior to non-GM wheat, is being introduced into the grain marketing system. Furtan et al. (2003) say that the existence of market externality removes the first-mover advantage for wheat producers from the approval of GM wheat. In addition, there are large distributional effects: wheat producers loose economic surplus, while the consumers and the technology provider gain economic surplus.

4.2 Segregation and Risk – Canola Example

With the introduction of GM crops, genetic contamination has become a major concern. Initially, when GM canola was introduced to Canada in 1995-96, a voluntary identity preservation, production and marketing (IPPM) system was developed to contain the GM canola to the North American market. This was done in response to the fear that Japan, the largest export market at the time, would interrupt trade until they had time to study the GM technology. A closed loop system to keep GM canola in North American markets operated for two years. The IPPM system was then abandoned when Japan approved new varieties for importation. Although the IPPM system worked, it was costly. The estimated costs were C$33 to C$41/tonne, which added 12 to 15 percent to the cost of producing and transporting conventional canola (Smyth and Phillips, 2001). Ultimately, the IPPM system was abandoned because of the opportunity costs of limited marketing opportunities and freight inefficiencies. Smyth and Phillips (2001) suggested that these two costs could have been reduced had the grain merchandising system acted collectively to establish IPPM standards.

Even though IP systems are currently being used for various specialty grains, much work remains to create an IP system to segregate GM and non-GM wheat in a cost effective way. The Canadian Wheat Board is on record saying that under the grain merchandising system as it currently stands, there is no way to effectively segregate GM wheat from non-GM wheat, one of several conditions the board would want satisfied before it approved commercial release of GM wheat (Reuters, 5-15-09).

5.0 USDA Wheat GM Status - Certificates For Grain Exports

For several years, the USDA Grain Inspection, Packers and Stockyards Administration (USDA-GIPSA) sends out a statement on its letterhead with every inspection certificate stating that "there are no transgenic wheat varieties for sale or in commercial production in the United States at this time." As of December 15, 2009, this is still the case. This certificate accompanies approximately 50% of US wheat exports, at the request of buyers (Wilson et al., 2003).

6.0 Wheat Industry Stakeholder Positions on the Possible Introduction of GM Wheat

Stakeholders in the wheat industry have convened several wheat summits between 2006 and 2009. This group includes wheat millers, bakers, and grower groups from Australia, Canada, and the US. This group put forth a document agreeing to pursue the eventual commercialization of GM wheat. Given the rapid adoption of GM canola, corn, cotton, and soybeans, wheat has received intense scrutiny as it has undergone experimental development.

Although these stakeholders of the wheat industry have agreed to support the commercialization of GM wheat, some within the wheat industry have concerns arising from the lack of foreign customer acceptance. One miller of note, the King Arthur Milling Company, has announced on its website (http://www.kingarthurflour.com/) that it will not sell any products containing GM wheat. In 2002 Ron Olsen, vice president of General Mills, said that consumer confidence would be lost if GM wheat were used in his company's food products. Olsen expressed concern about alienating General Mills customers (US Wheat Associates Aug. 28, 2002). Olson further explained the problems that would be experienced up the food chain, beyond the grower, noting a traditional economic concept: "When you inject a supply driven concept into a demand driven market, it's a recipe for failure." Currently, the General Mills product line includes Gold Medal Organic Flour.

The Canadian Wheat Board (CWB) has stated publicly that it will not support the adoption of GM wheat unless key conditions are in place, including assurances that its overseas markets would accept the crop. The CWB also stated that it wanted to see a greater benefit from any trait introduced to wheat through genetic engineering, such as resistance to fusarium disease or improved yield and quality. The CWB said that as the merchandising system currently stands, there is no way to effectively segregate GM wheat from non-GM wheat, another condition the board would want satisfied (Reuters, 5-15-09).

In 2000, the Australian Wheat Board (AWB) expressed concern about GM wheat because of foreign consumer concerns about GM wheat (Reuters, March 17, 2000). However, in 2007, the AWB went on record saying "AWB supports the development of agricultural biotechnology under controlled conditions because of the potential benefits to farmers and the community" (Australian Wheat Board, June 2007).

The Western Canadian Wheat Growers made a presentation to the Canadian National Millers Association on September 15, 2009, promoting the use of GM wheat, "*Toward Commercialization of Biotech Wheat*". The presentation acknowledged the negative factors impacting the acceptance of GM wheat: 1) market acceptance, 2) segregation issues, 3) liability issues, and 4) political acceptance. The presentation also acknowledged that GM wheat would not be accepted today.

One theme that emerges is that consumers would buy into GM wheat if the product had more consumer benefits and consumers were convinced of its safety. Another theme is that all sectors of the wheat industry acknowledge that now is not the time to introduce GM wheat. The broad coalition approach to GM wheat exhibited by the wheat stakeholders may be an outgrowth of consequences arising from unintended releases of GM crops in the US (GAO, 2008, see Table 2) and in Canada. These unintended releases resulted in product recalls (Starlink Corn) and export losses (LL601, LL604 Rice).

Table 2. Summary of the Six Known Unauthorized Releases of Regulated GE Crops into the Food and Feed Supply of the U.S., 2000-2008 (GAO, 2008).

Year	Product	Crop	Trait	Cause	Detection
2000	StarLink	Corn	Insect Resistance and herbicide tolerance	Cross-pollination, commingling of corn after harvest	Third party testing
2002	Prodigene	Corn	Pharmaceutical protein	Cross-pollination and uncontrolled volunteers	USDA inspection
2004	Syngenta Bt10	Corn	Insect resistance	Misidentified seed	Third-party testing
2006	Liberty Link Rice 601	Rice	Herbicide tolerance	Not determined	Third-party testing
2006	Liberty Link Rice 604	Rice	Herbicide tolerance	Not determined	Third-party testing
2008	Event 32	Corn	Insect resistance investigation	Under	Developer testing

The two most prominent unintended releases, Starlink corn and Liberty Link Rice, resulted in economic losses to farmers. The release of Starlink was done under a dual use label. Starlink corn was only approved for use as livestock feed. It got into the U.S. food system. Schmitz, et al. (2004) estimated that StarLink caused U.S. corn producers to lose between $26 and $290 million in revenue. Blue (2007) estimated that world-wide losses caused by the accidental release of LL601 GM rice ranged from $741 million to $1.285 billion.

In 2001 a genetically modified (GM) flaxseed developed at the University of Saskatchewan was taken off the market because of European fears the variety would contaminate other flax produced in Canada. The last of the 200,000 bushels of Triffid flaxseed, worth at least $2.5 million, was rounded up from farms across the Prairies and crushed, and the variety was deregistered. On October 30, 2009 the EU Rapid Alert System for Food and Feed (RASFF) had reported finding contamination by an unapproved genetically modified flax/linseed variety in cereal and bakery products in over 30 countries (EC, 10-30-2009).

The fears of the Canadian Wheat Board about losing export customers and the coordinated actions of the wheat industry stakeholders on the issue of GM wheat suggest an air of caution is appropriate for the U.S. wheat industry towards commercial release of GM wheat , as long as consumers overseas prefer non-GM wheat. The critical question is whether consumer attitudes will change before GM wheat becomes a reality.

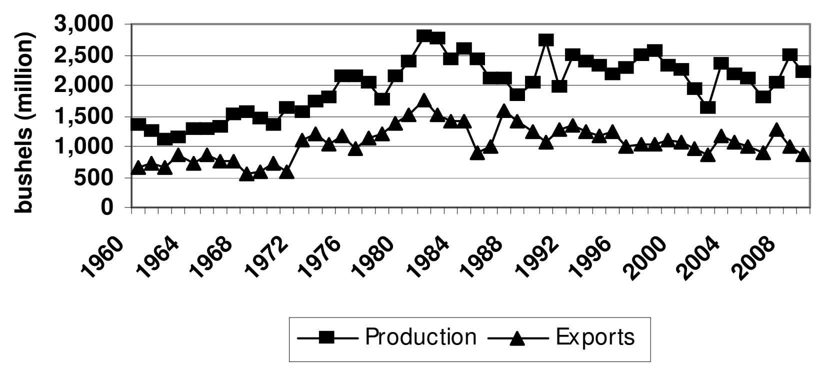
7.0 Wheat Production

7.1 U.S. Production and Yields

As a part of the investigation of the effects of GM wheat introduction, the US and World wheat market are reviewed. This review is done to identify the wheat export pools that would be at risk if GM wheat is introduced. Until its withdrawal I 2004, Monsanto was seeking approval for hard red spring (HRS) wheat genetically modified with the Roundup Ready® gene. A majority of the hard red spring wheat is grown in Western Canadian Provinces and the US states including South Dakota, North Dakota, Montana, Idaho, Washington, Oregon, and California. If GM HRS wheat were introduced, exports from this region of the U.S. would be at risk. The HRS wheat growing region overlaps substantially with durum wheat growing areas[3]. Exports of these two classes of wheat would be at risk given the state of the grain merchandising system. Given the GM testing and labeling regimes of the EU, Japan, South Korea, and Taiwan, durum wheat exports would also be at risk for possible contamination and export loss. Exports of the other three classes of wheat — hard red winter wheat, soft red winter wheat and white wheat – are less at risk if GM HRS wheat is adopted. This is due to the fact that their growing areas have substantially less growing area overlap with HRS wheat[4] and their exports go to countries that are less likely to reject GM wheat. In addition, the export share of soft red winter wheat is low compared to the other classes of wheat. In this section, wheat acreage and production of the various types of wheat are shown, followed by US exports of various wheat classes. Lastly, US wheat exports are compared to world wheat exports. This information will be used in a later section detailing the decline of US wheat sector competitiveness.

The U.S. is one of the major wheat exporters in the world. The other major wheat exporters are Canada, Australia, and Black Sea nations that are termed as the "Former Soviet Union." Figure 1 details total U.S. wheat production and exports.

Figure 1. US Total Wheat Production and Exports, 1960-2009 (Source: USDA-ERS)



Since 1960, 40 to 70 percent of U.S. wheat production has been sold into the export market. In 2009, the US produced 2.216 billion bushels of wheat. Wheat production rose in the 1960's and 70's, reaching a peak in 1981. Since that time, US wheat production and exports have trended downward.

Figure 2 details US wheat production by production type. Hard red winter wheat is the largest production class, followed hard red spring wheat, soft red

[3] White Wheat is grown Montana, Idaho, Washington, Oregon, and Michigan. Durum wheat is grown in South Dakota, North Dakota, and Montana.

[4] Hard Red Winter Wheat is grown throughout the Great Plains – from Texas to North Dakota and Washington State. Soft red winter wheat is grown in the Eastern US – from the Gulf of Mexico to the Great Lakes Region.

winter wheat, white wheat, and durum wheat. The number of acres of U.S. producing the levels of wheat shown in Figures 1 and 2 have been declining over time. In particular, winter and spring wheat acres have declined over time since 1980. Durum wheat acres have remained steady (Figure 3). Wheat yields have gone up over time particularly in winter and spring wheat classes. However, durum wheat yields have stagnated over the past 20 years (Figure 4).

Figure 2. U.S. Wheat Production by Wheat Type, 1984-2009 (source: USDA-ERS)

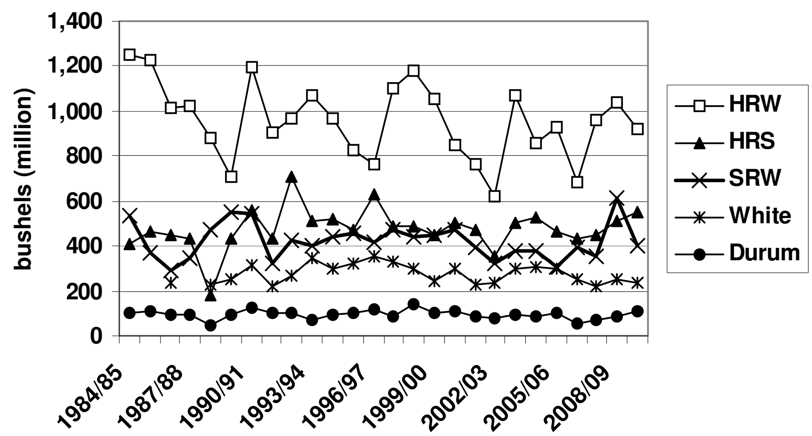


Figure 3. U.S. Wheat, Harvested Acres, 1980-2008. (Source: USDA-NASS)

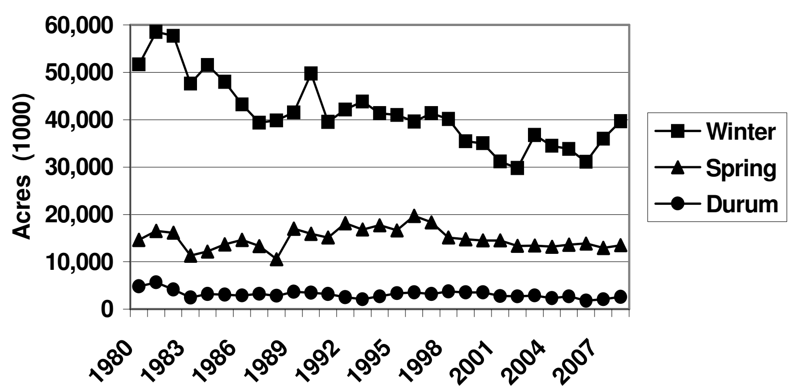
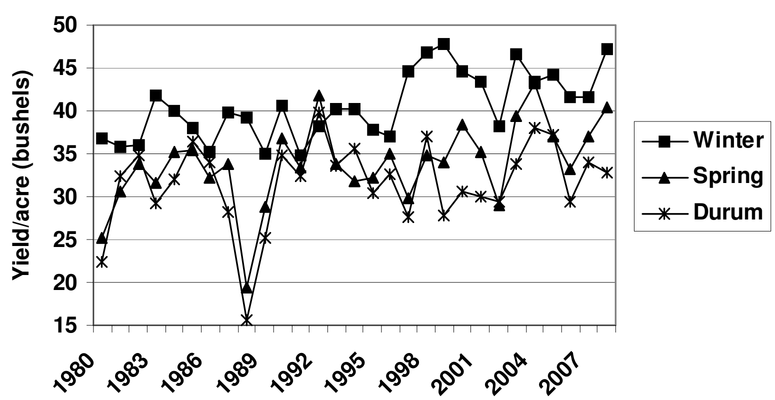


Figure 4. U.S. Wheat Yield, 1980-2008. (Source: USDA-NASS)



7.2 *U.S. Exports and Export Shares*

U.S. wheat exports have declined over time. Figure 5 shows US wheat exports by wheat class type. Export markets are highly volatile particularly the HRW export markets. Both HRW and HRS wheat exports have declined since the 1990/91 marketing year. In 2009, 37 percent of hard red winter production, 39 percent of hard red spring wheat, 32 percent of spring wheat, 71 percent of white wheat, and 50 percent of Durum were exported.

Figure 5. U.S. Wheat Exports by Wheat Type, 1984-2009 (Source: USDA-ERS)

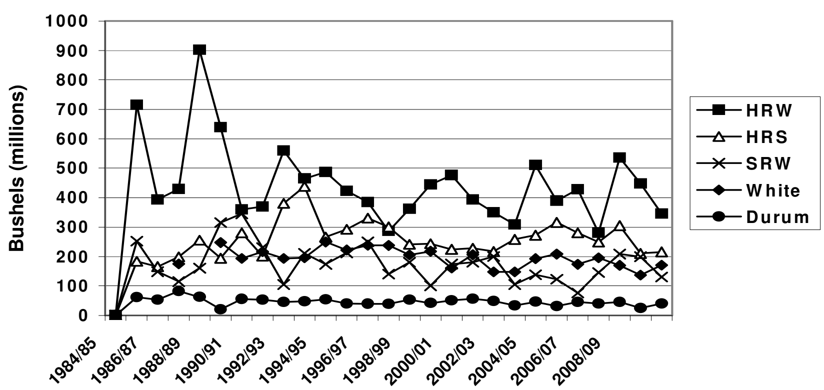
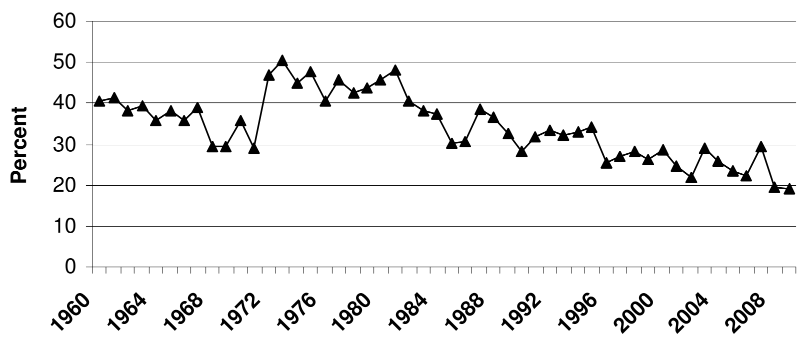


Figure 6. U.S. Export Share of World Wheat Exports, 1960-2009 (Source: USDA-ERS)



Relative to the world wheat export markets, the US share of world exports has gone down. In 1973 the US had 50 percent of the total world wheat export market. Since that time, the US wheat export share has declined to 19 percent. (Figure 6).[5]

It is against this backdrop that the wheat industry stakeholders say that the wheat industry must take measures to restore competitiveness. One of the solutions put forth is to allow for the introduction of wheat with GM traits.

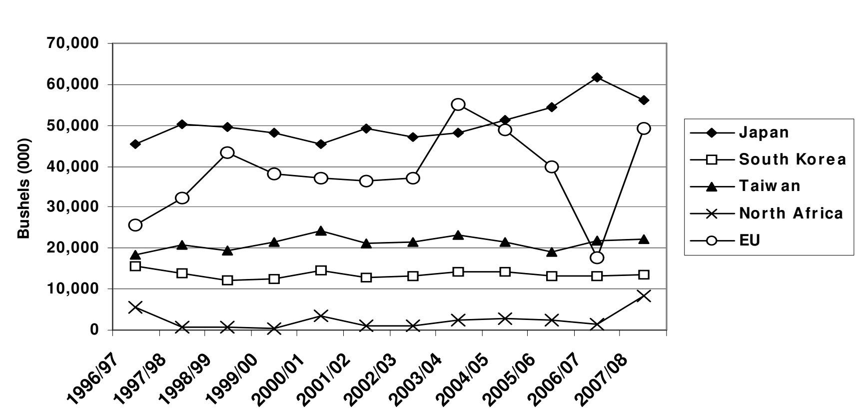
In the next section, wheat use and exports for the various classes of wheat are evaluated to determine which classes are most at risk should GM wheat be introduced.

[5] See Appendix Table 3 for world wheat production and exports.

7.3 U.S. Hard Red Spring and Durum Wheat Exports to Japan, Korea,, Taiwan, EU and North Africa.

The EU, Japan, Korea, Taiwan and North Africa are likely to restrict wheat imports from the US if HRS wheat is introduced. In addition, since durum wheat is grown in the same areas and marketed through the same channels, it, too is at risk for export loss if GM HRS wheat is introduced.

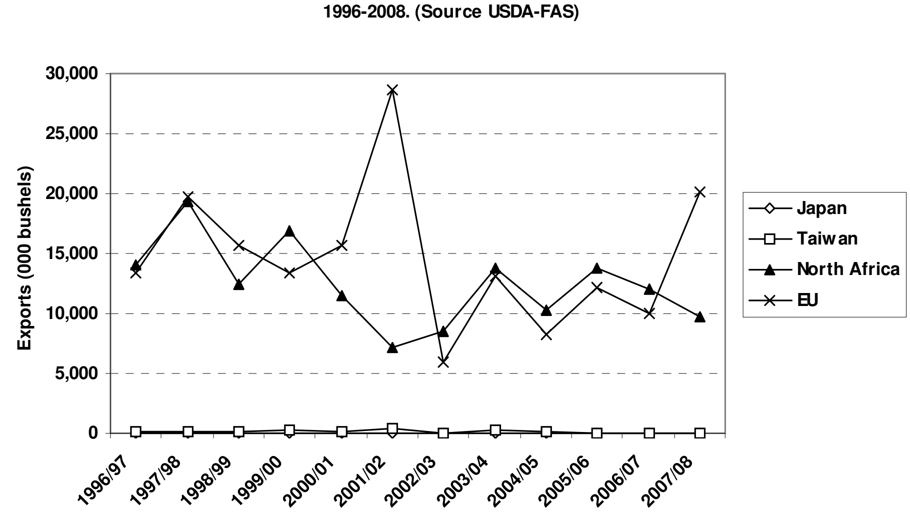
Figure 7. U.S. Hard Red Spring Wheat Exports to Countries Likely to Label or Reject GM Wheat, 1996-2008. (Source USDA-FAS)



The U.S. Export trends for these countries are presented for hard red spring wheat and durum wheat types (Figures 7 and 8). HRS wheat exports to Japan and the EU have trended up over time. Exports to Taiwan, South Korea, and North Africa have remained stable over time. In 2007/08 U.S. HRS wheat exports to Japan, South Korea, Taiwan, North Africa, and the EU amounted to 51 percent of total U.S. HRS wheat exports.

In 2007/08, U.S. durum wheat exports to Japan Taiwan, the EU, and North Africa were 75 percent of total US durum exports (Figure 8). The high export shares of HRS and durum wheat to countries that are likely to reject or curtail exports of GM HRS wheat place these exports at risk.

Figure 8. U.S. Durum Wheat Exports to Countries Likely to Label or Reject GM Wheat, 1996-2008. (Source USDA-FAS)



7.4 U.S. Hard Red Spring and Durum Wheat Exports to Latin America, Oceania (South Pacific), Asia, and Africa (South and Central)

Lower income countries are more likely to accept GM wheat (Wisner, 2003). Figure 9 presents U.S. HRS wheat exports to Latin America, Oceania, Asia, and Africa. Of the 4 regions presented in Figure 9, only HRS wheat exports to Latin America are trending upward. Should HRS wheat exports be lost to the EU, Japan, Taiwan, North Africa, and Korea due to GM wheat introduction, the lower income countries could take up the slack. However, export adjustments often take several years once a shock is introduced in to the world export markets. In 2007/08, HRS exports to the regions shown in Figure 9 were 49 percent of total US HRS wheat exports. Overall, US HRS wheat exports are balanced evenly between countries that are likely to reject GM wheat and countries that are more likely to accept GM wheat.

Figure 9. U.S. Hard Red Spring Wheat Exports to Countries Likely to Accept GM Wheat, 1996-2008. (Source: USDA-ERS)

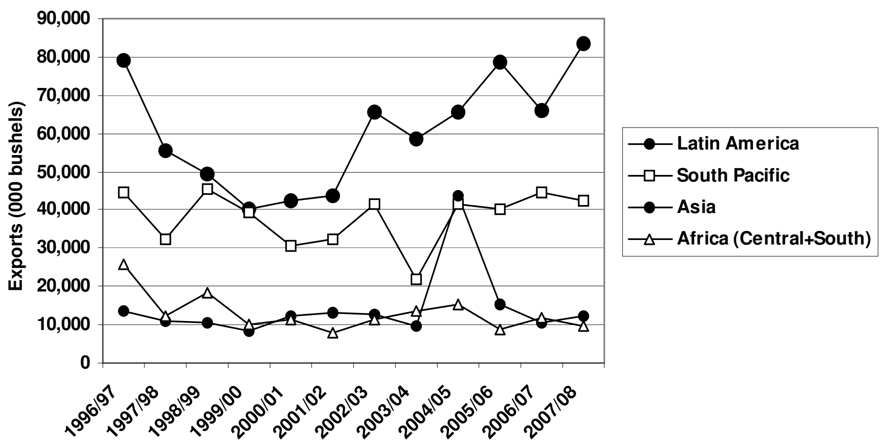
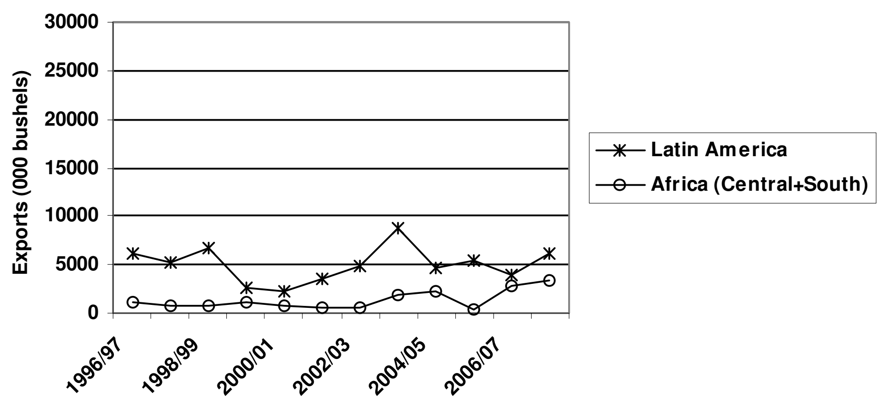


Figure 10. U.S. Durum Wheat Exports to Countries Likely to Accept GM Wheat, 1996-2008. (Soruce: USDA-ERS)



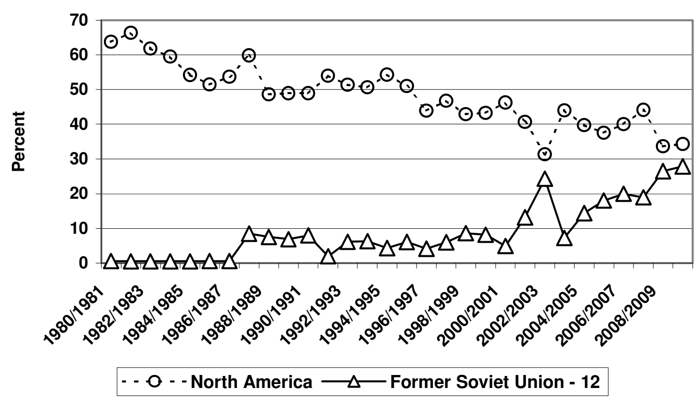
For Durum wheat, export shares to countries that will likely reject GM wheat dominate total U.S. durum wheat exports. Figure 10 shows durum wheat exports to Latin America and Africa. In 2007/08 U.S. exports of durum to Latin America and Africa were 24 percent of total durum exports. In comparison to HRS wheat, U.S. durum wheat exports are more at risk should GM wheat be rejected.

Since both HRS and durum wheat exports wold be at risk if the US adopts GM wheat, other sources of wheat will have to come from somewhere to fulfill the demand for wheat in countries hesitant to import GM wheat. That source could be the Former Soviet Union.

7.5 Russian and Former Soviet Union (FSU) Countries – Growth in Export Share

In the last several years, world wheat export shares of Russia and Former Soviet Union (FSU) countries have been increasing. As pointed out earlier, the US share of world wheat exports has steadily gone down since the 1960s. Figure 11 shows that the North American wheat export share of total wheat exports has gone down over time. The world wheat export share of Russia and the FSU has gone up from 10 percent in 2000 to almost 30 percent in 2008/09. The US has approximately 60 percent of North American wheat exports.

Figure 11. World Wheat Export Shares of North America and the Former Soviet Union, 1980-2009. (Source: USDA-FAS)



Russia and the Former Soviet Union countries present a challenge to the US dominance in wheat exports. If the EU and Japan reject or curtail GM wheat from the U.S., they could go to Russia and Ukraine to purchase wheat. Given the proximity of Russia and the Former Soviet Union countries to the EU, it is very likely their exports to the EU could replace US wheat exports. Given the cold war animosities of the past and the closer political alignment of the EU and Russia/FSU, this is not beyond the realm of possibilities.

7.6 U.S. Exports At Risk if GM Hard Spring Wheat is Introduced

To identify the export wheat pools at risk should GM HRS wheat be introduced, USDA-FAS data were used to identify the export destinations for all classes of wheat. Once these risky wheat pools are defined the level of pooled risky exports are compared to the total production class pool. This data is then used in the price impact analysis to determine the degree of farm level price risk. For the 2007/08 crop year, the Appendix Table 1A and 1B details the US exports to all country destinations in the world for all wheat classes.

Which exports are at risk? Given the regulatory approaches of the various countries in the world towards GM crops, various exports to certain countries are more at risk than others. Given the controversies caused by the various unintended GM releases[6] and the export and price responses that occurred, one can get a good idea of the economic response that may occur if the U.S. approves GM wheat.

Appendix Table 2 details a list of countries that have some sort of a labeling regime for GM food ingredients. As of this writing there are 48 countries that have some sort of a labeling regime. This list was taken from Robert Wisner (personal communication). In addition to the list drafted by Wisner, more countries were added to the list. As time has passed by, the number of countries

[6] Starlink corn - 2000, LibertyLink rice – 2006, Triffid Flax – 2001, 2009.

considering some form of labeling regulations has increased. Part of this is driven by consumer sentiment. The other reason is the trend towards greater traceability in certain countries especially the EU and Japan. This list is used to outline which exports are at risk.

Hard Red Spring Wheat and Durum Wheat – Exports at Risk

Figure 12 details the use share of US HRS wheat in 2007/08. Exports of HRS wheat are 54 percent of total production. Exports to countries that label GM products or reject GM products are 39% of US HRS total production.

Figure 12. U.S. Hard Red Spring Wheat Use by Type, 2007/08 Marketing Year. (Source: USDA-ERS)

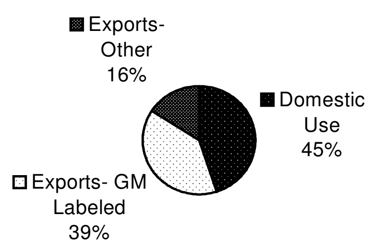
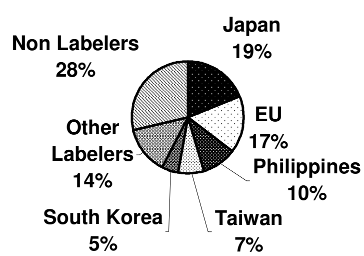


Figure 13 details the export destinations of US HRS wheat. A majority of the exports go to countries that label or limit the commerce in GMOs. Only 28 percent of the exports go to nonlabeling countries. Japan and the EU account for 36 percent of total U.S. exports. Since Japan and the EU have indicated a willingness to severely curtail HRS GM wheat, these exports are at risk.

Figure 13. Shares of US Hard Red Spring Wheat Exports by Destination, 2007/08. (Source: USDA-ERS)



Durum wheat could be most at risk should GM wheat be adopted in the U.S. The growing areas for HRS wheat and durum wheat overlap. Even if the durum wheat were not GM, the commonality of growing area and grain merchandising systems with HRS wheat would present a risk. At the least, GM testing will have to be implemented on U.S. durum wheat exports to satisfy the concern of foreign buyers.

A majority of the Durum wheat produced in the U.S. is consumed domestically. 25 percent of production goes to GM labeled exports while 8 percent goes to nonlabeling countries (Figure 14). While the amount of durum wheat exports relative to production is small, the exports predominantly go to countries that have stringent GM rules or label GM food products.

51 percent of U.S. durum wheat goes to the EU and 24 percent goes to North Africa (Figure 15). These countries have indicated that they intend to curtail U.S. purchases of wheat if it contains GM events. The export patterns shown in Figure 15 suggest that durum wheat is more at risk than HRS wheat should GM wheat be approved in the U.S.

Figure 14. U.S. Durum Wheat Use by Type, 2007/08 Marketing Year. (Source: USDA-ERS)

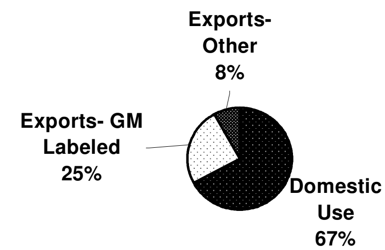
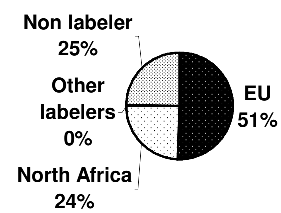


Figure 15. Shares of U.S. Durum Wheat Exports by Destination, 2007/08. (Source: USDA-ERS)



To determine the export loss and price effects from the introduction of GM HRS wheat, export pools of HRS and durum wheat going to countries that restrict GMOs or have GM labeling rules were identified. This analysis was done for the 2007/08 marketing year. This analysis tested two likely scenarios that could occur if the U.S. introduces GM HRS wheat first in the world.

Scenario I was completed assuming that only the EU and Japan shut down U.S. imports and the rest of the world remains indifferent to GM wheat. Scenario II assumes that the EU and Japan shut down U.S. imports and 40 percent of the exports to other labeling countries were shut down. The wheat in the exports that would be lost after GM introduction is assumed to be priced as feed wheat. Feed wheat is priced close to corn because it is a close substitute. The analysis assumes the use of demand elasticities of -0.3 and -0.2 for the HRS and durum wheats, respectively.

If export wheat could not be devoted to feed wheat use, these elasticities mean that export shutdowns would generate severe shocks to the system that would result in low prices. However, if lost-export wheat is devoted to feed wheat, export losses generate negative price effects tied to the price of corn. This ultimately buffers, or sets a floor under, the price shock. In 2007/08 the price of HRS and durum wheat were $7.16 and $9.92 per bushel/respectively. The price of corn was $4.20 per bushel in 2007/08. The price difference between HRS wheat and durum wheat and corn was $2.96 and $5.72, respectively.

Table 3 highlights the export and price impacts that would be caused by GM wheat introduction. In Scenario I, in which the EU and Japan totally shut down imports of U.S. wheat, the export loss is 106 million bushels. This amount is 35.36 percent of total US exports of HRS wheat. In Scenario I the 106 million bushel export loss would result in a 41 percent price drop. Scenario II generates a 149 million bushel loss which would amount to a 49 percent export loss.

Table 3. Export losses in the U.S. HRS wheat sector caused by GM HRS introduction.

Hard Red Spring Wheat	Export Loss (Million Bu.)	Percent of 2007/08 US HRS Exports Lost	Percent of 2007/08 US HRS, Demand Lost	Estimated Farm Price Impact on HRS Wheat (%)
Scenario I	**106**	**35.36**	**19.49**	**-41.34**
Scenario II	**149**	**49.79**	**27.44**	**-41.34**

Table 4. Export losses in the U.S. durum wheat sector caused by GM HRS introduction.

Durum Wheat	Export Loss (Million Bu.)	Percent of 2007/08 US Durum Exports Lost	Percent of 2007/08 US Durum Demand Lost	Estimated Farm Price Impact on Durum Wheat (%)
Scenario I	**20**	**50.62**	**16.66**	**-57.66**
Scenario II	**24**	**60.46**	**19.89**	**-57.66**

Table 4 shows the impact of export losses on durum wheat prices. For durum wheat, export losses arising from the introduction of GM wheat have a much greater impact on total exports compared to HRS wheat. In Scenario I, 50 percent of the durum wheat exports are lost if the EU and Japan shut down U.S. exports. The price is estimated to drop 57 percent. The reason that price impacts are larger for durum wheat is because most of the durum wheat goes to countries that are likely to reject GM wheat.

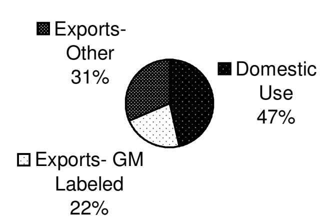
The price impacts shown in this analysis are higher than shown in Wisner's 2003 report for several reasons. From the time Wisner (2003) performed his analysis until 2008, grain prices have exhibited a dramatic rise. Wheat prices in the 2007/08 crop year reached a peak never before seen. Wheat prices went up relatively higher than corn prices. In this high price environment the price shocks will be larger.

7.7 U.S. Use and Export Shares of Hard Red Winter Wheat, Soft red Winter Wheat and White Wheat.

Hard red winter wheat, soft red winter wheat and white wheat are less at risk for export loss compared to hard red spring wheat and durum wheat. Hard red winter wheat is grown in the Great Plains and soft red winter wheat is grown in the Eastern U.S. These two classes of wheat are grown in areas that have little overlap with the hard red spring wheat growing region.

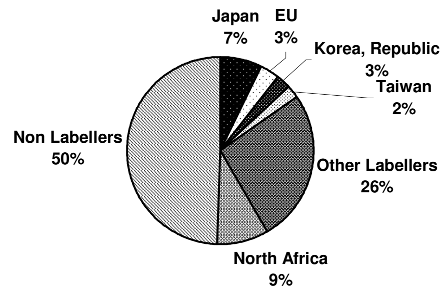
Hard red winter wheat is the largest class of wheat produced in the U.S. 53 percent of U.S. HRW wheat production is exported. Only 22 percent of total HRW production is exported to countries that label or restrict GM wheat (Figure 16).

Figure 16. U.S. Hard Red Winter Wheat Use by Type, 2007/08 Marketing Year (Source: USDA-ERS)



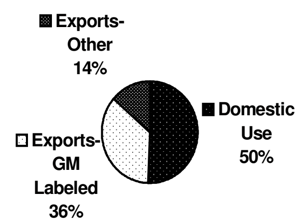
50 percent of U.S. HRW exports go to countries that label or restrict GM wheat. However, the countries most noted for severely restricting GM products – EU, Japan, Korea, Taiwan, and North Africa – comprise only a small proportion of HRW wheat exports. (Figure 17).

Figure 17. Shares of U.S. Hard Red Winter Wheat Exports, 2007/08, (Source: USDA-ERS).



Soft red winter wheat is grown in the Eastern US and as such would not be at as great a risk for export losses should GM wheat be introduced. 36 percent of SRW wheat production goes to exports to GM labeling countries (Figure 18).

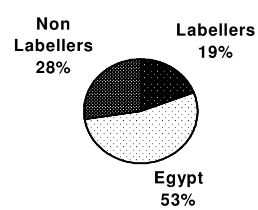
Figure 18. U.S. Soft Red Winter Wheat Use by Type, 2007/08 Marketing Year (Source: USDA-ERS).



Most the exports of SRW in 2007/08 went to Egypt (Figure 19). Since very little goes to the EU and Japan, there is little risk of export loss if GM wheat is approved. However, if GM SRW wheat were to be introduced in the future, this could impact SRW exports.

Most the exports of SRW in 2007/08 went to Egypt (Figure 19). Since very little goes to the EU and Japan, there is little risk of export loss if GM wheat is approved. However, if GM SRW wheat were to be introduced in the future, this could impact SRW exports.

Figure 19. Shares of U.S. Soft Red Winter Wheat Exports by Destination, 2007/08, (Source: USDA-ERS).



White wheat is grown in the Northwest U.S. 51 percent of white wheat production goes for export to GM labeling countries (Figure 20). Of the total white wheat exports, 19 percent goes to Japan, and 17 percent goes to South Korea. These two countries are the sources of export risk if GM wheat is approved (Figure 21).

Figure 20. U.S. White Wheat Use by Type, 2007/08 Marketing Year, (Source: USDA-ERS).

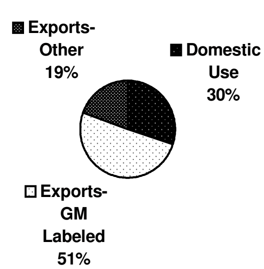
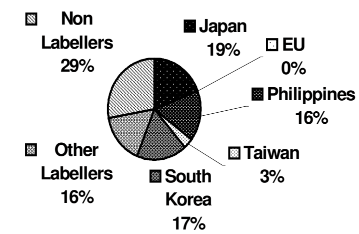


Figure 21. Shares of U.S. White Wheat Exports, 2007/08, (Source: USDA-ERS).



7.8 Trends in US wheat Acres and Wheat Competitiveness vs Corn and Beans

As mentioned in the introduction, many wheat industry stakeholders are concerned that the wheat sector has been losing its competitiveness. The acreage devoted to wheat has been declining since 1980 (Figure 22). As shown in the previous section, Ukraine and Russia have emerged as new competitors in the wheat market. Many reasons have been cited for this decline: 1) farmer retirement of large portions of land under USDA's Acreage Reduction Program, 2) planting flexibility provisions introduced in the 1996 Farm Act, 3) farmer enrollment of land in the USDA Conservation Reserve Program, 4) changes in crop rotations, which lengthened the rotation cycle from two to three years, and 5) biofuel mandates enacted in the U.S. All these factors favored planting of corn and soybeans in place of wheat (Ali and Vocke).

Figure 22. U.S. Wheat, Harvested Acres, 1980-2008. (Source: USDA-NASS)

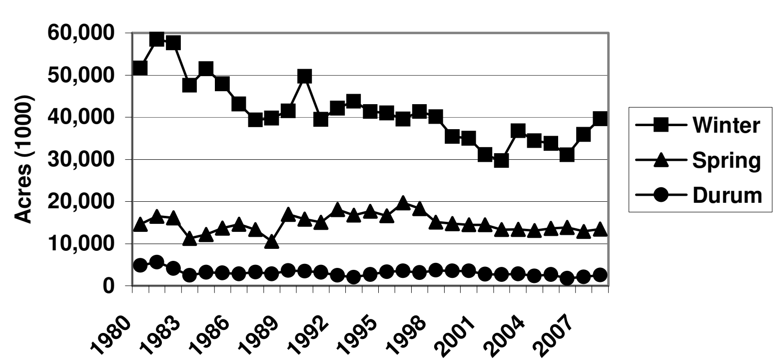


Figure 23. Wheat, Corn, and Soybean Shares of Total Crop Acres Harvested in the US, 1980-2008. (Source USDA-NASS)

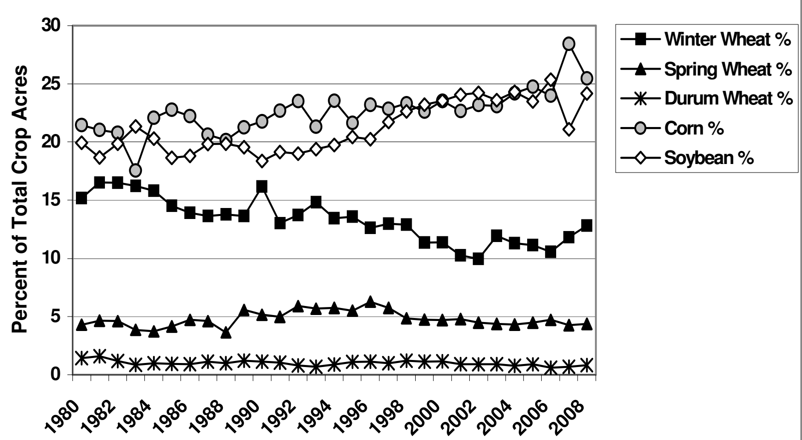


Figure 23 shows that total crop acres devoted to wheat have been declining while the acres devoted to corn and soybeans has been increasing. In a conversation with a Kansas State Cooperative Extension Agent, reasons were put forth for the decline of wheat acres. Besides the reasons listed at the beginning of this section, the decline in wheat acres can be explained in a macroeconomic sense. In the international market North America has remained as the dominant supplier of corn and soybeans. In the wheat market the U.S. has a much less comparative advantage in wheat production because there are several major export competitors.

Many in the wheat industry have attributed the loss of wheat acres to corn and soybeans partly to strong genetic improvements in corn and soybeans, and a slower pace of genetic improvement for wheat than for corn and soybeans. The reasons cited for this are: 1) genetic complexity and 2) lower returns to seed companies on investment for breeding wheat. To address this perceived lag, the wheat industry summits from 2006 to 2009 have put forth the idea that GM wheat is needed as one of the many tools to restore wheat competitiveness. The introduction of a GM wheat variety will not in and of itself restore competitiveness to the wheat sector. The fact that GM wheat is not approved anywhere in the world indicates that U.S. farmers are not at a competitive disadvantage in terms of wheat genetics. Furtan et al. (2005) make the case that introducing GM wheat in U.S. and Canada without an affordable segregation system does not confer first mover advantages to the early adopters of GM wheat. The main reason cited for this result is that major foreign customers do not want GM wheat. Given the foreign consumer concerns for GM wheat, other methods should be used to improve wheat genetics and cultural practices. The next section details the biotech development of wheat and some of the breeding techniques that can boost wheat yields using non-transgenic techniques.

8.0 Biotech Development of Wheat

Research and development of GM traits in wheat has grown since the early 1990s. Currently, the only GM wheat that has been close to ready for commercial release is the Roundup Ready® hard red spring wheat from Monsanto. Many in the wheat industry who opposed Roundup Ready® wheat, stress that other GM and non-GM traits should be developed that have more end-user benefit. The Canadian Wheat Board in its public pronouncements on wheat breeding efforts stated they wanted to see traits that had a greater benefit than Roundup Ready® wheat, such as resistance to fusarium disease or improved yield and quality. Breeding wheat turned out to be more difficult than for other crops.

The genetic development of wheat has lagged that found in corn and soybeans for several reasons: 1) wheat genetics are more complex, 2) wheat is a smaller volume crop compared to corn and soybeans, and 3) competition among exporters is more intense and compounded by radically different marketing systems (Wilson et al., 2003). The wheat genome is 10 to 20 times larger than other crop genomes. As a consequence, improving wheat genetics has been more costly and time consuming.

In general, plants can be changed genetically by 1) transformation, 2) plant breeding selections based on phenotypic selection, and 3) the use of DNA markers. The process of transformation involves introducing genes via a vector into the plant. Currently, foreign genes are introduced into the crop plant using a fungal pathogen such as agrobacterium tumefaciens.[7] Traditional plant breeding has relied on visual selection of phenotypes and data analysis of morphological characteristics of the crop plant. Marker assisted selection (MAS) is a relatively new selection technique that relies on DNA markers. The use of DNA markers allows plant breeders to change the genome using what is already known about the chromosomes through the gene mapping process.

As the plant breeding industry goes forward, MAS will become a more important component of changing genetics. At this time, MAS has had a small impact on variety development, however, there is optimism that it will be widely adopted in many plant breeding programs (Collard and Mackill, 2008). Collard and Mackill (2008) discuss in great detail how MAS can be utilized to its fullest potential. Three factors were discussed as to how this will happen: 1) greater integration into breeding programs, 2) that current barriers be understood and appropriate solutions developed, and

[7] See http://www.bio.davidson.edu/people/kabernd/seminar/2002/method/dsmeth/ds.htm for a description of agrobacterium tumefaciens mediated gene transfer.

3) overcoming the high cost of MAS for certain crop species and developing countries.

Moose and Mumm (2008) discuss the institutional adoption of MAS. Despite the fact that molecular breeding is an essential component of crop improvements by large companies, the applicability of the molecular approach remains a source of debate among some plant breeders in the public sector. Moose and Mumm stress that the grand challenges are identifying gene combinations that lead to crop improvement and integrating the various disciplines in the plant breeding area.

In wheat breeding, herbicide tolerance is the main trait under development, followed by product quality, fusarium resistance, and others. In 2004, Syngenta was developing a GM wheat resistant to fusarium, a fungus which damages crops and produces dangerous toxins. In 2006 Syngenta was still working on GM wheat (Food-Navigator.com, 2006). In 2009, however, Syngenta's chief executive Michael Mack said that Syngenta was not pursuing GM wheat because of GM consumer resistance (Reuters, 2-26-2009). In 2002, Dupont pulled out of hybrid wheat development because the return on investment was not in line with the investments made by Dupont (GENET 3-23-2002).

In addition to GM wheat development efforts, there are efforts to improve wheat varieties through non-GM breeding. Most notable is BASF's Clearfield HRS wheat which was created through mutagenesis. This wheat has been developed to be resistant to BASF's Beyond herbicide.[8] Many wheat breeding efforts are currently underway that do not use GM technologies. Jianming Yu and Rex Bernado at Kansas State University are developing marker assisted selection to accelerate classical plant breeding techniques (Bernardo and Yu, 2007). Their work focuses on corn, sorghum, wheat and barley. Other non-GM efforts are focusing on the Ug99 stem rust (Borlaug Global Rust Initiative, 2009), frost-resistant wheat (USDA-CSREES, 2009), and salt-resistant wheat (Countryman, 2004).

9.0 Organic Segregation from GM wheat

If GM wheat is approved by the US and Canada, what will happen to organic wheat production? This question has many facets that must be addressed. No one can say for sure what will happen to organic wheat production if GM wheat is introduced. However, one can look at what happened to organic canola production in Canada when GM Canola was introduced. Organic canola production was always a niche market. Today, organic canola production in Canada is almost nonexistent. The main reason is that GM events have permeated all canola varieties, even pedigreed seed lines.

A number of studies show that the pedigreed oilseed rapeseed supply is deeply contaminated with GM events. Researchers at the University of Manitoba conducted a survey of 27 pedigree seed lots of oilseed rape in 2002 (Friesen *et al*., 2003). Of the 27 seed lots, 14 had contamination levels above 0.25% and three seed lots had glyphosate resistance contamination levels in excess of 2.0%. Oilseed rape breeder Keith Downey suspected that, "There are varieties of certified seed out there, in which part of the level of contamination was coming right from the breeders' seed." (Organic Agriculture Protection Fund, 2002) Walter Fehr, an agronomist and director of the Office of Biotechnology at Iowa State University, said that the same was true of other crops, such as soybeans and maize (Charman, 2003). If the breeder seed supply is contaminated, then the whole system is contaminated, and it will be hard to find any fields that can be considered GM free. Another report suggested that even Canadian wheat (the GM version of which has not yet been approved) may be contaminated, since researchers were testing Roundup Ready® wheat at a national experimental station alongside plots of wheat destined for commercial seed growers (Zakreski, 2002). The extent of the penetration of contaminated seed into the canola seed supply is now so deep that segregating GM from non-GM seed will not help at this point (http://www.grain.org/front/).

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[8] See: BASF at http://agproducts.basf.us/products/beyond-herbicide.html

10.0 Summary

This report reviews the U.S. and world wheat industry to evaluate the impact of a possible introduction of Roundup Ready® hard red spring (HRS) wheat in the U.S. Recently, major stakeholders of the wheat industry have agreed to support development of GM wheat. The economic impacts of introducing GM wheat in the U.S. are dependent on foreign consumer sentiment. A review of the EU, Japanese, Korean, and Taiwanese consumers suggests they will likely reject GM wheat products or pay substantially less for them. Consumer sentiment against GMOs is strongest in the EU and Japan. EU regulations dictate strict labeling and traceability policies for all products sold in the EU.

Identity preserved (IP) systems have been proposed as a way to segregate GM and non-GM wheat if the U.S. introduces GM wheat. IP costs for such systems are 3 to 6 cents per bushel. At the current time IP systems analyses have not incorporated liability costs and other associated costs arising from IP systems failures.

U.S. wheat acres and world export shares have gone down since 1960. Trends in U.S. wheat exports indicate that HRS and durum wheat are most "at risk" of export loss if the U.S. approves Roundup Ready® wheat. Exports to Japan and the EU would likely be curtailed because of foreign consumer concerns. The combined EU and Japanese export losses would likely be 35 and 50 percent for HRS and durum wheat, respectively. In addition, the corresponding price drop will be 41 and 57 percent for HRS and durum wheat, respectively. If more countries in addition to the EU and Japan curtail their purchases of HRS and durum wheat, the U.S. export declines would be even higher. The routing of lost export wheat into feed wheat markets will limit the price drops to the price level of the corn market.

If the U.S. loses its HRS and durum wheat export markets due to GM wheat introduction, Russia and the Former Soviet Union would likely make up the difference – as indicated by their growing world wheat export market share.

A review of the wheat breeding literature suggests that in addition to the traditional plant breeding and GM transformation techniques, marker assisted selection (MAS) is being used to generate non-GM trait development in wheat. Non-GM trait development has recently focused on rust, drought, and salt resistant wheat varieties. In addition, mutagenesis has been used to create a non-GM herbicide resistant wheat that is commercially sold.

Depending on the trends for labeling and changing consumer sentiment, there is a mixed outlook for the marketing of GM wheat. Currently there are no commercial GM wheat varieties grown in the world. Some promote GM technology as one of the tools that can reverse the decline in the competitiveness of the wheat sector. However, the concerns of major foreign consumers about GM wheat and the lack of an affordable identity preserved segregation make the introduction of GM at the current time a risky proposition.

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Appendix Table 1A. US Wheat Export Destinations.			
Hard Red Winter	Hard Red Winter	Hard Red Spring	Hard Red Spring
Afghanistan	Korea, Republic	Japan	Honduras
Algeria	Madagascar	Spain	Tanzania
Bangladesh	Malawi	Italy	Trinidad
Bolivia	Malaysia	Belgium	Bangladesh
Brazil	Mauritania	United Kingdom	Sudan
Chile	Mauritius	Portugal	Vietnam
China	Mexico	Netherlands	Barbados
Colombia	Morocco	Malta	Saint Vincent
Congo (Braz)	Mozambique	Sweden	Cuba
Congo (Kins)	Namibia	Iceland	Tunisia
Costa Rica	Nicaragua	Korea, Republic	United Arab Emirates
Cuba	Nigeria	Taiwan	Guatemala
Djibouti	Other West Africa	Philippines	Ghana
Dominican Republic	Panama	Mexico	Singapore
Ecuador	Peru	Thailand	Cameroon
Egypt	Philippines	Malaysia	Senegal
El Salvador	Rep. of South Africa	Rep. of South Africa	Belize
Ethiopia	Saint Vincent	Sri Lanka	Somalia
Ghana	Senegal	China, Mainland	Chile
Greece	Sierra Leone	Indonesia	Mauritius
Guatemala	Somalia	Peru	Namibia
Guinea	Sri Lanka	Ecuador	Liberia
Haiti	Suriname	Venezuela	Iraq
Honduras	Taiwan	Colombia	
Indonesia	Thailand	El Salvador	
Iraq	Trinidad	Dominican Republic	
Ireland	Uganda	Morocco	
Israel	United Arab Emirates	Nigeria	
Ivory Coast	Vanuatu	Costa Rica	
Jamaica	Venezuela	Jamaica	
Japan	Vietnam	Panama	
Kenya	Yemen	Nicaragua	

Appendix Table 1B. US Wheat Export Destinations.		
Soft Red Winter	White	Durum
Japan	Japan	Italy
Spain	Finland	Portugal
Italy	Belgium	Netherlands
Philippines	Philippines	Switzerland
China, Taiwan	China, Taiwan	Spain
Korea, Republic	China, Taiwan	Germany
Egypt	Korea, Republic	United Kingdom
Mexico	Korea, Republic	Tunisia
Brazil	Thailand	Algeria
Peru	Sri Lanka	Morocco
Ecuador	Malaysia	Mexico
Rep. of South Africa	Mexico	Venezuela
Sri Lanka	China, Mainland	Nigeria
Malaysia	Mexico	Costa Rica
Indonesia	Indonesia	United Arab Emirates
Nigeria	Egypt	Cuba
Colombia	Yemen	Guatemala
Morocco	Yemen	Dominican Republic
Chile	Pakistan	Panama
Venezuela	El Salvador	
Jamaica	Bangladesh	
Dominican Republic	Singapore	
Honduras	Afghanistan	
Costa Rica	Chile	
Turkey	Ecuador	
El Salvador	United Arab Emirates	
Trinidad	Vietnam	
Guatemala	Vietnam	
Panama	Peru	
Nicaragua	Hong Kong	
United Arab Emirates	China, PR	
Mozambique	Colombia	
Congo (Kins)	Eritrea	
Belize	Ethiopia	
Vietnam	Ghana	
Barbados	Guatemala	
Congo (Braz)	Iraq	
Senegal	Korea, North	
Saint Vincent	Mauritania	
Pakistan	Russia	
Mauritania	Sudan	
	Turkey	
	Uruguay	
	Uzbekistan	
	Venezuela	
	Chad	
	All other countries	
	Former Soviet Union	
	New Zealand	

Appendix Table 2. Countries Requiring GMO Labeling

EU – 27				
Austria	Belgium	Bulgaria	Cyprus	Czech Republic
Denmark	Estonia	Finland	France	Germany
Greece	Hungary	Ireland	Italy	Latvia
Lithuania	Luxembourg	Malta	Netherlands	Poland
Portugal	Romania	Slovakia	Slovenia	Spain
Sweden	United Kingdom			
Other countries				
Switzerland	Paraguay	Sri Lanka	Australia	New Zealand
China	Thailand	Taiwan	Philippines	South Korea
Japan	Mexico	Russia	Ethiopia	South Africa
Malaysia	Ecuador	Peru	Indonesia	Eqypt
Brazil				

Appendix Table 3. World and U.S. wheat production, exports and ending stocks

Mkt year /1	World production (million bushels)	U.S. production (million bushels)	U.S. share (percent)	World exports (million bushels)	U.S. exports (million bushels)	U.S. share (percent)	World ending stocks (million bushels)	U.S. ending stocks (million bushels)	U.S. share (percent)
1960	8,577.856	1,354.998	15.80	1,611.469	654.001	40.58	3,044.180	1,502.009	49.34
1961	8,085.417	1,233.009	15.25	1,725.080	715.988	41.50	2,566.548	1,420.990	55.37
1962	9,067.613	1,091.986	12.04	1,698.551	649.004	38.21	2,786.863	1,270.010	45.57
1963	8,465.273	1,146.992	13.55	2,140.872	845.987	39.52	2,584.075	993.991	38.47
1964	9,733.813	1,282.980	13.18	2,016.091	723.006	35.86	2,883.610	921.018	31.94
1965	9,528.085	1,282.980	13.47	2,243.791	852.013	37.97	2,231.593	659.991	29.57
1966	11,047.033	1,314.984	11.90	2,145.980	770.993	35.93	3,219.557	513.016	15.93
1967	10,727.253	1,507.007	14.05	1,967.662	765.004	38.88	3,588.538	630.008	17.56
1968	11,896.658	1,557.015	13.09	1,847.033	543.991	29.45	4,457.416	904.006	20.28
1969	11,170.860	1,442.999	12.92	2,050.924	603.001	29.40	3,804.554	982.968	25.84
1970	11,263.086	1,351.985	12.00	2,075.248	741.010	35.71	2,958.934	822.986	27.81
1971	12,644.209	1,618.634	12.80	2,059.852	599.327	29.10	3,279.156	984.989	30.04
1972	12,400.488	1,546.212	12.47	2,381.029	1,116.347	46.89	2,753.133	597.012	21.68
1973	13,450.733	1,710.787	12.72	2,420.198	1,216.952	50.28	3,037.492	339.990	11.19
1974	13,052.321	1,781.923	13.65	2,264.662	1,018.499	44.97	2,989.211	435.009	14.55
1975	12,957.559	2,126.910	16.41	2,457.824	1,172.896	47.72	3,186.378	665.612	20.89
1976	15,224.683	2,148.772	14.11	2,345.461	949.531	40.48	4,679.385	1,113.261	23.79
1977	13,883.390	2,045.522	14.73	2,458.485	1,123.880	45.71	4,012.670	1,177.820	29.35
1978	16,128.358	1,775.530	11.01	2,820.557	1,194.134	42.34	4,954.816	924.104	18.65
1979	15,342.042	2,134.075	13.91	3,145.372	1,375.170	43.72	4,425.890	901.985	20.38
1980	16,015.371	2,380.919	14.87	3,311.564	1,513.841	45.71	4,139.436	989.104	23.89
1981	16,350.767	2,785.357	17.04	3,688.187	1,770.716	48.01	4,135.321	1,159.374	28.04
1982	17,370.185	2,764.964	15.92	3,709.241	1,508.623	40.67	4,774.074	1,515.053	31.74
1983	17,795.236	2,419.831	13.60	3,740.289	1,426.391	38.14	5,341.029	1,398.649	26.19
1984	18,699.352	2,594.767	13.88	3,808.339	1,421.430	37.32	6,177.500	1,425.252	23.07
1985	18,181.192	2,424.130	13.33	3,029.592	909.113	30.01	6,557.650	1,904.978	29.05
1986	19,256.717	2,090.570	10.86	3,280.258	998.510	30.44	7,028.925	1,820.908	25.91
1987	18,312.992	2,107.693	11.51	4,099.312	1,587.879	38.74	5,847.174	1,260.860	21.56
1988	18,189.900	1,812.200	9.96	3,863.638	1,414.853	36.62	4,950.076	701.621	14.17
1989	19,592.628	2,036.630	10.39	3,799.998	1,231.943	32.42	5,020.844	536.458	10.68
1990	21,627.311	2,729.764	12.62	3,815.577	1,069.462	28.03	6,290.046	868.144	13.80
1991	19,961.939	1,980.155	9.92	4,039.897	1,282.319	31.74	5,983.787	475.023	7.94
1992	20,665.985	2,466.789	11.94	4,043.241	1,353.565	33.48	6,491.879	530.653	8.17
1993	20,511.294	2,396.425	11.68	3,810.947	1,227.754	32.22	6,694.961	568.499	8.49
1994	19,205.276	2,320.990	12.09	3,608.784	1,188.292	32.93	5,992.642	506.586	8.45
1995	19,736.370	2,182.723	11.06	3,644.792	1,241.129	34.05	5,717.468	376.035	6.58
1996	21,358.935	2,277.375	10.66	3,928.013	1,001.523	25.50	6,005.796	443.607	7.39
1997	22,413.957	2,481.450	11.07	3,836.521	1,040.398	27.12	7,212.570	722.492	10.02
1998	21,687.828	2,547.331	11.75	3,721.550	1,045.726	28.10	7,635.968	945.930	12.39
1999	21,559.188	2,295.563	10.65	4,168.537	1,086.512	26.06	7,699.277	949.751	12.34

Appendix Table 3. World and U.S. wheat production, exports and ending stocks (continued).

Mkt year /1	World production (million bushels)	U.S. production (million bushels)	U.S. share (percent)	World exports (million bushels)	U.S. exports (million bushels)	U.S. share (percent)	World ending stocks (million bushels)	U.S. ending stocks (million bushels)	U.S. share (percent)
2000	21,417.872	2,228.175	10.40	3,728.531	1,062.040	28.48	7,618.294	876.191	11.50
2001	21,424.449	1,947.453	9.09	3,884.692	962.318	24.77	7,465.440	777.129	10.41
2002	20,866.018	1,605.884	7.70	3,885.353	850.213	21.88	6,122.825	491.410	8.03
2003	20,358.330	2,344.432	11.52	3,992.314	1,158.309	29.01	4,849.766	546.452	11.27
2004	22,986.020	2,156.782	9.38	4,103.097	1,065.898	25.98	5,519.309	540.096	9.79
2005	22,772.392	2,103.320	9.24	4,284.390	1,002.773	23.41	5,416.941	571.181	10.54
2006	21,883.452	1,808.415	8.26	4,101.921	908.488	22.15	4,688.718	456.136	9.73
2007	22,450.113	2,051.071	9.14	4,306.436	1,262.624	29.32	4,487.068	305.818	6.82
2008	25,071.079	2,499.160	9.97	5,168.481	1,015.486	19.65	6,127.528	656.500	10.71
2009	24,549.171	2,220.165	9.04	4,585.725	900.000	19.63	6,861.263	863.661	12.59

1/ Aggregated based on local marketing years. Latest data may be preliminary or projected.
Source: USDA, Foreign Agricultural Service, Production, Supply, and Distribution Database.

About the Author

Dr. E. Neal Blue was born in Indianoplis, Indiana in 1961 and was raised on a farm in Xenia, Ohio. After completing his undergraduate work at Purdue University in 1984, Neal went to the University of Nebraska where he received an M.S. degree in crop science in 1988. He received a Ph.D. in agricultural economics from The Ohio State University in 1995. From 1995 to 2001, Dr. Blue worked at The Ohio State University on projects related to preharvest pricing strategies for farmers, crop insurance analysis, and soil and water conservation issues.

Currently Dr. E. Neal Blue is a private agricultural consultant living in Columbus, Ohio. As a consultant has worked with universities, nongovernment organizations, and agribusinesses in the areas of crop insurance, regulatory approaches of genetically modifed crops, and food quality control.

A *Review of the Potential Market Impacts of Commercializing GM Wheat in the U.S.*, analyses the likely reaction of foreign customers for U.S. wheat. Wheat buyers in Europe, Japan, and other Asian countries are likely to switch to other sources of wheat, in order to ensure they are getting GM-free wheat.

As a result, the introduction of GM Hard Red Spring Wheat would likely cause an export shutdown to the European Union and Japan. The shutdown would result in a loss of 35-50 percent of U.S. hard red spring wheat exports and 50-60 percent of U.S. durum wheat exports. The sudden surplus of wheat in the domestic U.S. market would have to be sold for livestock feed, driving the price of these premium wheats down to their value as cattle or chicken feed.

Dr. Blue's report is the latest update of an October 2003 report, *Market Risks of Genetically Modified Wheat*, by Iowa State University Economics Professor Dr. Robert Wisner. In 2006, Dr. Wisner updated that report, and found that the introduction of genetically modified wheat would not reverse the declining market share of U.S. wheat exports, nor will it reverse the downward trend of wheat acres planted.

Western Organization of Resource Councils
220 South 27th Street, Suite B
Billings, Montana 59101
www.worc.org