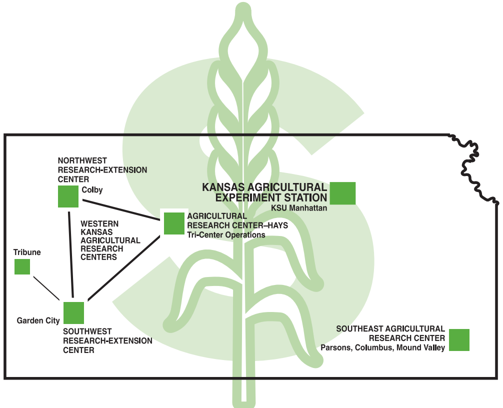


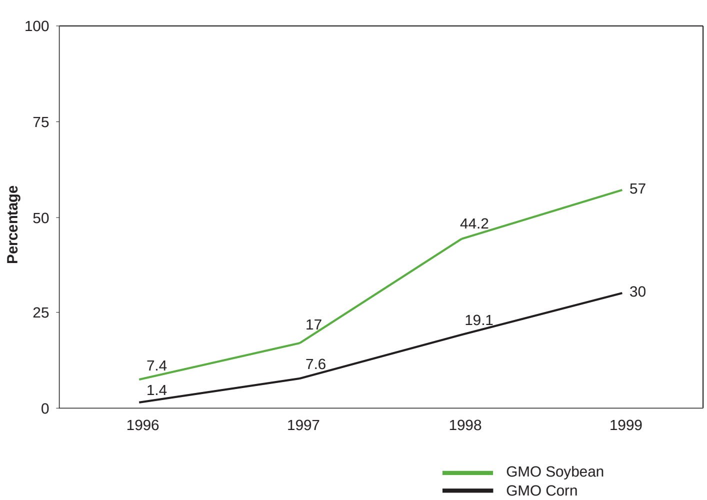
Agricultural Industry Competitiveness

Enhance the value of Kansas Agricultural goods

Economic Issues with Genetically Modified (GM) Food and Feed Grains

Genetically modified (GM) crops such as Roundup Ready™ soybeans and *Bt* corn gained rapid acceptance among crop producers in the United States in the late 1990s (Figure 1). However, controversies and concerns over GM grains have led to much confusion among both producers and consumers. This may explain why some food processors and export markets have announced plans to purchase only non-GM grain. It is important to understand what is unique about GM grains, their benefits, and their risks. The economic implications for Kansas producers and consumers also need to be considered.

Figure 1. *Percentage of U.S. Corn and Soybean Crop Planted to GM varieties, 1996 to 1999 (USDA ERS)*



What is GM?

GM is an abbreviation for "genetically modified" organism. A GM organism is a living plant, animal, fungus, or bacterium that has been altered by insertion of a new gene (or genes) through a process called transformation. The whole process of discovering, modifying, and inserting new genes is called genetic engineering. The term "genetically modified" is confusing because humans have been modifying traits of agricultural plants and animals since prehistoric times.

Traditionally, crop breeders used natural mutations, cross breeding, and selection to improve varieties. For example, most crop plants have been enhanced by breeding for better quality, higher yields, or pest resistance. However, there are three major drawbacks to conventional cross breeding. First, thousands of genes are shuffled when a cross is made. Therefore, adding a single new trait to a plant variety without affecting all the other traits has been difficult. Second, it has been difficult or impossible to precisely control the expression of a trait. For example, altering a seed protein to be expressed in the roots would not be practicable by conventional breeding methods. Third, genes for a desired trait may be lacking in the gene pool of the crop species. For instance, no soybean variety had resistance to glyphosate herbicide until Roundup Ready™ soybeans were introduced.

Genetic engineering offers the chance to overcome all of these shortcomings of traditional crop improvement. Because single genes can now be added to a variety, traits can be manipulated much more precisely. Plant breeders are gaining the ability to control exactly when and where a gene is expressed and the amount of the gene product. Even more important has been the ability to expand the gene

Table 1. New Crop Genetic Traits

Crop Trait	Description	GM Crop?
Bt	Resistance to Insects	yes
High Oil Corn	Increased energy	no
IMI or Clearfield	Resistance to Imidazolinone Herbicide	no
Liberty Link	Resistance to Glufosinate Herbicide	yes
Roundup Ready	Resistance to Glyphosate Herbicide	yes
STS	Tolerance to Sulfonylurea Herbicides	no
White Wheat	White Bran	no

pool. Since the genetic code is similar in all living things, genes can be removed from one organism and spliced into another. These spliced genes are called “transgenes” and resulting organisms are called “transgenic.” Transgenes allow breeders to incorporate completely novel traits into crop varieties.

Of course, not all new traits are the result of genetic engineering. Table 1 lists some new varieties that were developed through conventional breeding methods and some that are GM crops. The distinguishing feature of GM crops is that new traits are derived from artificially inserted genes.

Benefits of GM Crops

Due to the research investment required to support genetic engineering, agricultural biotechnology companies have focused on genetic traits where economic incentives are readily apparent. These economic incentives have been primarily enhancing revenue (i.e., higher yield or quality) or decreasing average production costs (i.e., less herbicide or insecticide inputs to achieve the same yield).

Insect resistance and herbicide resistance traits have dominated the first generation of GM crops. Disease resistance has been added to several horticultural crops as well. One reason for the rapid adoption of GM food and feed grains is because they reduce the average cost of production. In addition, these GM traits often simplify pest management for producers. An environmental benefit is reduced use of insecticide or fungicide sprays. However, herbicide use may be unchanged or even increase.

In the next generation of GM crops, there will be more emphasis on providing benefits to consumers. New genetic traits could result in food that tastes better, has better nutritional content, better shelf life, or has fewer detrimental compounds such as allergens. Other future GM crops will have special traits of interest to food processors or industrial users. New specialty oils or proteins, biodegradable plastics, pharmaceuticals, and edible vaccines are all being developed.

Risks of GM Crops

Risk factors of GM food and feed grains that are most commonly cited include human health, environmental, and social or ethical risks.

Health risks of GM crops could include transfer of antibiotic resistance from GM crops to human or animal disease pathogens, production of new toxins or carcinogens, or transfer of allergens to new crop varieties. Although the probability of antibiotic resistance transfer is considered low, many genetic engineers are now switching away from using antibiotic resistance as a selectable marker. Responsibility for testing for toxins, carcinogens, and allergens rests with the developers and is regulated by the EPA, FDA, and USDA. Regulations are under review to determine whether they need to be strengthened or made more transparent to the public.

Potential environmental risks may include escape of GM traits into weedy relatives or to disease pathogens, nontarget effects (e.g. monarch butterfly caterpillars affected by GM corn pollen), or buildup of resistance to GM crops (e.g. European corn borer could become resistant to *Bt* toxin).

Scientists recognize potential escape of GM traits as an important risk. The amount of risk depends on the particular GM trait and the particular recipient crop species. For example, sorghum, sunflower, and canola might be able to pass foreign genes to their wild relatives. Corn and soybeans are low risk because they cannot cross with weedy relatives. Nontarget effects also are important to consider, but publicized risks of *Bt* corn to monarch butterflies may have been overstated. Pests may adapt to GM traits just as they do to conventional pesticides or host resistance, so special management strategies will be needed.

Some critics contend that GM crops will have detrimental effects on the social or ethical structure of our world. Specific concerns are concentration of economic power into a few large multinational companies, erosion of rural communities, loss of biodiversity of agricultural systems, and “playing God” with natural species barriers. Some activists are particularly concerned about monopolization of agriculture by certain companies. They see GM crops as a power grab and a threat to the sustainability of rural communities. Finally, some people have a moral objection to scientists moving DNA from one species to another. Individuals must evaluate these social and ethical issues for themselves.

Current Controversy

Why is concern over GM food and feed grains important to U.S. producers? Recently, the EU, Japan, Thailand, and others have expressed concerns over GM food and feed grains. In many respects, this controversy resembles the current beef hormone debate. Consumer groups are lobbying to ban GM food and feed grains, increase regulation, and require labeling. Others argue that the controversy is nothing more than a trade barrier. To better understand this problem, it is helpful to look at trade factors that may have an effect on the debate.

U.S. Corn and Soybean Exports

A key demand driver for U.S. corn and soybeans is export markets. In addition, feed ingredients such as corn gluten and soybean meal also are key exports. Factors such as exchange rates and world demand and supply influence the relative percentage of exports from year to year.

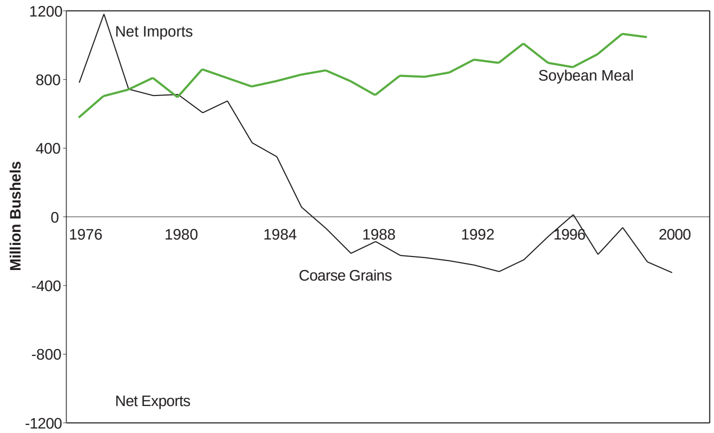
The United States accounted for almost half of total world soybean production (about 6000 million bushels annually) and almost 60 percent of total world trade in soybeans over 1995 to 1999 (USDA). Exports accounted for approximately 30 percent of total U.S. soybean use from 1995 to 1999 (USDA). This has averaged 15 percent for soybean oil and 20 percent for soybean meal over this same time period. The EU and Asian countries such as Japan and China are key export markets for soybeans. The United States is the largest exporter of soybeans to the EU accounting for approximately 40 percent of their needs over the 1995 to 1999 time period. Demand for non-GM soybeans is driven by non-GM food use (soybean oil).

With respect to corn, USDA reported that the United States produced approximately 40 percent of total world corn (about 23000 million bushels) over this same time period. Approximately 20 percent of this was exported. Corn gluten feed, a by-product of wet milling production, is a key export to the EU and accounted for approximately 85 percent of their imports over the 1996 to 1999 time period.

Almost 85 percent of corn exports are fed to livestock. However, some corn is used in food processing where the demand for non-GM corn is likely to be high. Failure to segregate corn for this market may result in greater demand for non-GM corn. Within the United States, approximately 15 percent of production is used in food processing and sweetener industries where demand for non-GM corn is likely to be highest.

A key figure to note is that the EU imports corn gluten and exports coarse grains. These are both used as livestock feeds. Corn gluten imports have been allowed due to recent trade agreements, which makes this feed more competitive as an energy source than coarse grain production. Figure 2 indicates that the EU has switched from being a net importer of coarse grains to a net exporter

Figure 2. *EU-15 Coarse Grains Exports and Soybean Meal Imports, 1976 to 1999 (USDA)*



in the mid-1980s. Much of this is due to increased yields. In particular, yields averaged 66 bushels per acre in the 1980s and 77 bushels in the 1990s (over 80 bushels in last 5 years alone). Much of the initial EU concern over GM food and feed grains has been directed at corn varieties rather than soybeans.

How might GM food and feed grains be linked to these trade issues? Limiting corn exports through failure to approve certain *Bt* corn varieties would likely force EU livestock producers to use coarse grains as livestock feed, which also would reduce EU exports and reduce their existing budgetary outlays to support these exports. The recent entrance into the EU of Spain and Portugal, which are both large importers of U.S. corn, has become a large market for EU-produced coarse grains.

Conclusions

There are legitimate health, environmental, and social concerns about the risks of bio-engineered crops. However, it is almost impossible to make blanket statements about GM crops since each GM trait and crop is different. Risks of GM crops must be assessed on a case-by-case basis. This process depends on a strong, credible regulatory system. USDA, EPA, and FDA share responsibility for this regulatory system in the United States. The GM crops and foods that are currently on the market have been thoroughly evaluated for safety. Although our regulatory system has approved them, many of our trading partners are unconvinced of the safety of GM crops. Likewise, several food processing companies have decided to avoid GM crops. This trend leads to uncertainty in the market place for GM crops.

Producers have identified the following risks: there could be a substantial price spread between GM and non-GM food and feed grain; to capture premiums, non-GM grain may have to be stored on farm, non-GM grain may have to be transported to special collection points; and there may be legal liability if grain sold as non-GM gets contaminated by GM grain. At the present time, if any economic incentives (e.g., premiums) for non-GM food and feed grains are present, they are likely to exist in regions where the grain is used in domestic or export food production for human consumption.

Growers will have to balance these changing risks against the added value of the GM crop in their production system. One way to monitor the news on GM crops is to visit the K-State Agricultural Biotechnology Web site (http://www.oznet.ksu.edu/biotech/). A key concern will be the performance of GM crops relative to non-GM crops. You can find this information by visiting the KSU Crop Performance Test web site (http://www.ksu.edu/kscpt/).

Segregation of GM and non-GM production will probably increase, especially among producers who plant corn and soybeans that are used in food processing. These producers will require economic incentives to produce non-GM products due to higher input and segregation costs. Longer-term, there may be some smaller markets for livestock feed for use in labeling "non-GM fed" meat products. With respect to Kansas, much of the corn and soybeans are used as feed inputs to livestock. Unless consumer concerns change quickly and permanently, it is unlikely that there will be short-run economic incentives for Kansas producers with non-GM corn and soybeans. However, over time, markets may develop and early adopters may receive economic incentives for non-GM production.

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