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GENETICALLY ENGINEERED CROPS

INTRODUCTION

The development of genetically engineered (GE) crops in the United States has become an increasingly controversial topic due to consumer safety, environmental, and economic concerns. Labeling in particular is an issue. There are currently only four states that have laws related to labeling food containing GE ingredients. One labeling bill was introduced in the Wisconsin Assembly during the 2013-2014 session, but the bill did not make it out of committee. This brief provides background on GE crops, the major issues of debate, and what is being done on the state and federal level to regulate GE crops.

HISTORY OF GENETIC MODIFICATION

For several thousand years, farmers have utilized techniques to improve crop quality and reduce the negative impacts of pests on crops. Gone unchecked, pests such as insects and weeds can cause crop failure or a decline in harvest. Traditional methods of achieving desired crop traits have relied on natural selection and selective breeding where farmers would keep the seeds from previous successful crops for later reuse. In some circumstances, traditional methods have provided adequate crop success. However, such methods rely on existing genetic variations within a species and may take several years to achieve a desired crop trait.

Herbert Boyer and Stanley Cohen demonstrated that DNA could be transferred across species by successfully transferring frog DNA into bacterial cells in 1973. Their study was the first to demonstrate that DNA could be transferred across species. This advancement in genetics has allowed scientists to alter crop DNA and achieve desired traits. Such traits can include resistance to disease, pests, and herbicide; an increase in nutritional value and shelf-life; and certain taste and cosmetic characteristics. Many traits have the potential to increase crop yield, allowing farmers to produce more product without needing additional land. Although genetic advances have provided farmers with new breeding methods, some concerns have been raised as to whether or not GE crops should be produced or used for human consumption.

The FDA approved the first GE crop, known as the Flav'r Sav'r™ tomato, for human consumption in 1994. The tomato was modified to prolong maturation, which prevented it from over ripening before arriving at the supermarket. Since the tomato's introduction, the market for GE crops has grown to include crops such as corn, soybeans, and cotton. As a result of the increased growth of GE crops, many processed foods such as cereals, soft drinks, and chips contain ingredients derived from such crops.

GENETIC ENGINEERING

Crops can be genetically engineered by artificially inserting genes known as "transgenes" from one organism to another, known as the host. One method of insertion of new genes may be achieved using a gene-gun. The gene-gun technique utilizes biologically inert particles (meaning they will not react with any biological substance) such as gold or tungsten atoms. The particles are coated with the desired genes, then they are "shot" into the host's plant tissue, which incorporates

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the new DNA material into the plant's DNA. Another method of gene insertion utilizes the soil bacterium known as *Agrobacterium tumefaciens*, which contains the necessary cellular components to transfer DNA from one species to another. Once a transgene is incorporated into a GE crop's DNA, the crop will express the trait regulated by the transgene.

TYPES OF GE CROPS

The GE crop profile in the United States largely consists of corn, soybeans, and cotton. Herbicide-tolerance, insect-resistance, and stacked-gene varieties are the most common modifications found in the commercial market. Stacked-gene varieties combine herbicide-tolerance and insect-resistance into one plant. In recent years, the adoption of crops that contain stacked genes has risen substantially. The United States Department of Agriculture (USDA) reports that as of 2014, 76% of corn and 79% of cotton acres are composed of stacked gene varieties.

Herbicide-tolerant (HT) crops are engineered to survive certain types of herbicide applications. Farmers commonly apply herbicide to crops in order to prevent weeds from outcompeting crops for resources such as nutrients, space, and light. Crops that have been genetically engineered to resist herbicide allow farmers to use herbicide on their crops without worrying about the herbicide affecting the crop.

Insect-resistance is also commonly found in several GE crops. Insect-resistant crops are engineered to contain a gene from a soil bacterium known as Bt (*Bacillus thuringiensis*). Once the gene is integrated into the crop genome, the Bt gene causes the crop to produce Bt toxin, which kills insects such as the European corn borer, root worm, and corn ear worm. An insect-resistant crop that has been engineered to produce Bt toxin is commonly referred to as a Bt crop.

Current research on GE crops has developed a possibility of one day having crops that are tolerant to extreme weather conditions such as drought, heat, or freezing. In addition to extreme weather tolerance, future crops could be engineered to produce vaccines, biofuels, and higher nutrient content. Although future advances in GE technology could provide beneficial crop traits, scientists must also examine the effects of how transgenes may affect other genes of an engineered crop, which can result in other unintended effects that could prevent a GE crop being commercialized.

GE CROP DEBATE

The debates for and against the production of GE crops include safety, environmental, and economic issues. Proponents argue that GE crops are safe for human consumption, are environmentally sound, and could aid in the fight against malnutrition. Citing concerns over feeding a growing world population, proponents have also stated that GE crops must be used in order to avoid food shortages and price spikes. Critics state that GE crops pose a health risk for consumers and cause environmental degradation. Over the past couple of years, both parties have expressed ideas and concerns about labeling initiatives, prompting legislators to attempt to address their concerns through introduced legislation.

Proponents believe that GE crops, such as Bt corn and cotton, provide a safer alternative to using pesticides and other toxic chemicals which have been shown to negatively affect human and environmental health. Depending on the pesticide, some have been shown to negatively impact the nervous system and hormone regulation. Studies have also linked certain pesticide use with degradation of air, soil, and water quality. Those who support GE crops believe consuming crops that contain residual amounts of pesticide is more harmful than consuming crops that have been modified.

Overall insecticide use has decreased among GE seed adopters and non-GE seed adopters since 1995. Applications of insecticide in the United States have been reduced from 0.21 pound per planted corn acre in 1995 (before the commercial introduction of Bt corn) to 0.02 pound per plant corn acre in 2010. With the exception of a large increase in insecticide applications during a boll weevil infestation, insecticide use for cotton has also exhibited a decreasing trend over the past two decades. The reduction in insecticides can also be attributed to area wide use of Bt crops. Many studies have found evidence that such use has reduced the populations of certain insects, allowing farmers to rely less on insecticides.

Although insect-resistance may offer some reductions in insecticide applications, opponents are concerned with the negative impacts associated with planting Bt crops. As insects are exposed to Bt crops, some populations that survive exposure and reproduce could develop a resistance to Bt toxin over time. Subsequent generations of those insects could result in populations of Bt-resistant insects that are no longer negatively affected by Bt toxin. In response to the potential of Bt-resistance, the EPA required that Bt crop growers must comply with mandatory refuge requirements. The requirements state that a sufficient amount of acreage of non-Bt crops must be planted near Bt crops. The effectiveness of the requirement depends on insects from both crop sections mating together and successfully reproducing generations that are still susceptible to Bt toxin. A 2008 study monitored refuges over the course of a decade and concluded that the mandate has reduced the rate of evolution of Bt resistance among insects.

GE technology supporters believe that some social issues, such as malnutrition, can benefit from GE crops. In 2004, scientists successfully completed a trial harvest of "golden rice," which was genetically engineered to produce beta-carotene, a precursor of vitamin A. Scientists have suggested that golden rice could be an effective method of alleviating vitamin A deficiency. Such deficiency can cause vision loss, impaired immune functions, and birth defects. A study published in *The American Journal of Clinical Nutrition* found that golden rice was more effective than spinach, and just as effective as pure beta-carotene in oil, in providing vitamin A to children. Currently, golden rice is produced in the Philippines in an effort to alleviate malnutrition.

Opponents believe introducing GE crops into the environment will cause irreparable harm to the natural diversity of the ecosystem through unwanted gene transfer. Studies have observed that some HT crops have affected neighboring nonresistant plants, which now express the genes for herbicide tolerance. Unwanted gene transfer for herbicide tolerance can create "superweeds," which are resistant to traditional herbicides. As weeds develop a resistance to herbicides, farmers may end up using more herbicide than originally anticipated and subsequently offset the benefits associated with planting HT crops.

The abundance of GE crop ingredients found in the United States food supply has raised concerns over whether foods containing such ingredients should be labeled. Proponents of labeling argue that consumers have a right to know whether or not their food has been genetically engineered. Some proponents cite personal or religious concerns about consuming products that may have ingredients containing DNA from a different organism. Labeling opponents state that adding a label to all products containing GE ingredients would make a product appear to be harmful or different from products without GE ingredients. Opponents also say that adding labels would be cumbersome for small businesses.

Public opinion polls indicate that Americans overwhelmingly support federal legislation that would require labeling of GE foods. However, in unprompted polls that asked about what types of labels they would like to see added to food, less than 1% suggested GE food labels.

Both proponents and opponents of GE crops contend that scientific evidence bolsters their claims with respect to the safety of consuming GE crops. However, there are no scientific, peer-reviewed studies that have confirmed that GE crops are unsafe for human consumption. The American Association for the Advancement of Science has stated that GE crops are the most-studied and tested crops in the food supply. Several hundred peer-reviewed studies have examined the effects of feeding GE food to a variety of animals. Such studies have generally concluded that consuming GE food does not produce detrimental effects, even in cases when the projects were long-term and examined multiple generations of animal test-subjects.

ECONOMIC IMPACTS OF GE CROPS

The economic effects of GE crops felt by farmers is highly dependent on the type of crop(s) grown. Although studies have generally indicated that the adoption of Bt corn or cotton produces a net increase in economic return, some evidence from studies that focus on Bt corn suggests that profitability depends on the level of pest infestations.

For many reasons, food that is labeled as non-GE may sometimes be more expensive than foods containing GE ingredients. Although GE crops do not increase yield potential, studies have come to different conclusions about whether GE or non-GE crops produce a higher overall yield. However, a 2009 publication from the Union of Concerned Scientists reviewed multiple studies and concluded that GE crops have only made modest contributions to yield increases. The report also stated that most of the gains seen in recent years are attributed to traditional breeding and agricultural practices.

Additionally, non-GE crops must subsequently undergo a segregation process while being transported to processing and distribution facilities. Complete segregation of GE and non-GE foods is very difficult because agricultural land, transport, storage, and processing facilities are typically shared by multiple organizations within the food industry. To ensure the purity of non-GE products, quality assurance testing, certification, and traceability costs must be incurred. Added onto the compensation suppliers receive for selling non-GE products, the additional costs are passed onto the consumer in the form of higher prices.

It is unclear how much mandatory labeling would affect food prices. Reports have alluded to increases of only a few thousand dollars per year to over $1 billion per year. The differences in cost estimates are attributed to the different assumptions made in the calculations, such as the level of response from the food supply chain. If the food industry must make changes to labels, those changes will cause a small increase in production costs relative to significant increases associated with manufacturing incurred by the segregation requirements if a manufacturer decides to only use non-GE ingredients.

Another possible scenario could include actual changes to the ingredients. The industry may decide to switch to non-GE ingredients to avoid the negative stigma. In addition to added costs of using non-GE ingredients, it is possible that a food manufacturer would need to switch the ingredient with something different such as using potato starch rather than corn starch. Such change could alter the taste or texture of a product and potentially have a negative impact on sales due to customer dissatisfaction.

GE CROPS IN WISCONSIN

Wisconsin currently grows GE corn and soybeans. Since 2000, the percentage of planted GE crops in Wisconsin has grown substantially (see Table 1). According to the USDA, 92% of all corn planted in Wisconsin is GE. Wisconsin's GE corn profile is composed of insect-resistant (3%), herbicide-tolerant (17%), and stacked gene (72%) crop varieties. In 2014, 95% of all soybeans planted in Wisconsin were GE. That figure is up from 51% in 2000.

Table 1: Genetically Engineered Wisconsin Crop Varieties, 2000 and 2014

Modification Type	2000	2014
	Percent of all corn planted	
Insect-resistant (Bt) corn. . . .	13	3
Herbicide-resistant corn	4	17
Stacked gene corn	1	72
All GE corn varieties	18	92
	Percent of all soybeans planted	
Herbicide-tolerant soybeans . .	51	95

Wisconsin's GE crop profile is similar to the overall profile of corn and soybeans in the U.S. For 2014, 93% of corn, 94% of soybeans, and 96% of cotton planted in the U.S. was genetically modified (see Table 2). Scientists are optimistic that the next several decades could exhibit a dramatic change in the U.S. GE crop profile. Ongoing research and development for engineered crops that produce vaccines, supplemental nutrients, or pharmaceuticals could one day comprise a sizable portion of the total GE crop production in the U.S.

Table 2: Genetically Engineered U.S. Crop Varieties, 2000 and 2014

Modification Type	2000	2014
	Percent of all corn planted	
Insect-resistant (Bt) corn. . . .	18	4
Herbicide-resistant corn	6	13
Stacked gene corn	2	76
All GE corn varieties	25	93
	Percent of all soybeans planted	
Herbicide-tolerant soybeans . .	54	94
	Percent of upland cotton planted	
Insect-resistant (Bt) cotton. . .	15	5
Herbicide-tolerant cotton . . .	26	12
Stacked gene cotton	20	79
All GE upland cotton varieties	61	96

LEGISLATION IN WISCONSIN

2013 Assembly Bill 874 was introduced by Representatives Taylor, Clark, Genrich, Ohnstad, and Wright, and cosponsored by Senators Risser, Erpenbach, and Harris, on March 18, 2014. It was referred to the Committee on Consumer Protection, but failed to progress further and it died in committee. The bill sought to require any GE food to have a label and prohibit retailers from selling such items without a label indicating the presence of GE ingredients. Some exemptions to the labeling requirement were provided, such as food produced from animals that may or may not have consumed GE products and unpackaged food prepared by restaurants. Certain processed foods containing GE ingredients would have been exempt from the labeling requirements until July 1, 2020. If the bill had passed, the labeling requirement would not have gone into effect until one year after enactment.

CURRENT LAW

Section 146.60 of the Wisconsin Statutes governs the release of GE organisms into the environment. This section was created by 1989 Wisconsin Act 15. It requires a notification to the state at least seven days prior to the release of a GE organism into the environment. If a person fails to notify the state, they will be required to pay up to $25,000 in penalties and potentially serve up to one year in jail. This section was amended by 1997 Act 283, which provided up to a two year prison term for subsequent notification violations. In 2001, Act 239 further amended the financial and imprisonment penalties for subsequent violations.

Federal law gives regulatory jurisdiction over GE products to three agencies: the Food and Drug Administration (FDA), the USDA Animal and Plant Health Inspection Service (APHIS), and the Environmental Protection Agency (EPA). Federal policy over GE product safety is determined by the properties of the product, such as chemical composition, rather than the way it was produced.

OTHER STATE LAWS

Several states have laws and regulations in place that prevent producers from labeling genetically engineered products as organic. However, the state of Maine allows foods containing less than 1% of genetically engineered ingredients to be labeled as GE ingredient free. Other states have laws that address the sale and labeling of genetically engineered seeds. Currently, two states have laws that require labels for any genetically engineered seeds: Vermont and Virginia.

Only four states have passed legislation related to labeling foods containing GE ingredients. In 2007, Alaska enacted a law requiring all GE fish and fish products to be labeled and many other states have recently considered legislation that would require any food containing GE organisms to be labeled. On May 8, 2014, Vermont passed 2014 Act 120. The act requires food products containing GE ingredients to be labeled as such. Pending the outcome of a lawsuit challenging the law, any food sold in Vermont by a retailer after July 1, 2016, must be labeled if it is entirely or partially produced with genetic engineering. Laws passed in Connecticut and Maine also require food containing GE ingredients to be labeled, however Connecticut's law will not go into effect until at least four other states adopt similar legislation, and Maine's law will not go into effect until at least five other states follow suit.

According to Lexis, 20 state legislatures currently have introduced bills that, if passed, would require labels on any food product that contains ingredients derived from GE crops. Colorado and Oregon are currently the only states with ballot measures, Proposition 105 and Measure 92, respectively, which will be voted on in the November 2014 general election. Such legislation is strongly supported by consumer advocacy groups and organic farmers. Opponents of labeling legislation include many agricultural biotech companies, some farmers, and scientists. Currently, federal regulations do not require foods containing GM products to be labeled. However, crop producers and manufacturers may voluntarily label their products as such.

SOURCES

Barry, Gerard. *Golden Rice and Vitamin A Deficiency*. Accessed September 2012. http://www.scribd.com/fullscreen/82525883?access_key=key-2nv27h0ahnrlbv23yg4f.

Christou, Paul, and Dennis McCabe. "Direct DNA Transfer Using Electric Discharge Particle Acceleration (ACCELLTM Technology)." *Plant Cell, Tissue and Organ Culture* 33, no. 3 (1993): 227-228. doi: 10.1007/BF02319006.

Cohen, Stanley N., et al. "Construction of Biologically Functional Bacterial Plasmids *In Vitro*." *Proceedings of the National Academy of Sciences*, 70, no. 11 (1973): 3240-3244. doi:10.1073/pnas.70.11.3240.

Fernandez-Cornejo, Jorge, et al. "Genetically Engineered Crops in the United States." *Economic Research Report* 162. Washington, DC: United States Department of Agriculture, 2014. http://www.ers.usda.gov/media/1282246/err162.pdf.

Fish, Andrew C., and Larisa Rudenko. *Guide to U.S. Regulation of Agricultural Biotechnology Products.* Washington, DC: Pew Charitable Trusts, Pew Initiative on Food and Biotechnology, September 2001. http://www.pewtrusts.org/uploadedFiles/wwwpewtrustsorg/Reports/Food_and_Biotechnology/hhs_biotech_0901.pdf.

Gillam, Carey. "U.S. GMO crops show mix of benefits, concerns – USDA report." *Reuters*, February 24, 2014, US edition. http://www.reuters.com/article/2014/02/24/usda-gmo-report-idUSL1N0LT16M20140224.

Kiil Leber, Sandra. "Biotechnology: Curse or Cure?" *State Government News* 43, no. 1 (January 2000): 23-26.

National Conference of State Legislatures. "Biotechnology Statutes Chart." October 2012. http://www.ncsl.org/research/agriculture-and-rural-development/state-biotech-statutes.aspx.

Phillips, Theresa. "Genetically Modified Organisms (GMOs): Transgenic Crops and Recombinant DNA Technology." *Nature Education* 1, no. 1 (2008): 213. http://www.nature.com/scitable/topicpage/genetically-modified-organisms-gmos-transgenic-crops-and-732.

Singh, Om V., et al. "Genetically Modified Crops: Success, Safety Assessment, and Public Concern." *Applied Microbiology and Biotechnology* 71 (August 2006): 598-607. doi: 10.1007/s00253-006-0449-8.

United States Department of Agriculture. "Genetically engineered (GE) varieties of corn, upland cotton, and soybeans, by State and for the United States, 2000-2014." Accessed October 31, 2014. http://www.ers.usda.gov/datafiles/Adoption_of_Genetically_Engineered_Crops_in_the_US/alltables.xls.

United States Department of Agriculture. "Recent Trends in GE Adoption." Last modified July 5, 2012. http://www.ers.usda.gov/data-products/adoption-of-genetically-engineered-crops-in-the-us/recent-trends-in-ge-adoption.aspx.

Van Eenennaam, Alison, et al. "The Potential Impacts of Mandatory Labeling for Genetically Engineered Food in the United States." *Issue Paper* 54. Ames, IA: Council for Agricultural Science and Technology, April 2014. http://www.cast-science.org/file.cfm/media/products/digitalproducts/CAST_Issue_Paper_54_web_optimized_29B2AB16AD687.pdf.