Unit 5 Genetically-Engineered Food
Lesson 2: All in Favor, Say Aye

Whenever you accept our views we shall be in full agreement with you. Moshe Dayan (1915-81). Israeli general.¹

The use of biotechnology, genetically engineered agricultural and food production practices have not been without their critics and controversy from many different groups. According to Schlenker and Long, the use of genetic modification for food crops remains controversial. However, with the use of Mendel’s principles of inheritance,² selection and breeding practices resulted in "...the green revolution of the 1960s and 1970s..." which in turn resulting in a doubling of crop yields. "This transformation in crop production are [sic] credited with helping to reduce the food shortages in the developing world” (2008, page 215).³

Illustration: Mendel’s Genetics

In cross-pollinating plants that either produce [sic] yellow or green pea seeds exclusively, Mendel found that the first offspring generation (f1) always has yellow seeds. However, the following generation (f2) consistently has a 3:1 ratio of yellow to green. (2000)⁴

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This 3:1 ratio occurs in later generations as well. Mendel realized that this was the key to understanding the basic mechanisms of inheritance. (2000)\(^5\)

The inheritance of each trait is determined by "units" or "factors" that are passed on to descendents unchanged, individuals inherit one such unit from each parent for each trait, a trait may not show up in an individual but can still be passed on to the next generation. (2000)\(^6\)

Mendel's observations from these experiments can be summarized in two principles: the principle of segregation and the principle of independent assortment. (2000)\(^7\)

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Segregation of alleles in the production of sex cells (2000)\(^8\)

According to the principle of independent assortment, different pairs of alleles are passed to offspring independently of each other. The result is that new combinations of genes present in neither parent are possible. For example, a pea plant's inheritance of the ability to produce purple flowers instead of white ones does not make it more likely that it will also inherit the ability to produce yellow pea seeds in contrast to green ones. Likewise, the principle of independent assortment explains why the human inheritance of a particular eye color does not increase or decrease the likelihood of having 6 fingers on each hand. (2000)\(^9\)

Schlenker and Long identify three primary goals related to genetic modification of food plants

1. **Resistance to disease and insects**: Plants have a better tolerance to weed-killing herbicides or carry a protein that acts as a built-in insecticide.
2. **Increased tolerance to weather conditions**: Crops have improved ability to withstand more extreme environmental conditions.
3. **Increased nutritional value**: Improved grains with increased protein and micronutrients could lessen the continuing nutrient deficiency in developing countries.

(2008, page 215, ¶1)\(^{10}\)

According to the USDA’s Agricultural Biotechnology Web site, the “USDA supports the appropriate use of science and technology, including biotechnology” (2008).\(^{11}\) Key reasons for the USDA’s support and involvement in biotechnology for food production is

...to help meet agricultural challenges and consumer needs of the 21st century.

USDA plays a key role in assuring that products produced using biotechnology are safe to be grown and used in the United States. Once these products enter

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commerce, USDA supports bringing these and other products to the worldwide marketplace. (2008)¹²

In 1992, the Food and Drug Administration published a policy explaining how existing legal requirements for food safety apply to products developed using the tools of biotechnology. It is the agency’s responsibility to ensure the safety of all foods on the market that come from crops, including bioengineered plants, through a science-based decision-making process. This process often includes public comment from consumers, outside experts and industry. FDA established, in 1994, a consultation process that helps ensure that foods developed using biotechnology methods meet the applicable safety standards. Over the last five years, companies have used the consultation process more than 40 times as they moved to introduce genetically altered plants into the U.S. market. (2008)¹³

Advantages of Genetically Modified Foods

According to statistics available through the CSA Web site, the world population exceeds 6 billion people with a project increase to 12 billion within the next 50 years. Due to the steadily increasing population ensuring an adequate food supply is a major concern. The use of genetic modification has distinct advantages according to CSA:

- **Pest resistance:** Crop losses from insect pests can be staggering, resulting in devastating financial loss for farmers and starvation in developing countries. Farmers typically use many tons of chemical pesticides annually. Growing GM foods such as B.t. corn can help eliminate the application of chemical pesticides and reduce the cost of bringing a crop to market
- **Herbicide tolerance:** For some crops, it is not cost-effective to remove weeds by physical means such as tilling, so farmers will often spray large quantities of different herbicides (weed-killer) to destroy weeds, a time-consuming and expensive process, [sic] that requires care so that the herbicide doesn't harm the crop plant or the environment. Crop plants genetically-engineered to be resistant to one very powerful herbicide could help prevent environmental damage by reducing the amount of herbicides needed.
- **Disease resistance:** There are many viruses, fungi and bacteria that cause plant diseases. Plant biologists are working to create plants with genetically-engineered resistance to these diseases
- **Cold tolerance:** Unexpected frost can destroy sensitive seedlings. An antifreeze gene from cold water fish has been introduced into plants such as tobacco and potato. With this antifreeze gene, these plants are able to tolerate cold temperatures that normally would kill unmodified seedlings
- **Drought tolerance/salinity tolerance:** As the world population grows and more land is utilized for housing instead of food production, farmers will need to grow crops in locations previously unsuited for plant cultivation. Creating plants that can withstand long periods of drought or high salt content in soil and groundwater will help people to grow crops in formerly inhospitable places.


• Nutrition: Malnutrition is common in third world countries where impoverished peoples rely on a single crop such as rice for the main staple of their diet. However, rice does not contain adequate amounts of all necessary nutrients to prevent malnutrition. If rice could be genetically engineered to contain additional vitamins and minerals, nutrient deficiencies could be alleviated.

Extended Shelf Life
Whitney and Rolfes discuss a key benefit to using bt foods; the extension of shelf life “...promotes less waste and higher profits” (2002, page 673-673). For example, vegetables such as bt tomatoes contain a gene that instead of triggering decomposition after picking blocks the “...softening enzyme...” in the protein and “...without this protein, the genetically altered tomato softens more slowly than a regular tomato allowing growers to harvest it at the most flavorful...vine-ripe stage” (2002, page 673-673).

Efficient Food Processing
Extended shelf life is a benefit to both growers and grocers. Foods with delayed decomposition characteristics can be transported over greater distances which saves money. Whitney and Rolfes provide an example of how the protein rennin, used to coagulate milk in the production process for cheese traditionally came from the stomach of live calves. Today, scientists use a copy of the rennin gene for insertion into bacteria which in turn allows bacterial cultures “...to mass produce rennin—saving time, money and space (2002, page 673-673).

Biopharming
Since scientists are now able to clone animals, the use of cloned animals for pharmaceutical research and development is considered an important benefit to the use of biotechnology. While the pharmaceutical industry is not the same as the food industry, any technological advances and breakthroughs in biopharming contains the potential for application in bt foods (2002, page 673-673).

Improved Nutrient Composition
An important benefit to using bt foods relates to nutrient composition. “Genetic engineering can also improve the nutrient composition of foods. Genetically modified crops contain a potential for increased phytochemicals that help maintain health and reduce the risks of chronic diseases 2002, page 673-673).

Food Safety Regulation of bt Foods
To ensure a safe food supply the US Congress enacted legislation and directives to the United States Department of Agriculture (USDA) in 1906. Primary responsibilities included the inspection of food producers such as meatpacking plants, poultry farms and processing plants. A second agency, the US Food and Drug Administration (FDA) has regulatory responsibility for safety of foods except meat and poultry. This combined agency approach and “...interagency cooperation is...
essential for mounting an effective response to new food-related threats to health” (Schlenker & Long, 2008, page 216-217)19

“Food producers have a responsibility to ensure that their foods are safe and in compliance with applicable legal requirements” (Frank, 2008, page 113).20

Support for the Use of Biotechnology

A position statement by the American Dietetic Association on biotechnology says:

It is the position of the American Dietetic Association (ADA) that biotechnology techniques have the potential to be useful in enhancing the quality, nutritional value, and variety of food available for human consumption and in increasing the efficiency of food production, food processing, food distribution and waste management. (Frank, 2008, page 114, ¶1).21

IN 2005, the National Academy of Sciences identified foods from biotechnology (bt) crops as safe, with oversight needed. According to Frank, “A Gallup poll reported 14% of Americans with limited awareness and 80% believing grocery store foods are safe to eat” (2008, page 111, ¶3).22 Gail Frank discusses how the “FDA states that bt foods present no inherent risk and, therefore, are regulated as food. Because of the federal Food, Drug, and Cosmetic Act, the FDA uses characteristics of the food as the basis for regulation and decision making” (2008, page 115, ¶).23

Organizations with Statements Supporting Biotech (bt) Foods

- American Council on Science and Health: http://www.acsh.org/
- American Culinary Federation, Inc: http://www.acfchefs.org/AM/Template.cfm?Section=Home6
- Institute of Food Technologies: http://www.ift.org/cms/
- Council for Biotechnology Information: http://www.whybiotech.com

Summary

According to CSA, 2000,

Genetically-modified foods have the potential to solve many of the world’s hunger and malnutrition problems, and to help protect and preserve the environment by increasing yield and reducing reliance upon chemical pesticides and herbicides. Yet there are many challenges ahead for governments, especially in the areas of safety testing, regulation, international policy and food labeling. Many people feel that genetic engineering is the

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inevitable wave of the future and that we cannot afford to ignore a technology that has such enormous potential benefits. However, we must proceed with caution to avoid causing unintended harm to human health and the environment as a result of our enthusiasm for this powerful technology.\textsuperscript{24}

Schlenker and Long pose a viable question for nutrition educations to think about as well as a caveat related to the benefits of using bt foods.

Will our impressive new technologies meet the needs of the future? Optimists would say yes. Biotechnology holds a word of promise and with the proper safeguards and controls, [sic] it may yield products that meet the needs of consumers almost perfectly.