

7C-3

Objectives

- Explain how genetic engineering is used to modify plants
- Describe some potential adverse environmental impacts of genetically modified plants

7C-3 Genetically Modified Plants

DNA technology is being applied to plants as well as humans. The same basic research techniques of genetic engineering studied in the previous sections can be used in plant research. Some of the characteristics that researchers are working to achieve by genetic engineering include increased flavor and nutrient content, herbicide and pest resistance, and easier transportation. Plants that have undergone genetic engineering are called **genetically modified (GM) plants**.



7C.4

Genetically engineered Bt cotton effectively prevents damage from many pests, increasing the crop yield per acre.

Flavr Savr Tomatoes and Golden Rice

Most tomatoes in the grocery store outside of the normal growing season are picked green, transported, and then ripened by exposure to ethylene gas. If the tomatoes are left on the vine until they are fully ripe, they are easily bruised during shipping and spoil rapidly. The Flavr Savr tomato was marketed in 1994. It was the first whole GM food approved for sale in the United States. It was developed so that it could remain on the vine until fully ripe and then be shipped without spoiling. However, the Flavr Savr tomatoes were pulled from the market in 1997 because of bruising during transportation, poor taste, and financial problems in the company.

The World Health Organization estimates that 124 million children worldwide get an insufficient amount of vitamin A in their diet. A half million children go blind each year as a result of vitamin A deficiency, and another one to two million die. Golden rice was produced to help overcome this problem. Genes from a bacterium and a daffodil were inserted into the rice's genome. As a result, golden rice produces beta carotene. Once the rice is eaten, the body converts beta carotene into vitamin A. One would think that farmers would be rushing to plant golden rice; however, since no one knows what effect the GM rice might have on the environment, none is being grown.

Pest-Fighting Crops

Farmers are constantly fighting pests that can destroy their crops. Often this fight requires multiple applications of poisons that may also kill helpful insects and could contaminate nearby water supplies. Researchers found that the spores from a soil bacterium named *Bacillus thuringiensis* contain a crystalline protein with an interesting property. Once ingested by the insect, the protein breaks down and releases a toxin that causes perforations in the gut wall, killing the insect. The researchers were able to identify the location of the bacterial gene, snip it out, and insert it into the genome of corn. The Bt corn, as it is called, produces the protein, and when an insect begins to eat the corn plant, it is killed. There are also Bt varieties of cotton and soybeans.

In addition to insect pests, farmers also fight plant pests, or weeds. They must select herbicides that will spare the crop while killing the ~~noncrop plants~~. ~~Using recombinant DNA technology, researchers have~~ developed soybeans and corn that are herbicide resistant. Farmers can plant these strains of corn or soybeans that will survive the herbicides used to control weeds.

GM Plants as Food

Are GM plants being used to produce GM food for humans? Yes, primarily from two crops: corn and soybeans. Ingredients from these crops are widespread in processed food. It is estimated that as much as 60% of the food on the grocer's shelves have some GM food component. There are currently twelve GM plants that are approved for commercial production in the United States. Since GM and non-GM crops are often not separated during processing, it is possible that food containing ingredients from any of the twelve approved crops might contain some GM components. Table 7C-1 shows where GM products might be found in food.

The Future of GM Plants and Foods

Since the production and use of GM plants is relatively new, there are no long-term studies that document their safety and their impact on the environment. In the United States, several government agencies are responsible for ensuring the safety of GM plants. They include the Environmental Protection Agency (EPA), the Department of Agriculture (USDA), and the Food and Drug Administration (FDA).

Much of the concern about these products is their potential impact on human health and the environment. For example, some people fear that the new proteins produced in GM plants might be toxic to humans or that the traits that produced herbicide-resistant plants could be transferred to wild varieties, producing "super weeds." The bacteria that are used as vectors are often resistant to certain antibiotics. If these bacteria remain

viable, some fear they will lead to a more rapid emergence of antibiotic-resistant bacteria. For these reasons, some countries have banned the importation of any GM plants or foods.

Another concern is the ownership of GM plant technology. Companies that spend millions of dollars on the development of new GM crops will certainly want financial success. If there is no demand for the product, there will be little incentive to plant the crop, even though it requires less of the chemical pesticides and herbicides or even though it has potential health benefits. A demand for the product might price the seeds beyond what farmers could afford to pay.

Considering the potential blessings and dangers in genetically modified plants may seem unimportant compared to the other aspects of biotechnology discussed in this chapter. However, these issues are no less a part of the dominion mandate than stem cell research or gene therapy. Investigating and weighing the effects of GM plants on the environment and on other humans are a part of fulfilling man's duty to exercise wise and good dominion over the earth under God. All of God's creation is precious to Him, its Maker. Likewise, it should be precious to us, its governors.

Table 7C-1 GM Versions of Food Crops

Food type	Likely to be found in food products	Comments
Soybeans	Yes	These are mostly herbicide resistant. Some estimate that over 70% of soybean crop is of some GM variety, typically found as soybean oil, flour, or protein extracts in processed food.
Corn	Yes	Over 30% of field corn crop is GM. Growers do not separate GM and non-GM corn; therefore, if a product includes corn, it is likely to contain some GM corn. Sweet corn (that which is sold as fresh ears) is much less likely to be GM—probably around 3%–5%.
Canola	Yes	Around 60% is GM. Canola oil is used in vegetable cooking oils, processed cheese, many “nondairy” products, cosmetics, soap, chocolate, and salad dressings.
Cotton	Yes	Over 70% of crop is GM varieties. Cotton seed oil is used in many products, such as peanut butter, pastries, chips, crackers, and cookies.
Tomato	No	Although the Flavr Savr tomato was on the market in the mid-1990s, it was pulled due to poor performance. Other approved varieties have not made it to consumers.
Potato	Unlikely	These comprise a very small portion of crop. Poor sales caused the developer to stop production.
Squash, sugar beets, rice	Unlikely	GM varieties have been developed, but either farmers are reluctant to plant them due to consumer concerns (European markets are closed to GM foods), or they are awaiting approval by the appropriate government agencies.
Salmon	Not at this time	Although GM salmon have been reported in the news to be faster growing than non-GM salmon, they have not been approved for human consumption. In fact, no GM animals have been approved for human consumption.