

Genetically Modified Food

An Introduction to the Ethical Issues in Genetically Modified Foods

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Let's begin with a pop quiz—True or False:

1. All plants contain genes.
2. Only genetically modified plants contain genes.
3. Plants can be modified to contain animal genes.
4. A tomato containing a jellyfish gene would taste like squid.
5. Genetically modified foods are available at Safeway.
6. I have never eaten a genetically modified food.

The answers are true, false, true, false, true, and . . . most likely, false. The truth is that we have been eating genetically modified (GM) foods for a decade. About 75 percent of processed food that is produced in the United States contains some GM ingredients. This includes crackers, breakfast cereals, and cooking oils. Almost everything that contains soy or corn—including the nearly ubiquitous high fructose corn syrup—has been genetically modified.

Humans were modifying crops long before the advent of genetics and "modern" biotechnology. Once humans began to practice settled agriculture some 8000 years ago, they selected which plants to plant, grow, and harvest—first choosing from the wild and then from cultivated crops. These first farmers chose plants that grew well *and* demonstrated resistance to disease, pests, and shifting weather patterns. Ever since, farmers have bred, crossed, and selected plant varieties that were productive and useful. These age-old techniques can now be complemented, supplemented, and perhaps supplanted by an assortment of molecular "tools" that allow for the deletion or insertion of a particular gene or genes to produce plants (animals and microorganisms) with novel traits, such as resistance to briny conditions, longer "shelf-life," or enhanced nutrient content. A change in a plant's genetic sequence changes the characteristics of the plant. Such manipulation of genes—genetic engineering—results in a genetically modified organism or GMO.

Both "traditional" biotechnology and "modern" biotechnology result in crops with combinations of genes that would not have existed absent human intervention. A drought-resistant crop can be developed through "traditional" methods involving crosses with resistant varieties, selection, and backcrossing. Modern biotechnology can speed up this process by identifying the particular genes associated with drought resistance and inserting them directly. Whether developed through traditional or modern means, the resultant plants will resist drought conditions but only the second, genetically engineered one, is a GMO or, if meant for human consumption, a GMF.

Genetic engineering has both sped up the process of developing crops with "enhanced" or new characteristics and allowed for the transfer of genes from one organism to another, even from great evolutionary distances, such as the insertion of a gene from an African frog into rhododendrons to confer enhanced resistance to root rot. Moving genes between species creates transgenic plants and crops.

Importantly, genetic engineering is not the whole of agricultural biotechnology, which also includes techniques such as tissue and cell culture. This conference primarily concerns itself with a small piece of agricultural biotechnology, the genetic engineering of food crops.

The most commonly grown GM food crops are those that have been engineered to withstand herbicide spraying (e.g., Roundup Ready soybeans and corn) or to produce substances toxic to insects (e.g., *Bt* corn). Crops that can tolerate herbicides have been an economic success story—approximately 80 percent of the U.S. market in soybeans and cotton is in plants that can withstand the popular herbicide Roundup.

To date, most of the development of GM crops—dubbed "first generation crops"—has been aimed at benefiting the farmers' bottom line—increasing yields, resisting pests and disease, and decreasing the use of herbicides. Over 80 percent of the soybeans and 40 percent of the corn grown in the U.S. is genetically modified. Worldwide, close to a billion acres are planted in GM crops, mostly corn and soy for animal consumption.

The first GM food produced was the Flavr Savr tomato in 1994, touted for its flavor and long shelf life. Interestingly, the Flavr Savr tomato did not contain an alien gene; rather, a gene normally present in the tomato was blocked so that a normal protein involved in ripening was not produced giving the tomato a longer shelf life and, theoretically, better flavor. It failed to attract consumers.

Despite the tomato's flop, so-called "second generation" crops will once day line supermarket shelves. These include products such as Monsanto's Roundup Ready soybeans with reduced trans fats and increased heart-healthy mono-unsaturated fats; Syngenta's StayRipe banana, which ripens slowly and has a prolonged shelf life; potatoes and peanuts less liable to trigger life-threatening allergic reactions; and tomatoes that help prevent cancer and osteoporosis (Stokstad, Eric: "Monsanto Pulls the Plug on Genetically Modified Wheat," *Science* 304:1088, 2004; Associated Press: "Americans Clueless about Gene-altered Foods," MSNBC.com, March 26, 2005).

Also in the pipeline are GM crops designed to produce pharmaceuticals, so-called "pharma crops." Last year, the California Rice Commission advised the state Food and Agriculture Department to allow Ventria Bioscience of Sacramento to grow 50 hectares of GM rice near San Diego. Ventria planned to grow two types of rice modified with synthetic human genes—one to make human lactoferrin to treat anemia and the second to produce lysozyme to treat diarrhea (Dalton, Rex: "California Edges towards Farming Drug-producing Rice," *Nature* 428: 591, 2004). Anemia and diarrhea plague children under 5 in developing countries. But the California Food and Agriculture Department denied Ventria's request after rice growers expressed concern that international customers would refuse their rice out of fear of contamination. Earlier this week (4/12/05), brewer Anheuser-Busch threatened to boycott rice from Missouri if Ventria is allowed to set up its "biopharming" practices there. Again, the concern is the potential that the GM rice could cross-pollinate other crops and introduce foreign genes and proteins into the human food chain.

INB Biotechnologies (Philadelphia) is developing a nontoxic anthrax vaccine through the

transgenic modification of petunias, causing the plant to manufacture new proteins, which when eaten prompt the development of anti-anthrax antibodies. So, instead of "eat your peas," the imperative will be to "eat your petunias!"

The advent of GM crops provides new opportunities for increasing agricultural production and productivity, enhancing nutritional value, developing and delivering pharmaceuticals and vaccines, and feeding the world. But, it is far from easy sailing for GM foods in light of the public concern for associated risks—risks to human and animal health; risks to biodiversity and the environment—and intermittent consumer outrage at not knowing if "the breakfast of champions" has had a genetic boost or not. GM foods are not labeled as such and the industry game of "I've Got a Secret" has bred distrust among consumers and fuels an inherent skepticism about the safety of GM foods.

A common approach to thinking about the ethics of the genetic engineering of food crops and the appropriate regulatory environment is by evaluating safety and weighing potential risks and benefits.

The risk side of the ledger includes (Food and Agriculture Organization of the United Nations):

1. First are potential risks to the environment and wildlife.
 - a. Genes may "escape" and find their way into other members of the species or other species. Imagine the trouble if herbicide-resistant genes found their way into weeds.
 - b. GM crops could compete or breed with wild species threatening biodiversity.
 - c. Monogenetic crops may not react sufficiently to environmental stresses, posing the danger of an reenactment of Ireland's potato famine.
 - d. What are the risks to birds, insects and other non-target species that come into contact with or consume GM plants?
2. Second are potential risks to human health.
 - a. There is the potential that allergy-producing genes will be inserted into unrelated foodstuffs. Since GM foods are not labeled, a person could suffer a potentially fatal allergic reaction, e.g., an allergenic Brazil nut gene was transferred to a soybean variety, but the resultant modified crop was never released to the public.
 - b. GM products may inadvertently enter the human food supply as evidenced by the settlement earlier this month between Syngenta and the U.S. government over the accidental sale of unapproved GM (Bt10) corn seed to farmers.
3. Third are potential socio-economic effects.
 - a. Small-scale farmers could be negatively impacted by the market dominance of a few powerful seed companies. Some worry about the potential loss of traditional farming practices such as collecting, storing, and replanting seed.

- b. The proprietary nature of biotechnology may slow basic research, and patent protection may hinder the entry of GM foods into developing countries as has been the case with pharmaceuticals.
4. Fourth is the potential risk to public trust generated in part by industry refusal to label GM foods as such.

The benefit side of the ledger stresses:

1. First, there are potential benefits to agricultural productivity through the development of crops more resistant to pests, disease, and severe weather, decreasing the risk of devastating crop failure.
2. Second are potential benefits to the environment including:
 - a. Improved productivity could result in more food from less land and a decreasing reliance on the cultivation of marginal land.
 - b. Genetically engineered pest and disease resistance could reduce the need for pesticides and other chemicals, thereby decreasing the environmental load and farmer exposure to toxins.
 - c. The potential longer shelf life of fruits and vegetables could decrease the gross wastage associated with transportation and storage.
3. Third are potential benefits to human health and wellbeing.
 - a. Genetic engineering could be used to remove genes associated with allergies, e.g., the blocking of the gene that produces the allergenic protein in peanuts.
 - b. The insertion of genes into crops such as rice and wheat can enhance their nutritional value, e.g., Golden Rice.
 - c. Genetic modification could be used to produce healthier foods, e.g., by eliminating trans fats or caffeine for example.
 - d. Genetic engineering could be used to develop pharmaceuticals and vaccines in plants, decreasing the risk of adverse reactions and enabling faster vaccination of large populations.

Although weighing risks and benefits is necessary, it is neither easy nor the sole concern in considering the ethics of agricultural biotechnology. Certainly, both human wellbeing and environmental safety are of primary concern; but our ethical obligations are not discharged solely by a guarantee of some degree of protection from harm, as important as that is. We also must be concerned with justice and the common good—raising concerns about human and environmental sustainability and the just distribution of nutritious food *and* acknowledging the need for thoughtful regulation that addresses necessary human and environmental protections while pursuing benefit. Such a task might well begin with a good dose of humility.

And so, we approach the "future of food" and the questions we have before us today:

Should we have genetically modified foods?

And, since we do, how ought they be regulated?

How do we weigh values and risk in biotechnology?

And, finally, is the genetic modification of food necessary to relieve world hunger?

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