



Eleven Things to Know about GMOs

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1. What is a GMO?

A GMO, or Genetically Modified Organism (also call genetically enhanced or transgenic organism), refers to a plant or animal with DNA altered using one of a variety of genetic engineering methods. A GMO is not a single type of crop nor is it a crop variety – it is technique (or tool) that can be used in many different ways for many different purposes. Sometimes GMOs are equivalently called Genetically Engineered (GE) crops. Transgenic GMOs have DNA from another species inserted into its genetic code. Cisgenic GMOs have DNA from a member of the same species. Other techniques “silence” or “turn off” existing genes in a plant or animal.

2. Why are crops genetically modified?

By modifying the genetic material in an organism, the plant can exhibit traits that are desirable for the environment or humans, either for farmers producing the plant or for consumers. For example, crops have been modified to produce a compound preventing pests (primarily bugs) from feeding on them, which protects yield and quality. Other plants have been modified to tolerate certain broad spectrum herbicides (weed killers and suppressors). This allows producers to use herbicides that are less persistent in the environment, meaning they rapidly degrade to relatively benign compounds when contacting soil or exposed to sunlight. This encourages adoption of no-till technology because it has allowed farmers to control weeds without having to disturb the soil through tillage. By using gene-modifying technology, decades or more can be shaved off traditional crop breeding practices.

Some food crops have been genetically modified to improve shelf life, so less food is wasted. Others are more nutritious than naturally occurring varieties. For example, golden rice, a GMO variety that produces beta carotene, which the body then converts to vitamin A. Vitamin A is important in prevention of blindness. Children in many developing countries suffer from higher rates of blindness because diets, which rely on rice as a staple crop, are deficient in vitamin A.

3. Are GMOs safe to eat?

There have been hundreds of studies testing the safety of GMO-derived foods, and long-term tests involving mil-

lions of animals. The evidence overwhelmingly supports the safety of eating currently approved GMO-derived foods. As concluded by the Swiss National Science Foundation, GM food crops are the most studied food crop ever (http://www.nfp59.ch/e_index.cfm). Scientists who advise governments, including the United States Food and Drug Administration (<http://www.fda.gov/ForConsumers/ConsumerUpdates/ucm352067.htm>) and European Union Academies Science Advisory Council (<http://www.easac.eu/home/reports-and-statements/detail-view/article/planting-the.html>), have concluded that currently approved GMO-derived foods are safe for both humans and animals to consume. The UN's World Health Organization also stated that currently approved GMO-derived foods are safe (http://www.who.int/foodsafety/areas_work/food-technology/faq-genetically-modified-food/en/). All crop breeding (conventional and GMO alike) involve risks, but all major scientific authorities have concluded that GMO crops are no riskier than conventionally bred crops.

References: Nicolia A, Manzo A, Veronesi F, Rosellini D. Crit Rev Biotechnol. 2013 Sep 16.

Van Eenennaam, A. L., & Young, A. E. (2014). “Prevalence and impacts of genetically engineered feedstuffs on livestock populations.” *Journal of Animal Science*, 92(10), 4255-4278.

4. What crops in the U.S. are genetically modified?

USDA Animal and Plant Health Inspection Service lists the status of applications for GMO approvals at https://www.aphis.usda.gov/biotechnology/petitions_table_pending.shtml. The list includes apples, rice, papaya, corn, soybeans, cotton, potato, sugar beet, canola (rapeseed), tobacco, tomato, squash and some ornamental plants. Not all of the GM food crops are sold in grocery stores. The major commercial applications of GMOs that have been widely adopted are corn, cotton, canola, papaya, soybeans and sugar beets. As of 2015, there is no commercial production of GMO rice or wheat.

5. What are the environmental effects of GMOs?

GM crops must be shown to be relatively safe for the environment before becoming available for planting by farmers. USDA Biotechnology Regulatory Service “... evaluates genetically engineered organisms to ensure they are as environmentally safe as their traditionally bred counterparts, and thus can be used freely in agriculture” (<http://www.usda.gov/documents/BIOTECHNOLOGY.pdf>). No GM crops can

be produced without USDA approval. A large-scale review of the scientific literature found that adoption of GMOs has reduced chemical pesticide use by 37 percent and has increased crop yields by 22 percent. By increasing yield, less land is needed to produce a given quantity of food, meaning sensitive environmental lands are less likely to be brought into cultivation. As indicated, herbicide-resistant crops have facilitated adoption of no- and low-till farming, which helps prevent topsoil erosion.

Reference: <http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0111629>

6. Do farmers to use more pesticides with GMOs?

No. Actually the reverse is true. In 2014, the USDA concluded “insecticide use has decreased with the adoption of insect-resistant crops, and herbicide-tolerant crops have enabled the substitution of glyphosate for more toxic and persistent herbicides” (<http://www.ers.usda.gov/media/1282246/err162.pdf>).

7. How are GMOs regulated?

In the U.S., three agencies, Environmental Protection Agency, Food and Drug Administration, and Department of Agriculture, play a role in regulating GMO crops. EPA regulates GM crops with bio-pesticide markers. FDA ensures GM crops grown for human and/or animal consumption are safe. USDA Animal and Plant Health Inspection Service is required to assure GM crops are not a threat to existing plants (<http://www.fda.gov/ForConsumers/ConsumerUpdates/ucm352067.htm>).

8. Are GMOs banned in Europe?

No. The European Union has approved the consumption of most of the major GMO crops used in the U.S. There is, however, less cultivation of GMOs in Europe as the EU has been slower to give approval for cultivation. GMO corn is grown in Spain and a few other EU countries. The EU imports large quantities of GMO soybeans from North and South America, mainly for use in animal feed. In Europe, GM foods are required to be label as such if 1 percent or more of the product is derived from GM crops. As a result, few GMO-derived foods are sold (<http://www.cfr.org/agricultural-policy/regulation-gmos-europe-united-states-case-study-contemporary-european-regulatory-politics/p8688>) except for products from animals fed GMO corn and soybeans, which are not required to be labeled.

9. Should food companies be required to label foods with GMOs?

There are several existing voluntarily labeling programs, such as the USDA organic certification, which provides consumers choices on this matter in the marketplace. Thus, the question isn't whether GMOs should be labeled, but rather whether labels should be mandatory. Typically, U.S. regula-

tions have required mandatory disclosures to those products known to affect health outcomes for some of the population (e.g., the fat content or whether a product contains peanuts). Because the preponderance of the evidence indicates that currently approved GMOs do not affect human health, GMOs have not required a label. A major concern of opponents of mandatory labeling is that it may stigmatize GMO-derived foods, and grocers may not shelve them. The result is that food manufacturers may begin to source more expensive, non-GMO foods, which will increase food prices. It may be the case that companies selling newer consumer-oriented GMOs such as the arctic apple which does not brown, will actively advertise the presence of GMOs because of the benefits conveyed to the consumer.

10. What are the economic effects of farmers using GMOs?

Farmers evidently believe GMOs are beneficial because they have voluntarily chosen to pay higher prices to buy GMO seed. In 2015, USDA reports that 92 percent of corn, 96 percent of cotton and 94 percent of soybeans grown in the U.S. were genetically modified. Clearly, farmers find economic advantages to raising GM crops. A review of the research found adoption of GMOs increased farmer profits by 68 percent. Formal economic analyses also show farmers profit from growing GMOs, although there is some downside due to trade disruption with importing countries.

Reference: <http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0111629>

11. What are the potential downsides of GMOs?

It is possible to imagine certain genetic modifications could harm human health (e.g., introducing a peanut gene into corn might lead to unexpected allergenic responses). While none of the currently approved crops are of this sort, and the FDA regulatory process is designed to prevent this outcome, it remains a theoretical possibility. The implication is that each new GMO should be considered on a case-by-case basis.

Adoption of herbicide-resistant varieties has probably helped contribute to the development of herbicide-resistant weeds. This is not a problem unique to GMOs. There are several herbicide-resistant weeds that have developed in non-GMO crops, but it is likely that weed resistance has probably been hastened by widespread GMO adoption.

Some people are concerned about the involvement of large agribusiness seed and chemical companies in the food supply chain. It is true that current GMO crops are produced and sold by large companies, but consolidation in the farm sector was underway long before the advent of GMO crops, and has occurred in sectors where there are no GMOs. Concerns about consolidation and concentration are therefore not unique to GMOs. Moreover, there are many Universities, non-profits and small start-ups working on new GMO applications.

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