

# GE Science

## GMO: Frequently Asked Questions

### The Basics of GMOs

#### ***What is genetic modification?***

Genetic modification, also known as “genetic engineering,” is a technologically advanced way to select desirable traits in crops. While selective breeding has existed for thousands of years, modern biotechnology is more efficient and effective because seed developers are able to directly modify the genome of the crop.

Plants that are genetically engineered (GE) have been selectively bred and enhanced with genes to withstand common problems that confront farmers. These include strains of wheat that are more resistant to drought, maize that can survive pesticides, and cassava that is biofortified with additional nutrients.

In addition to resistance-based attributes and biofortification, some GM crops can produce higher yields from the same planted area. GM crops have the potential to strengthen farming and food security by granting more certainty against the unpredictable factors of nature. These resistances and higher yields hold great promise for the developing world and for global food security. Yet, controversy remains over access to this biotechnology, corporation patents on certain plant strains, and claims regarding the safety and quality of GM foods as compared to non-GM foods.

#### ***Why are seed developers genetically modifying organisms?***

Genetic modification can protect crops against threats to strong yields, such as diseases, drought, pests, and herbicides used to control weeds, and therefore improve the efficiency of food production. While farmers have been selectively breeding plants for centuries, genetic engineering allows new traits to be developed much more quickly. Utilizing traditional selective breeding can take multiple growing seasons to develop and test a new variety. Genetic engineering is more precise than conventional hybridization and therefore is less likely to produce unexpected results. For example, mutagenic breeding is not considered genetic engineering yet it exposes plant material to radiation or chemicals to create varieties with new traits.

#### ***GMOs seem to be in the news a lot lately. Is the GMO process new?***

GMOs are in the news a lot right now, but not because they are new. They have actually been in our food supply for nearly 20 years. Farmers have been using hybridization and mutation breeding of crops to improve their resistance to pests or environmental conditions for decades. But scientists began to sufficiently understand the genetic makeup of certain plants to be able to modify genes that

would strengthen the plants' ability to resist new pests or diseases and thus improve yields so that farmers began planting GMO crops in the mid-1990s.

## **GMOs and the Environment**

### ***What are the effects of genetic modification on the environment?***

In order to feed a world population that is expected to top 9 billion by 2050 and to do so in ways that do not harm the environment, farmers will need to roughly double current production levels on about the same amount of land. Genetically modified crops are more efficient and therefore use less agricultural inputs to produce the same amount of food. From 1996-2012, without GM crops the world would have needed 123 million more hectares of land for equal crop production.[i] GM technology reduced pesticide use by 8.9% in the period from 1996- 2011.[ii] Because genetically modified crops require less ploughing and chemical usage, GM technology can reduce fossil fuel and CO2 emissions. Genetic engineering can therefore help to ameliorate the effects of agriculture on the environment. Farming accounted for 24 percent of global greenhouse gas emissions in 2010 and 70 percent of freshwater use.[iii] Additionally, scientists are developing GM crops that are resistant to flood, drought, and cold, which improves agricultural resistance to climate change. GM crops also allow for greater use of no-till cultivation, which helps with carbon sequestration, soil erosion prevention, and better soil fertility.[iv]

## **GMOs and Human Health**

### ***How are GM crops related to nutrition and food security?***

Genetic modification can improve the nutritional profile of food and therefore serves as a key element in reducing global rates of malnutrition. For instance, golden rice is enhanced with beta-carotene and therefore provides a dose of vitamin A, a nutrient lacking in many diets around the world. Vitamin A deficiency leads to the death of nearly 700,000 children each year, so golden rice is a crucial initiative in reducing malnutrition.[v] Additionally, in India, using Bt corn led to the consumption of more nutritious foods, including fruits, vegetables, and animal products because of increased incomes. Another study in India showed that each hectare of Bt cotton increased caloric intake by 74 calories per person per day and that 7.93% of households using Bt cotton were food insecure as opposed to 19.94% of those using non-GM cotton.[vi]

### ***What is the scientific consensus of the impact of GM foods on humans?***

From 2003-13, 1,783 studies showed no human or environmental dangers from genetically engineered crops, with a study concluding that "the scientific research conducted thus far has not detected any significant hazard directly connected with the use of GM crops."[vii] The European Commission released a meta study of 50 research projects and found that "the use of biotechnology and of GE plants *per se* does not imply higher risks than classical breeding methods or production technologies."[viii] One study in 2013 suggested that consumption of GM foods affected the health of

lab animals, but the study's publication was subsequently pulled and its findings undermined because of digressions from standard scientific research principles.[ix]

## **GMOs: Farmers and their Crops**

### ***Why use genetic engineering if other methods are just as effective at boosting productivity?***

Genetic engineering research has focused on overcoming problems that affect productivity, such as disease, weeds, and pests. When crops can avoid disease, weeds, and pests, crop yield is enhanced. Genetic modification is only one of the tools that farmers can use to boost productivity, and it does not eliminate the need for other advances such as hybridization, agricultural chemicals, and farm machinery. Rather, genetic modification is a technologically advanced application of biotechnology that works in conjunction with other modern agricultural practices.

### ***Are there examples of how genetic engineering has been able to strengthen plants in order to help them survive?***

Yes. In the early 1990s, papayas in Hawaii were hit with Papaya Ring Spot Virus, devastating the crop with a 40 percent reduction in just five years. Scientists developed two varieties of papaya that were resistant to the virus, and today healthy papayas are now growing in Hawaii. [x]

### ***How widely are GE seeds being accepted and used by farmers across the globe?***

These statistics tell the story of the level of acceptance and use of GE seeds by farmers of plots large and small, in both the developed and developing world. According to the independent International Service for the Acquisition of Agri-biotech Applications (ISAAA), a not-for-profit organization, the global area of biotech crops for 2012 was 170.3 million hectares, grown by 17.3 million farmers in 28 countries, with an average annual growth in areas cultivated of approximately 6%. More than 90% of farmers growing biotech crops are resource-poor farmers in developing countries.[xi]

### ***With both an increased cost to the farmer and the largest focus of GE crops mainly on staple crops, is the opportunity for using GE mostly limited to farmers in developed countries?***

No. Interestingly, according to the International Service for the Acquisition of Agricultural Biotechnology Applications “of the 28 countries that plant transgenic crops, 20 are developing countries....(and) 90% of those who grew biotech crops – that is, more than 16 million – were resource-poor smallholder farmers in developing countries.”[xii]

### ***How does the use of GM technology affect smallholder farmers in developing countries?***

Genetic modification helps to eliminate some of the problems faced by smallholder farmers, such as droughts, pests, and crop disease. From 1996-2013, genetic modification added \$116.9 billion to the agricultural sector, and more than 50% went to farmers in developing countries. In 2013, over 16 million smallholders in developing countries grew biotech crops. Fifteen million smallholder farmers in Burkina Faso, China, India, Pakistan, and a few other developing countries grow Bt cotton. In

countries with weak or nonexistent extension services, farmers can face challenges in accessing GM seeds and in learning best practice growing techniques. Some countries ban the importation of seed while others exclude genetically modified seeds.

## **GMOs: Business and the Economy**

### ***What are the economic effects of GM crops?***

Genetic modification prevents crop loss due to disease, insects, and herbicides used to control weeds, resulting in more efficient production and potentially lower food prices. According to the World Bank, agricultural sector growth is the most effective pathway for reducing poverty and increasing food access. Genetically modified crops increase farmers' revenue by reducing some input costs, including for pesticides and water; reducing crop losses; and allowing farmers more time to pursue other labor activities. GM crops also reduce insurance costs for farmers by producing more consistent yields. For example, in India, smallholder farmers who planted *Bt* cotton earned 50% more with higher productivity per hectare and reduced pest damage.[xiii]

### ***Why do companies that are selling GE seeds have such tight controls over them?***

Because of tight government budgets, today much less research is being conducted in the public realm using tax dollars which would facilitate greater public access to that research.

Companies that are in the seed business are taking on the financial and research challenges to develop new seeds themselves. As a result of their substantial investments in time and money, these companies are filing patents on the seeds that they eventually bring to the farmer.

### ***Doesn't genetic engineering mainly benefit large agribusiness and the main global staple crops?***

The large seed companies, of which most are American, are making investments in research and production of technologies that respond to the global marketplace. They are less likely to invest in the genetic engineering of indigenous crops that are not globally traded but are nonetheless important locally. This has led critics to claim that GM will undermine biodiversity. Supporters, on the other hand, believe that GM has many benefits for neglected crops, especially when funded by the public sector. As mentioned above, the papaya crop in Hawaii was being consumed by a virus, and the industry faced failure until the introduction of a transgenic papaya turned it around. Researchers in Uganda and Kenya are showing positive gains on a wilt that affects bananas, by transferring two genes from green peppers. Other crops that researchers are working on include eggplants, blackeyed peas, and cowpeas.[xiv] Researchers have also recently finished sequencing the genome of Tef, Ethiopia's staple crop.[xv] Studies also show that small farmers in poor countries benefit from GM crops with increased incomes as a result of higher yields and lower input costs for fertilizers and pesticides.[xvi]

## **GMOs: Rules and Regulations**

***With companies then playing a significant role in developing new GE seeds, what are governments doing, if anything, to regulate these new biotechnologies?***

Governments on the national level across the globe are actively reviewing and regulating for approval these new technologies. Each new technology goes through a comprehensive regulatory review that in the United States also includes the opportunity for public comments. In 1986 the U.S. government created the Coordinated Framework for the Coordination of Biotechnology, with three agencies having primary responsibility for its implementation, the Food and Drug Administration, the Environmental Protection Agency and the Animal and Plant Health Inspection Service. [xvii]

***What about the push to eat more “natural” foods? Aren’t GMOs unnatural?***

There is actually no FDA regulation or specific definition of the term “natural” on food labels, so there is little merit to any label claiming that a food product is “natural.”[xviii] Typically, though, the term indicates that a food product is not highly processed and/or does not contain added colors or preservatives. Genetically modified crops are not “unnatural” under this definition.

***What is the controversy about labeling foods that contain genetically modified ingredients?***

There have been a number of state referendums that would require all foods to be labeled if they contain any genetically engineered ingredients. Proponents argue that consumers have the right to know what is in their food. Some studies have found that between 60-70 percent of food in the United States has some GM ingredients. Without any new state or federal laws, manufacturers of foods that do not contain GM may already label their products as GM-free if they choose.

Opponents suggest that this type of label would put a stigma on a farming technology that numerous studies show has no negative health implications. Additionally, labeling would require the adoption of significant changes in how crops are grown, stored, and processed that would result in increased food prices. One study by researchers at Cornell University estimated that the budget for a family of four could increase by an additional \$500 to \$800 a year under new labeling requirements. Different state rules for labeling would make it difficult for companies to comply.

***What does the organic label mean and what is its relationship to genetic engineering? Does an organic label mean it is GMO free?***

The National Organic Program was created by the Department of Agriculture in 2002 to regulate organic foods. Foods may only be labeled “organic” if grown by certified organic producers and processors. To obtain the organic certification, synthetic fertilizers and pesticides may not be used, nor can seeds that have been genetically engineered. Equally, food processors may not mix organic and nonorganic materials during processing. These products then are allowed to use the USDA Organic label.[xix]

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[i] James, Clive, "TOP TEN FACTS About Biotech/GM Crops in 2013," International Service for the Acquisition of Agri-Biotech Applications (ISAAA), March 5, 2014. [http://www.igtcglobal.com/files/news/Top\\_Ten\\_2013\\_Biotech\\_Facts\\_5\\_March.pdf](http://www.igtcglobal.com/files/news/Top_Ten_2013_Biotech_Facts_5_March.pdf)

[ii] ISAAA Brief 44-2012, Executive Summary, "Global Status of Commercialized Biotech/GM Crops: 2012," <http://www.isaaa.org/resources/publications/briefs/44/executivesummary/>

[iii] Searchinger T. et al 2013. *Creating a Sustainable Food Future*. Washington, DC: World Resources Institute.

[iv] Calestous Juma, "Societal Benefits of Agricultural Biotechnology. Global Status and Outlook, Testimony before the Committee on Agriculture, U.S. House of Representatives, July 9, 2014 <http://agriculture.house.gov/sites/republicans.agriculture.house.gov/files/pdf/hearings/Juma140709.pdf>

[v] The Bill and Melinda Gates Foundation. "What We Do. Agricultural Development. Golden Rice." <http://www.gatesfoundation.org/what-we-do/global-development/agricultural-development/golden-rice>

[vi] Qaim, Matin and Shahzad Kouser, "Genetically Modified Crops and Food Security," June 5, 2013. PLoS ONE 8(6). <http://www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0064879>

[vii] Nicolai, A., Manzo, A., Veronesi, F., and Rossellini, D. 2013. An Overview fo the Last 10 Years of Genertically Engineered Crop Safety Research. *Critical Reviews in Biotechnology*, 34(1).

[viii] European Commission, 2010, A Decade of EU-funded GMO Research. Brussels: European Commission p. 16.

[ix] "Elsevier Announces Article Retraction from journal Food and Chemical Toxicology," Cambridge, MA, November, 28, 2013. <http://www.elsevier.com/about/press-releases/research-and-journals/elsevier-announces-article-retraction-from-journal-food-and-chemical-toxicology>

[x] "What is Agricultural Biotechnology?", Cornell University, Agricultural Biotechnology Support Project II and Program for Biosafety Systems. [http://absp2.cornell.edu/resources/briefs/documents/warp\\_briefs\\_eng\\_scr.pdf](http://absp2.cornell.edu/resources/briefs/documents/warp_briefs_eng_scr.pdf)

[xi] Executive Summary, "Global Status of Commercialized Biotech/GM Crops: 2012," <http://www.isaaa.org/resources/publications/briefs/44/executivesummary/>

[xii] Ibid.

[xiii] Calestous Juma, "Societal Benefits of Agricultural Biotechnology. Global Status and Outlook, Testimony before the Committee on Agriculture, U.S. House of Representatives, July 9, 2014. <http://agriculture.house.gov/sites/republicans.agriculture.house.gov/files/pdf/hearings/Juma140709.pdf>

[xiv] Juma, 2014.

[xv] Cannarozzi, Gina et al, Genome and transcriptome sequencing identifies breeding targets in the orphan crop tef (*Eragrostis tef*). BMC Genomics 2014, 15:581. <http://www.biomedcentral.com/1471-2164/15/581>

[xvi] Carpenter, J.E. 2013. The socio-economic impacts of currently commercialized genetically engineered crops. *International Journal of Biotechnology* 12(4). P. 249, Zilberman D., Sexton, S.E., Marra, M., and Fernando-Cornejo, J., 2010, p. 5.

[xvii] U.S. Department of Agriculture, Biotechnology – Frequently Asked Questions (FAQs). <http://www.usda.gov/wps/portal/usda/usdahome?contentid=BiotechnologyFAQs.xml>

[xviii] U.S. Food and Drug Administration. What is the meaning of ‘natural’ on the label of food? <http://www.fda.gov/aboutfda/transparency/basics/ucm214868.htm>

[xix] Paarlberg, Robert. *Food Politics: What Everyone Needs To Know*. Oxford University Press, 2010.