GET TO KNOW GMOS AND THE ENVIRONMENT

This guide is designed to help you understand why over 18 million farmers globally[1] plant GMO crops, and better understand the role of plant biotechnology in agriculture and its environmental benefits.

Farmers may choose to grow GMO crops for a variety of reasons, including better yield, improved farm income, decreased labor intensity, and better overall crop management. One of the primary benefits of using GM seeds is reduced impact on the environment. For example, the use of fewer inputs and reduced soil tillage enhances farmers' ability to grow crops more sustainably.

Farmers choose seeds that are best for their farms and businesses. Soil, weather and other characteristics can vary on farms, even in the same geographic area, so seed choice is an individual matter for each farmer. **Farmers look for ways to grow crops using resources more efficiently, with less impact on the environment.** Farmers may choose GM seeds because they have a desired trait – such as insect or disease resistance – that best suits their business and/or growing conditions. To help farmers address their needs, the ten commercially approved GM crops in the U.S. were created for a variety of reasons, including:

REDUCING AGRICULTURE'S ECO-FOOTPRINT: GMOS HAVE HELPED FARMERS REDUCE THEIR ENVIRONMENTAL FOOTPRINT BY ALLOWING THEM TO USE FEWER INPUTS AND ENABLING A SHIFT TO REDUCED TILLAGE. THESE PRACTICES HAVE LED TO LESS TIME SPENT ON A TRACTOR, LESS FUEL USED AND FEWER EMISSIONS. AS A RESULT, GMOS HAVE HELPED REDUCE CO_2 EMISSIONS EQUIVALENT TO REMOVING 12.4 MILLION CARS FROM THE ROAD FOR ONE YEAR. THEY HAVE ALSO LED TO 1.2 BILLION POUNDS LESS PESTICIDES BEING USED BETWEEN 1996 AND 2013.[3]

Kilograms converted to pounds.

- **Resistance to harmful insects:** A farmer can use a GM seed containing one or more traits making it resistant to certain insects, such as the European corn borer. For example, the widespread use of Bt corn has suppressed this devastating insect that plagued farmers in the United States for nearly a century. The use of Bt corn has resulted in higher yield and reduced insecticide applications.
- **Resistance to certain herbicides:** Herbicide-tolerant crops developed through genetic engineering have enabled farmers to use more benign herbicides[2] and have led to an increase in no-till agriculture, preserving precious soil moisture and reducing greenhouse gas emissions by retaining carbon dioxide in the ground.
- **Resistance to diseases:** Farmers used GMO technology to save the papaya industry when it was threatened by disease. In the 1990s, virus-resistant papayas were adopted in Hawaii to combat the papaya ring spot virus, which had devastated many farmers' crops. The resistant Rainbow papaya now accounts for more than 75% of Hawaii's papaya production.[4]
- **Drought and heat tolerance:** GM seeds can also help farmers manage risks associated with adverse weather conditions. For instance, drought-tolerant corn includes a trait that can help the plant adapt and maintain kernel development when water is less available.[5] Additionally, researchers are looking for new ways to help crops adapt to rising temperatures.

BY USING GM SEEDS FARMERS MAY SEE SIGNIFICANT YIELD GAINS BECAUSE THEY LOSE LESS OF THEIR CROPS TO PESTS AND DISEASE. BETWEEN 1996 AND 2013, GM TECHNOLOGY WAS RESPONSIBLE FOR HELPING FARMERS PRODUCE AN ADDITIONAL 152 MILLION TONS OF SOYBEANS, 302 MILLION TONS OF CORN, 23.9 MILLION TONS OF COTTON LINT AND 8.8 MILLION TONS OF CANOLA.[3]

Metric tonnes converted to tons.

- **Reduction of food waste:** The Food and Agriculture Organization of the United Nations estimates that about one-third of food produced worldwide becomes waste. Much of that loss is in fruits and vegetables.[6] New fruit and vegetable crops have been developed so that they bruise less when handled or don't brown when exposed to oxygen, ensuring they remain appealing to processors and consumers. These traits may help reduce food waste in the U.S. at the farm, processor and table levels by hundreds of millions of pounds per year.[7] Less food sent to landfills means less methane emissions, one of the most harmful greenhouse gasses.[8]

[1] James, C. 2014. Global Status of Commercialized Biotech/GM Crops. ISAAA Brief No. 49. Retrieved from http://www.isaaa.org/resources/publications/briefs/49/default.asp

[2] Fernandez-Cornejo et. al. 2014. Genetically Engineered Crops in the United States. USDA Economic Research Report No. (ERR-162). Retrieved from http://www.ers.usda.gov/publications/err-economic-research-report/err162.aspx

[3] Brookes, G. and Barfoot, P. (2015). GM crops: global socio-economic and environmental impacts 1996-2013. Retrieved from http://www.pgeconomics.co.uk/page/38/

[4] The Rainbow Papaya Story. Retrieved from http://www.hawaiipapaya.com/rainbow.html

[5] Physiological responses related to increased grain yield under drought in the first biotechnology-derived drought-tolerant maize. (2014). Retrieved from http://onlinelibrary.wiley.com/doi/10.1111/pce.12446/pdf

[6] Cutting food waste to feed the world. (2011). Retrieved from http://www.fao.org/news/story/en/item/74192/icode/

[7] Simplot Plant Sciences. Retrieved from http://www.simplotplantsciences.com/. The advantages of a nonbrowning apple are clear. Retrieved from http://www.okspecialtyfruits.com/arctic-apples/advantages-nonbrowning-apple

[8] The Food Recovery Hierarchy. (2014). Retrieved from http://www.epa.gov/foodrecovery/

- **Improving manufacturing processes:** Certain biotech corn varieties enable more efficient biofuels production by improving the process by which cellulose and/or starch is broken down and converted to fuel.[9,10] This helps reduce the environmental impact by decreasing the amount of water, electricity and natural gas needed to produce ethanol.

In making targeted improvements to crops through genetic engineering, farmers can reduce the amount of land, water and chemicals needed to produce more food for a growing world population. GM crops will help meet the challenges that a changing climate presents and keep food affordable and accessible.

Both GM and non-GM seeds are available options for farmers to meet their needs. Farmers might choose conventional, non-GM seeds if:

- They are not facing significant pest or disease pressures that need to be managed by using GM seeds.
- GM seeds haven't been developed to combat their pest of concern.
- They are organic farmers, in which case they cannot or do not want to use GM seeds on their farms. Instead, these farmers may use organic or approved conventional seeds, along with pesticides deemed compatible with organic systems and cultural practices (e.g., rotations, tillage).

GMOS: SAFE FOR THE ENVIRONMENT

Crops from GM seeds are studied extensively around the world to make sure they are safe for the environment before they reach the market. Up to three U.S. government agencies review GM plants for food and environmental safety:

The data clearly demonstrate that GM seeds have environmental benefits, but some groups make claims that are not supported by fact. Here we correct some of those claims related to GMOs and their impact on the environment.

GMOs *are not* responsible for the development of "superweeds." Crops (both GM and traditional) rarely cross-pollinate with weeds, and farmers use various planting methods to prevent that from happening. Moreover, weeds that are resistant to herbicides - "superweeds" - are the result of reliance on a single method of weed control (not GMOs) that enables weeds resistant to that method to thrive.[11]

GMOs *do not* kill bees and butterflies. Before a genetically modified crop can be grown commercially, researchers developing GM crops must demonstrate that the new plants are not harmful to "non-target" insects, such as bees and butterflies.[12] Research shows that there is a variety of factors causing the deaths of both bees (e.g. pests and parasites like the Varroa mite, microbial disease, inadequate diet, loss of genetic diversity) and butterflies (e.g. deforestation, parasitism, ebbing populations of Monarchs' host milkweed and other nectar plants). Claims that GMOs directly kill bees and butterflies have been soundly debunked.[13]

GMOs *do* enhance biodiversity. Genetically engineered crops have reduced agriculture's impact on biodiversity by eliminating the need to bring more land into production, enhancing adoption of conservation tillage practices, reducing the need for insecticide use, and using more environmentally benign herbicides.[14] More beneficial insects and bacteria thrive and promote healthy, nutrient rich soil development by recycling organic material.

[9] Researchers genetically modify a crop to break down its own cellulose. (2008) Retrieved from http://www.technologyreview.com/news/409913/corn-primed-for-making-biofuel/

[10] Industrial Important Microbial alpha-Amylase on Starch-Converting Process. (2013) Retrieved from http://www.academia.edu/6079961/Industrial_Important_Microbial_alpha-Amylase_on_Starch-Converting_Process

[11] Weed Science Society of America Fact Sheet. Retrieved from http://wssa.net/wp-content/uploads/WSSA-Fact-Sheet-on-Superweeds_16-Sep-2014.pdf

[12] Ecological Non-Target Organism Risk Assessment process for Plant-Incorporated Protectants. Retrieved from http://www.epa.gov/oppbppd1/biopesticides/regtools/biotech-reg-prod.htm#nontarget

[13] Are GMOs contributing to the death of bees and butterflies? Retrieved from https://gmoanswers.com/studies/top-10-gmos-death-bees-and-butterflies

[14] Carpenter, J. (2011). Impacts of GM Crops on Biodiversity. GM Crops, 2(1), 7-23. Retrieved from http://www.agrobio.org/bfiles/fckimg/Carpenter - Impacts of GM Crops on Biodiversity.pdf.

LOOKING FOR MORE INFORMATION?

GMO Answers is a resource for information about GMOs and biotechnology in agriculture.

Explore: Visit the Explore the Basics section of our website, which offers information about GMOs and agriculture in a simple, visual and user-friendly format.

Ask: Visit our Ask section to submit a question and have it answered by an independent or company expert.

Engage: Join the conversation by posting a comment and participating in a constructive dialogue with other members of the community.

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