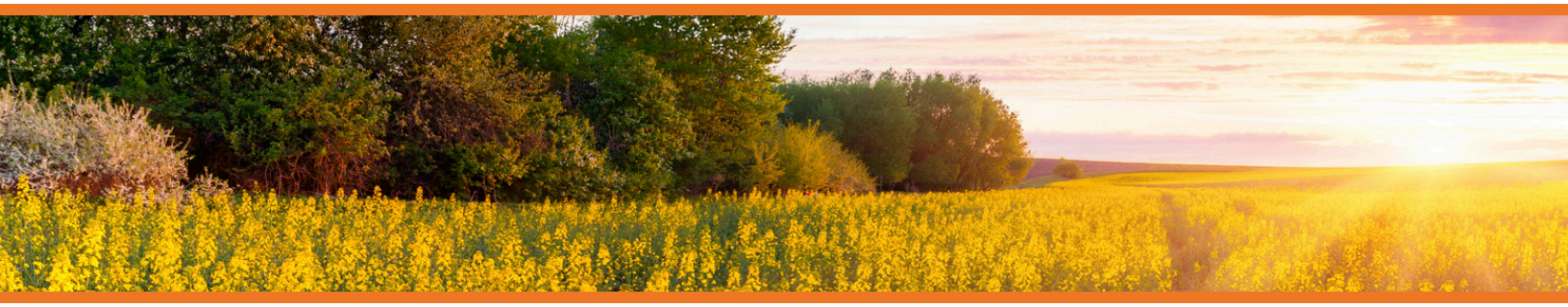
# GET TO KNOW GMOS



## A RESOURCE FOR YOU

GMO Answers was created to do a better job of answering consumers' questions—no matter what they are—about GMOs. Our goal is to make information about GMOs in food and agriculture easier to access and understand. We know consumers are skeptical of GMOs and want to understand more about their food, how it is grown and its journey from the farm to their table. The core of GMO Answers is an open, public conversation.

Independent experts from a wide array of disciplines are lending their time to this dialogue: farmers, nutritionists, academics, researchers and others with expertise about agriculture and GMOs. They are joined by employees of BASF, Bayer CropScience, Dow AgroSciences, DuPont Pioneer, Monsanto Company and Syngenta, members of the Council for Biotechnology Information (CBI), to help ensure consumers have facts available when making up their minds.

Visitors to GMO Answers have asked for help in communicating about GMOs in an easy-to-understand and transparent way. We designed this guide for you with this in mind, using information that can be found on GMO Answers. It's important for us all to be open to a conversation about GMOs, listen to concerns, tell your stories and provide straight answers. We hope this guide will help you when communicating about GMOs.

## WHAT IS A GMO?

**When people refer to genetically modified organisms (GMOs),they are speaking about those crops developed with genetic engineering.**

Plant breeders use dozens of plant-breeding techniques to create new varieties of crops with the traits or characteristics they need, for example, traits that are useful to farmers, such as resistance to insects, diseases or drought, or traits attractive to consumers, like increased levels of nutrients.

One of these techniques is genetic engineering, which enables plant breeders to take individual traits from one plant or organism and transfer it to the plant they are interested in improving. They can also use genetic engineering to make a change to an existing trait in a plant they are developing.

Genetic engineering differs from other plant-breeding techniques by enabling specific, predictable changes to be made to the plant.

**WHAT'S IN A NAME? GMO, GENETIC MODIFICATION, BIOTECHNOLOGY, BIOTECH SEEDS, GENETIC ENGINEERING**

THE TERM "GENETICALLY MODIFIED ORGANISM," OR "GMO," IS COMMONLY USED TO DESCRIBE ANY OF THE TERMS ABOVE, BUT IT ACTUALLY MEANS THAT A CHANGE HAS BEEN MADE TO THE DNA OF AN ORGANISM. HUMANS HAVE BEEN MAKING CHANGES TO PLANT AND ANIMAL DNA SINCE WE BEGAN FARMING SOME 10,000 YEARS AGO.

### THERE ARE NINE GMO CROPS AVAILABLE IN THE U.S. TODAY WITH ONE MORE APPROVED AND COMING TO MARKET SOON


ALFALFA


CORN (FIELD & SWEET)


CANOLA


COTTON


PAPAYA


SQUASH


SOYBEANS

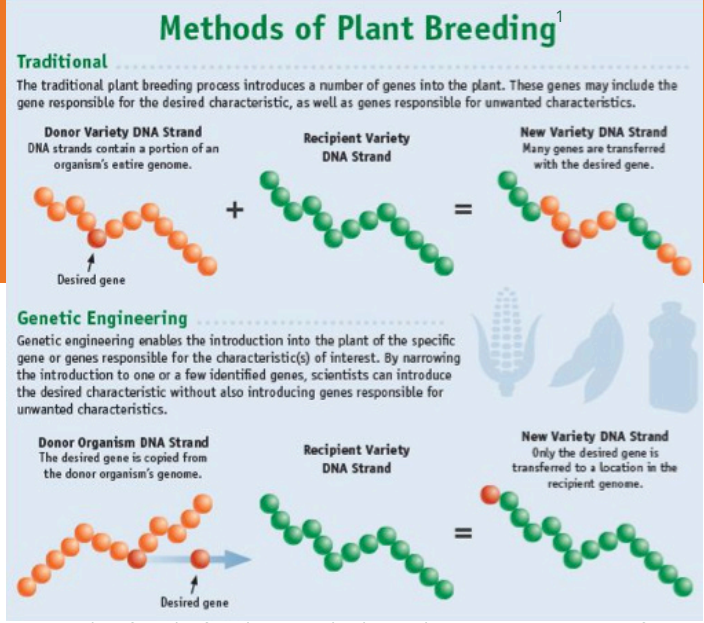

POTATO


SUGAR BEETS


APPLE

# THE EVOLUTION TO GM SOLUTIONS

**There are many breeding techniques utilized to develop seeds for modern agriculture, and they are often grouped into three categories, from oldest to newest: selective breeding, mutagenesis and genetic engineering. Each of these techniques may be used to develop a new plant variety, sometimes in a continuum over many years. For example, seeds developed through selective breeding may be altered through mutagenesis and then altered again using genetic engineering.**




[1]This infographic, from the U.S. Food and Drug Administration, uses segments of DNA to demonstrate how genetic engineering compares to traditional breeding.

**Selective Breeding ("traditional breeding"):** Early plant breeders looked for and cross-bred plants that had the characteristics they wanted. They have crossed plants within a species (beginning 10,000 years ago) and across species (hundreds of years ago). Traditional breeding of different grass species led to the development, over time, of modern corn from its teosinte ancestor. And today's bread wheat was created by crossing, over time, at least 11 different species.

**Mutagenesis ("mutation breeding"):** Beginning in the 1920s, breeders started seeking more diversity than they were able to achieve through selective breeding to create new traits. They began to make changes in plant DNA by exposing seeds to chemicals or gamma irradiation and then selecting the plants that now displayed the traits they wanted. More than 3,200 varieties of commonly consumed plant products have been developed using mutagenesis, including varieties of red grapefruit, bananas, peanuts, peppermint and rice.

**Genetic Engineering ("GMO"):** While selective breeding and mutagenesis methods usually involve crossing or altering thousands of genes, genetic engineering enables breeders to select a trait or characteristic that exists anywhere in nature and insert the associated gene(s) into the target plant. Genetic engineering also allows a breeder to make changes in a plant's makeup without any insertions whatsoever, for example, by silencing ("turning off") existing genes. So far, there are only nine commercialized GM crops available in the United States. The GM apple is approved and coming to market soon, with many more in development here and around the world, including the eggplant, pineapple and tomato. For more information on international approvals, visit the GM Approval Database at ISAAA.org.

**WITH EACH OF THESE TECHNIQUES, PLANT BREEDERS TEST THE RESULTING PLANTS TO ENSURE THEY PERFORM AS EXPECTED. SEED COMPANIES ALSO TEST GM PLANTS TO ENSURE THEY ARE AS SAFE FOR HUMAN AND ANIMAL CONSUMPTION AND FOR THE ENVIRONMENT AS THEIR NON-GM COUNTERPARTS. THE SAFETY INFORMATION IS REVIEWED BY FEDERAL REGULATORS BEFORE THE SEEDS ARE SOLD TO FARMERS.**

# WHY DO FARMERS CHOOSE TO USE GMOS?

Farmers choose seeds that are best for their farms and businesses. Farmers look for ways to grow crops using resources more efficiently, with less impact on the environment. They put time, effort and money into determining which seeds, inputs and management practices are best for their unique land, business and growing conditions. More than 18 million farmers around the world have chosen to plant GM crops for a variety of reasons, including better yield, improved farm income, fewer inputs and more efficient crop management. The majority are farmers with small landholdings in developing countries[1]. Farmers may choose GM seeds for a variety of reasons, including:

***RESISTANCE TO HARMFUL INSECTS:*** A FARMER CAN USE A GM SEED THAT CONTAINS TRAITS THAT MAKE IT RESISTANT TO CERTAIN INSECTS, SUCH AS THE BT CORN; THIS HELPS THE FARMER REDUCE PESTICIDE APPLICATIONS AND TIME SPENT ON THE TRACTOR, THEREBY ALSO REDUCING THE ENVIRONMENTAL FOOTPRINT. EXAMPLE: WIDESPREAD USE OF GM CORN HAS SUPPRESSED THE DEVASTATING EUROPEAN CORN BORER, WHICH PLAGUED FARMERS IN THE UNITED STATES FOR NEARLY A CENTURY.

SINCE 1996, CROP BIOTECHNOLOGY HAS REDUCED THE AMOUNT OF PESTICIDES USED BY NEARLY 1.3 BILLION POUNDS.[2]

***RESISTANCE TO DISEASES:*** FARMERS HAVE USED GMOS TO SAVE A CROP AND THEIR INDUSTRY. IN THE 1990S, VIRUS-RESISTANT PAPAYAS WERE ADOPTED IN HAWAII TO COMBAT THE PAPAYA RING SPOT VIRUS THAT HAD DEVASTATED THE PAPAYA INDUSTRY.

***BETTER YIELDS:*** AS NOTED IN THE EXAMPLES ABOVE, FARMERS HAVE SEEN SIGNIFICANT YIELD GAINS BECAUSE THEY ARE LOSING LESS OF THEIR CROP TO PESTS AND DISEASE.

BETWEEN 1996 AND 2014, CROP BIOTECHNOLOGY WAS RESPONSIBLE FOR AN ADDITIONAL 158.4 MILLION TONS OF SOYBEANS, 321.8 MILLION TONS OF CORN, 24.7 MILLION TONS OF COTTON LINT AND 9.2 MILLION TONS CANOLA.[3]

***FEWER INPUTS:*** GMOS HAVE HELPED FARMERS REDUCE THEIR ENVIRONMENTAL FOOTPRINT BY ENCOURAGING THE ADOPTION OF SUSTAINABLE AGRICULTURAL PRACTICES, FOR EXAMPLE, SHIFTING TO REDUCED OR NO TILLING OF FIELDS AND FEWER PESTICIDE APPLICATIONS (IN THE CASE OF BT CORN, FOR EXAMPLE). THESE PRACTICES HAVE ALSO MEANT LESS TIME SPENT ON A TRACTOR, WHICH HAS TRANSLATED INTO FEWER EMISSIONS AND MORE CARBON SEQUESTRATION IN THE SOIL.

BIOTECH CROPS REQUIRE LESS FUEL AND LESS TILLAGE. IN 2014, THE COMBINED GM CROP-RELATED CARBON DIOXIDE EMISSION SAVINGS FROM REDUCED FUEL USE AND ADDITIONAL SOIL CARBON SEQUESTRATION WERE EQUAL TO THE REMOVAL OF 9.95 MILLION CARS FROM THE ROAD.[4]

# WHEN DO FARMERS NOT CHOOSE GM SEEDS?

Farmers might choose conventional, non-GM seeds if they are not facing significant pest or disease pressures that can be managed more economically by using GM seeds. Or, GM seeds may not have been developed to combat their pest of concern.

Organic farmers opt for organic or conventional seeds, as the use of GM seeds in organic farming is prohibited. (This decision was made by the National Organic Standards Board. In these cases, farmers would use approved pesticides to combat pests.)

**BOTH GM AND NON-GM SEEDS ARE AVAILABLE OPTIONS FOR FARMERS. SEED COMPANIES CONTINUE TO DEVELOP NON-GM CROP VARIETIES.**

It's important for all types of seeds to be available to farmers so their farming needs can be met. The companies sponsoring GMO Answers support farmers' decisions to purchase seeds that fit their business models and make sense economically. One of the core principles of GMO Answers is:

**"RESPECTING FARMERS' RIGHTS TO CHOOSE THE SEEDS THAT ARE BEST FOR THEIR FARMS, BUSINESSES AND COMMUNITIES AND PROVIDING SEED CHOICES THAT INCLUDE NON-GM SEEDS BASED ON MARKET DEMANDS."**

[1] James, C. (2013). Global Status of Commercialized Biotech/GM Crops: 2013. ISAAA Brief, 46. Retrieved from http://www.isaaa.org/resources/publications/briefs/46/default.asp.

[2, 3, 4] Brookes, G., and Barfoot, P.(2016). GM crops: global socio-economic and environmental Impacts 1996–2014. Dorchester, UK: PG Economics Ltd

Note: Metric tonnes converted to tons.

# WHAT ARE PEOPLE CONCERNED ABOUT? AND HOW DO I ANSWER THEIR QUESTIONS?

## HEALTH AND SAFETY

**We've received more questions about the health and safety of GMOs than any other topic on GMO Answers. GMOs do not present any new health risks—they do not cause new allergies, cancer, infertility, ADHD or any other diseases or conditions. GMOs on the market have undergone rigorous testing, and scientific authorities around the world agree that the overwhelming evidence to date indicates that there is no unique safety or health risk associated with GMOs.**

**Nutrition:** The biotech crops currently available on the market have the same nutrition and composition as non-GMOs. Food from GMOs is digested in the body the same way as food from non-GM crops.

**Safety:** Scientific authorities around the world, such as the U.S. National Academy of Sciences, United Nations Food and Agriculture Organization, World Health Organization, the American Medical Association and the American Association for the Advancement of Science have looked at hundreds of scientific studies and concluded that GMO food crops do not pose any more risks to people, animals or the environment than any other foods. [5]

**Health Benefits of GMOs:** Companies, academic researchers and government scientists have developed new GMOs that offer expanded potential for nutrition; one example is a genetically modified soybean with an enhanced, healthier oil profile, much like olive oil, made to be longer-lasting, potentially healthier and free of trans fats.

ACCORDING TO THE EUROPEAN COMMISSION, "THE MAIN CONCLUSION, AFTER MORE THAN 130 RESEARCH PROJECTS COVERING A PERIOD OF MORE THAN 25 YEARS OF RESEARCH AND INVOLVING MORE THAN 500 INDEPENDENT RESEARCH GROUPS, IS THAT BIOTECHNOLOGY, IN PARTICULAR GMOS, ARE NOT PER SE MORE RISKY THAN, E.G., CONVENTIONAL PLANT-BREEDING TECHNOLOGIES." [6]

## GMOS AND THE ENVIRONMENT

**By making targeted improvements to crops through genetic engineering, farmers can raise more food for a growing world population while reducing agriculture's impact on the environment. GM seeds can also contribute to a reduction in the amount of land, water and chemicals needed to produce more food in a variety of ways, for example:**

**Insect resistance:** A farmer may use a GM seed, such as Bt cotton, that is resistant to certain insects, reducing pesticide applications and saving time spent on a tractor, thereby reducing the environmental footprint.

INSECT-RESISTANT (IR) TECHNOLOGY USED IN GM COTTON AND GM CORN HAS DELIVERED YIELD GAINS FROM REDUCED PEST DAMAGE. THE AVERAGE YIELD GAINS OVER THE 1996-2014 PERIOD ACROSS ALL USERS OF THIS TECHNOLOGY HAS BEEN +7% FOR IR CORN AND +9.9% FOR IR COTTON IN THE U.S. [7]

**Herbicide resistance:** Herbicide-tolerant crops developed with genetic engineering have helped enable an increase in no-till agriculture, preserving precious soil moisture and reducing greenhouse gas emissions by trapping carbon dioxide in the ground.

[5] Learned Societies and National Academies Endorsing Safety of Genetically Modified Crops. (2013). Retrieved from http://www.cga.ct.gov/2013/KIDdata/Tmy/2013HB-06527-R000305-Scientific%20Bodies%20Affffirming%20Safety-TMY.PDF.

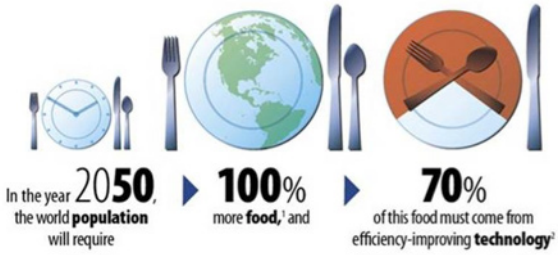
[6] A decade of EU-funded GMO research 2001–2010. (2010). Retrieved from http://ec.europa.eu/research/biosociety/pdf/a_decade_of_eu-funded_gmo_research.pdf.

**Drought tolerance:** GM seeds can also be used to grow plants in extreme weather conditions, such as drought-tolerant corn. Plants that tolerate low rainfall levels help farmers reduce risk during drought periods. For example, drought-tolerant traits in corn can help the plant maintain hydration, kernel development and insect resistance when water is less available.

**ACCORDING TO PG ECONOMICS, SINCE 1996, THE USE OF PESTICIDES ON THE GM CROPS WAS REDUCED BY NEARLY 1.3 BILLION POUNDS AS A RESULT OF GMOS.[9]**

Crops from GM seeds are extensively studied to make sure they are safe for the environment before they reach the market. In fact, the Environmental Protection Agency conducts a mandatory review of GM plants that are resistant to pests, diseases or herbicides to assess whether or not they will impact the environment, including impact on beneficial insects.

**DID YOU KNOW? SEVENTY PERCENT OF THE WORLD'S ADDITIONAL FOOD NEEDS CAN BE PRODUCED ONLY WITH NEW AND EXISTING AGRICULTURAL TECHNOLOGIES. [8]**




## REGULATORY OVERSIGHT

**Before they reach the market, crops from GM seeds are studied extensively to make sure they are safe for people, animals and the environment. Today's GM products are the most researched and tested agricultural products in history. Global regulatory agencies in 70 countries have reviewed the safety information and found no risk.**

In the United States, GM crops are reviewed by at least two, and sometimes three, federal regulatory agencies: the U.S. Department of Agriculture (USDA), the Environmental Protection Agency (EPA) and the Food and Drug Administration (FDA).


## RESEARCH AND TESTING

**GMO researchers characterize very precisely what change they are making to the plant's DNA, how it will impact the plant's performance, and whether any safety issue is raised.**

The plants are then extensively tested, and researchers look for any difference between the GM plant and conventional plants. Just as with other breeding technologies, plants that do not perform do not continue through the development process and do not reach the market. GM plant "performance" includes meeting stringent safety testing requirements.

**DID YOU KNOW? GM SEEDS TAKE AN AVERAGE OF $136 MILLION AND 13 YEARS TO BRING TO MARKET BECAUSE OF EXTENSIVE RESEARCH AND REGULATORY APPROVALS CONDUCTED BY GOVERNING AGENCIES IN THE UNITED STATES AND AROUND THE WORLD. [10]**

[7, 9] Brookes, G., and Barfoot, P. (2016). GM crops: global socio-economic and environmental Impacts 1996–2014. Dorchester, UK: PG Economics Ltd.

[8] Skoet, J., Croppenstedt, A., Deuss, A., Fiorenzi, F., & Teodosijevic, S. [2002] The State of Food and Agriculture 2002. FAO Agriculture Series, 34, 1–246.

[10] McDougall, P. (2011). The cost and time involved in the discovery, development and authorization of a new plant biotechnology derived trait. Retrieved from: http://www.biotech.ucdavis.edu/PDFs/Getting_a_Biotech_Crop_to_Market_Phillips_McDougall_Study.pdf

## LABELING

**This is a very popular topic that is frequently addressed in the media, online and by consumers. You will likely get questions from your friends and family about GMO labeling.**

### EVERY CONSUMER HAS THE RIGHT TO CHOOSE FOOD THAT IS HEALTHY AND NUTRITIOUS. THAT'S WHY IT IS CRITICAL THAT LABELS ARE FACTUAL, VERIFIABLE, UNDERSTANDABLE AND NOT MISLEADING.

**Mandatory labels:** We believe a government requirement to label GMOs would convey that foods made with GM seeds are somehow different from conventional or organic food and therefore less safe or less nutritious—but this is not the case. Hundreds of independent studies have confirmed the safety of GMOs, and regulatory authorities around the world agree. The biotech industry supports labeling of foods, whether developed through modern biotechnology or another method, if there is a change in nutritional composition or if a component could raise food-safety concerns, for example, allergenicity.

Current GMO food-labeling proposals at the state level include arbitrary requirements and exemptions. A patchwork of state GM-labeling laws creates concerns around interstate commerce of food products. Several state attorneys general have already noted this flaw in these proposed GM-labeling laws and have publically stated they could be "unconstitutional" if enacted.

**Voluntary labels:** We support the current FDA labeling policy that promotes voluntary labeling. Today, consumers have the right to choose food based on presence or absence of GM ingredients. There are numerous voluntary labels available on the market, such as "USDA Organic," "Non-GMO" and "GMO-Free."

**We support both farmer and consumer choice.**

Whether it is GMO, conventional or organic, there is a place and need for all types of production in our agricultural system!

## THE FUTURE OF GMO

Companies, academic researchers and government scientists are developing new GMOs with enhanced nutrition and traits that are meant to appeal to the consumer and even bring back near-extinct plant species. These emerging developments present expanded potential for our food supply and the environment. Examples include:

- Apple and potato varieties that have been enhanced through biotechnology so they don't brown, and are therefore more appealing to consumers and reduce food waste.
- BioCassava Plus, which delivers more nutritious higher yielding, and more marketable cultivars of cassava, a staple crop consumed by more than 700 million people worldwide.
- A genetically modified American chestnut tree that can withstand the blight that decimated the species in the 20th century, nearly wiping out a highly valued hardwood tree that was once prevalent in the eastern part of the country.

## 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.

TWITTER FACEBOOK PINTEREST YOUTUBE GOOGLE+