TOPICS AND ANSWERS FROM WWW.GMOANSWERS.COM

Hundreds of questions have been posted and answered on GMOAnswers.com; below are excerpts from answers to frequently raised topics and concerns about GMOs. Complete questions and answers can be found at **www.GMOAnswers.com**.

REGULATORY AND OVERSIGHT

GMO crops are subjected to more testing than any other new crop variety, and, as a result, we know more about this set of crops than any of the other crops that plant breeders have developed (and we've eaten!) over the past few centuries. In the U.S., GM crops are subjected to regulatory review by at least two, and sometimes three, federal agencies: the FDA, USDA and EPA. FDA is responsible for assessing the safety of any GM crop used for food or animal feed, and USDA assesses the crop's potential impacts on the environment and agriculture. If the GMO has been modified to provide resistance to pests that would like to eat the crop before we can e.g., insects and plant pathogens, then EPA also assesses the environmental and food safety of the new substance produced by the plant that provides the pest resistance trait. Only then do foods from those crops enter our food supply.

LONG TERM HUMAN HEALTH

GMO foods have a long, safe track record (20 years in the marketplace).[3] From their introduction in 1996 until now, scientists have found, through repeated and extensive testing, that GMO foods are no more risky than comparable non-GMO foods, nor do they differ in nutritional value. Currently approved GM crops developed through specific genetic additions or subtractions are as safe as conventional and organic crops developed via random genetic shuffling. Most people do not realize that plant breeders have been randomly altering and admixing plant genomes for centuries. Techniques using chemicals and radiation to break plant DNA and induce mutations have been used to develop many conventional and organic crops. Whether using traditional approaches or genetic engineering, the goal of plant scientists is to develop crops with new and agriculturally useful traits. Humans have been changing plant genomes for generations – we just **have new, more precise, tools.**

"PEOPLE DO NOT REALIZE THAT PLANT BREEDERS HAVE BEEN ALTERING PLANT GENOMES FOR CENTURIES."

GMO PRODUCTS

Currently a total of 10 crops are commercially available in the United States –alfalfa, apples, canola, corn (field and sweet), cotton, papaya, potatoes, soybeans, squash and sugar beets. Only a few products in the produce aisle are GMOs – some potatoes, some sweet corn, some summer squash, some papayas and some apples. Processed foods, such as sugar or vegetable oil, may carry ingredients from GM crops, but the modified features of the crop are not present in the food and do not change the safety or nutritional values of the food.

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APPROXIMATELY 1.4 BILLION POUNDS LESS ACTIVE INGREDIENT OF INSECTICIDE HAS BEEN USED IN THE UNITED STATES BECAUSE OF GM CROPS BETWEEN 1996 AND 2016...[4]

ENVIRONMENT

Through the use of GM crops, farmers are seeing improved performance and less environmental impact. Herbicide-tolerant GM crops have helped farmers to practice conservation tillage farming. In conventional farming, the fields are plowed ("tilled") to control weeds. Because of the superior weed control from GM crops, farmers now till much less often. That has led to improved soil health and water retention, reduced runoff, and reduced greenhouse gas emissions from agriculture. Insect-resistant GM crops have greatly reduced the amount of insecticide that has to be applied to insect-protected crops. Between 1996 and 2016, GM insect-resistant crops have led to the reduction of insecticide applications, including 634.9 million pounds on cotton crops and 202 million pounds on maize crops.[4] GM plants in development to more efficiently utilize nitrogen mean less fertilizer will be needed, saving farmers money, and less fertilizer ends up in the environment. GM plants are available to withstand moderate water deficits. In the near future these same traits may allow the same yields or better while consuming less water.

"A SERVING OF GOLDEN RICE COULD PROVIDE HALF THE REQUIRED DAILY INTAKE OF PRO-VITAMIN A FOR A 1 TO 3 YEAR OLD CHILD."

FUTURE OF GMO

We're already making progress toward a promising future for GMOs. Scientists have demonstrated biotechnology can be used to increase the amount and stability of pro-vitamin A, iron and zinc and improve the protein digestibility of sorghum. In the coming years, this technology is anticipated to benefit Africans who rely upon sorghum, which traditionally is deficient in key nutrients. "Golden Rice," is another example of a nutritionally improved biotech crop. It's genetically engineered t o provide an increased amount of beta-carotene, that the body coverts into Vitamin A. Daily consumption of approximately one cup (or approximately 150 g. uncooked weight) could provide 50 percent of the Recommended Daily Allowance of vitamin A for an adult.[5]

Technology exists to help breeders develop high quality hybrids more quickly, which can help us improve productivity and sustainability faster. Scientists now are working on ways to further improve the staple crops that people in developing countries rely on for food. This will help food security in these countries by producing more food where it's actually consumed.

Biotechnology also can help farmers grow more with less. Analysis of U.S. Department of Agriculture data show global corn acres have increased 31 percent since 1981, while production increased 93 percent. Between 1996 and 2016, crop biotechnology was responsible for an additional 213.5 million tons of soybeans, 404.91 million tons of corn, 27.47 million tons of cotton lint and 11.65 million tons of canola.[4] That trend has to continue if we're to meet growing demand, despite conditions like drought, poor soil nutrient levels and insect pressure – all of which many experts predict will present an even greater challenge in the future.

JOIN US. ASK TOUGH QUESTIONS. BE SKEPTICAL. BE OPEN. WE LOOK FORWARD TO SHARING ANSWERS.

WWW.GMOANSWERS.COM | @GMOANSWERS

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OPEN TO YOUR QUESTIONS ABOUT HOW OUR FOOD IS GROWN

Genetically modified organisms (GMOs) are a major topic of discussion today. Across our society, media and the Internet, a growing number of people have shared a wide range of questions and emotions on the topic – ranging from excitement and optimism to skepticism and fear.

Talking about GMOs in this charged environment can be challenging and made more difficult by the lack of connection between most consumers and how their food is grown. Engaging in the conversation about GMOs – particularly for people involved in the production of our food – is essential to creating a greater level of trust and transparency about GMOs.

The following information is provided by GMO Answers to help support growers and organizations along the food value chain as they discuss GMOs with their members and stakeholders.

GMO Answers is funded by the members of The Council for Biotechnology Information, which includes BASF, Bayer, Corteva and Syngenta. Our members are dedicated to the responsible development and application of plant biotechnology.

BACKGROUND ON gmo answers

GMO Answers (www.GMOAnswers.com) was created to do a better job answering questions – no matter what they are – about GMOs. The biotech industry stands 100 percent behind the health and safety of the GM crops on the market today, but we acknowledge that we haven't done the best job communicating about them – what they are, how they are made, what the safety data says.

The Council for Biotechnology Information (CBI) and developers of biotech seeds, along with our farmer and agriculture partners who are aligned with GMO Answers, support FIVE CORE PRINCIPLES.

FIVE CORE PRINCIPLES:

1. Respecting people around the world and their right to choose healthy food products that are best for themselves and their families
2. Welcoming and answering questions on all GMO topics
3. Making GMO information, research and data easy to access and evaluate and supporting safety testing of GM products; including allowing independent safety testing of our products through validated science-based methods
4. Supporting farmers as they work to grow crops using precious resources more efficiently, with less impact on the environment and producing safe, nutritious food and feed products
5. 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 demand

WHAT ARE GMOS?

Biotechnology in plant agriculture has come to mean the process of intentionally making a copy of a gene for a desired trait from one plant or organism and using it in another plant. The result is a GMO (genetically modified organism).

WHY DO FARMERS USE GMOS?

Farmers choose seeds based on what is best for their farms, market demand and local growing environments. Farmers select GMOs to reduce yield loss or crop damage from weeds, diseases, and insects, as well as from extreme weather conditions, such as drought. Farmers choose to use GMOs to reduce the impact of agriculture on their environment and their costs – by applying pesticides in more targeted ways, for example. Farmers have also used genetic modification to save a crop – such as papaya from Hawaii – that was being threatened by a disease.

THERE ARE CURRENTLY 10 CROPS COMMERCIALLY AVAILABLE FROM GMO SEEDS IN THE US:

GENETIC TRAITS EXPRESSED IN GMOs IN THE U.S.

APPLE
Genetic Traits
Non-browning
Uses: Food

POTATO
Genetic Traits
Reduced Bruising and Black Spot
Non-browning
Low Acrylamide
Blight Resistance
Uses: Food

FIELD CORN
Genetic Traits
Insect Resistance
Herbicide Tolerance
Drought Tolerance
Uses:
- Livestock and poultry feed
- Fuel ethanol
- High-fructose corn syrup and other sweeteners
- Corn oil
- Starch
- Cereal and other food ingredients
- Alcohol
- Industrial uses

CANOLA
Genetic Traits
Herbicide Tolerance
Uses: Cooking oil, Animal feed

ALFALFA
Genetic Traits
Herbicide Tolerance
Uses: Animal feed

SOYBEAN
Genetic Traits
Insect Resistance
Herbicide Tolerance
Uses:
- Livestock and poultry feed
- Aquaculture
- Soybean oil (vegetable oil)
- High oleic acid (monounsaturated fatty acid)
- Biodiesel fuel
- Soymilk, soy sauce, tofu, other food uses
- Lecithin
- Pet food
- Adhesives and building materials
- Printing ink
- Other industrial uses

RAINBOW PAPAYA
Genetic Traits
Disease Resistance
Uses: Table fruit

COTTON
Genetic Traits
Insect Resistance
Herbicide Tolerance
Uses: Fiber, Animal feed, Cottonseed oil

SUGAR BEET
Genetic Traits
Herbicide Tolerance
Uses: Sugar, Animal feed

SWEET CORN
Genetic Traits
Insect Resistance
Herbicide Tolerarnce
Uses: Food

SUMMER SQUASH
Genetic Traits
Disease Resistance
Uses: Food

THE EVOLUTION OF CROP IMPROVEMENT
BUILDING ON GENETIC DIVERSITY

Farmers have intentionally changed the genetic makeup of all the crops they have grown and the livestock they have raised since domestic agriculture began 10,000 years ago. Every fruit, vegetable and grain that is commercially available today has been altered by human hands, including organic and heirloom seeds.

WILD CABBAGE

CROP DOMESTICATION *is* GENETIC MODIFICATION

BRUSSELS SPROUTS

ROMANESCO BROCCOLI / ROMAN CAULIFLOWER

BROCCOLI

KALE

BOK CHOY

In the late 20th century, advances in technology enabled us to expand the genetic diversity of crops. For years, university, government and company scientists intensively researched and refined this process. A major result has been GM seeds that maintain or increase the yield of crops while requiring less land and fewer inputs, both of which lessen the impact of agriculture on the environment and reduce costs for farmers.

HUMANS CREATED TODAY'S CORN CROP

Over the past century, corn has evolved with the availability of hybrid corn in the 1930s and the planting of GM crops in the mid-1990s. Due to the benefits provided by insect resistance and/or herbicide tolerance traits in GM corn, more and more of it has been planted. Contrary to popular belief, the development and increased usage of GM corn has not changed the physical appearance of corn.

What has changed, due to modern plant breeding, is size, consistency, seed performance, yield, the number of ears per stalk, and the position of the ear and the leaves on the stalk. Currently, a plant has only one ear located about waist high (the height of a combine blade), and its leaves grow at a more upright angle to better catch sunrays and rain. A century ago, farmers planted about 8,000 corn plants per acre. Today they plant about four times as many plants per acre.[1]

EXTENSIVELY RESEARCHED AND STUDIED

Before they reach the market, crops from GM seeds are studied extensively to ensure they are safe for people, animals and the environment. Today's GM products are the most researched and tested agricultural products in history.

Bringing a new GMO to market involves comprehensive safety and environmental reviews by regulatory bodies around the world. In addition to the review process conducted in the U.S. by the U.S. Department of Agriculture (USDA), U.S. Environmental Protection Agency (EPA) and U.S. Food and Drug Administration (FDA), other nations conduct their own rigorous certification processes and regulatory approvals. 67 countries currently certify GM products for cultivation (growing), food import for people, feed import for animals and/or trials and testing. In 2017, 24 countries grew GMOs and even more imported GMOs.[2]

PRECISE UNDERSTANDING OF PLANTS

When creating a GMO, researchers copy specific genetic information from one plant or organism and introduce it into another to improve or enhance a specific characteristic or trait, such as resistance to insects.

The researchers characterize very precisely what change they are making to the plant's genome, and how it will impact the metabolism of the plant cells. The plants are then extensively tested in the greenhouse and field, and researchers look for any difference between the GM plant and conventional plants. Plants grown in the field across a range of environments are also harvested and analyzed for their compositional makeup.

THE SAME AS OTHER CROPS

Biotech crops currently available on the market are the same from a compositional and nutritional standpoint as their non-GM counterparts. For example, GM corn is the same as non-GM corn. Testing has shown and FDA review has confirmed that GMOs are nutritionally the same as non-GM crops, including the same levels of key nutrients like amino acids, proteins, fiber, minerals and vitamins.

No commercially available crops in the U.S. were created by nature alone. Every fruit, vegetable and grain that is commercially available today has been altered by human hands, including organic and heirloom seeds, for taste, yield or disease resistance.

THE HISTORY OF GENETIC MODIFICATION IN CROPS

10,000 years ago
Humans begin crop domestication using selective breeding.

1700s
Farmers and scientists begin cross-breeding plants within a species.

1940s and 1950s
Breeders and researchers seek out additional means to introduce genetic variation into the gene pool of plants.

1980s
Researchers develop the more precise and controllable methods of genetic engineering to create plants with desirable traits.

1990s
The first GMOs are introduced to the marketplace.