# GMO Facts: 10 Common GMO Claims Debunked

## Learn About These GMO Facts

Photograph by Travis Rathbone; Stylist: Sarah Guido for Halley Resources

Genetically modified apples may soon hit the market

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Later this year, the U.S. Department of Agriculture may approve the Arctic Granny and Arctic Golden, the first genetically modified apples to hit the market. Although it will probably be another two years before the non-

browning fruits appears in stores, at least one producer is already scrambling to label its apples GMO-free.

The looming apple campaign is just the latest salvo in the ongoing war over genetically modified organisms (GMOs)—one that's grown increasingly contentious. Over the past decade, the controversy surrounding GMO facts has sparked worldwide riots and the vandalism of crops in Oregon, the United Kingdom, Australia, and the Philippines. In May, the governor of Vermont signed a law that will likely make it the first U.S. state to require labels for genetically engineered ingredients; more than 50 nations already mandate them. Vermont State Senator David Zuckerman told Democracy Now!, "As consumers, we are guinea pigs, because we really don't understand the ramifications."

But the truth is, GMOs have been studied intensively, and they look a lot more prosaic than the hype contends. To make Arctic apples, biologists took genes from Granny Smith and Golden Delicious varieties, modified them to suppress the enzyme that causes browning, and reinserted them in the leaf tissue. It's a lot more accurate than traditional methods, which involve breeders hand-pollinating blossoms in hopes of producing fruit with the desired trait. Biologists also introduce genes to make plants pest- and herbicide-resistant; those traits dominate the more than 430 million acres of GMO crops that have already been planted globally. Scientists are working on varieties that survive disease, drought, and flood.

So what, exactly, do consumers have to fear? To find out, Popular Science chose 10 of the most common claims about GMOs and interviewed nearly a dozen scientists. Their collective answer: not much at all.

**1) Claim: Genetic engineering is a radical technology.**

Humans have been manipulating the genes of crops for millennia by selectively breeding plants with desirable traits. (A perfect example: the thousands of apple varieties.) Virtually all of our food crops have been

genetically modified in some way. In that sense, GMOs are not radical at all. But the technique does differ dramatically from traditional plant breeding.

Here's how it works: Scientists extract a bit of DNA from an organism, modify or make copies of it, and incorporate it into the genome of the same species or a second one. They do this by either using bacteria to deliver the new genetic material, or by shooting tiny DNA-coated metal pellets into plant cells with a gene gun. While scientists can't control exactly where the foreign DNA will land, they can repeat the experiment until they get a genome with the right information in the right place.

That process allows for greater precision. "With GMOs, we know the genetic information we are using, we know where it goes in the genome, and we can see if it is near an allergen or a toxin or if it is going to turn [another gene] off," says Peggy G. Lemaux, a plant biologist at the University of California, Berkeley. "That is not true when you cross widely different varieties in traditional breeding."

**2) Claim: GMOs are too new for us to know if they are dangerous.**

It depends on how you define new. Genetically engineered plants first appeared in the lab about 30 years ago and became a commercial product in 1994. Since then, more than 1,700 peer-reviewed safety studies have been published, including five lengthy reports from the National Research Council, that focus on human health and the environment. The scientific consensus is that existing GMOs are no more or less risky than conventional crops.

**3) Claim: Farmers can't replant genetically modified seeds.**

So-called terminator genes, which can make seeds sterile, never made it out of the patent office in the 1990s. Seed companies do require farmers to sign agreements that prohibit replanting in order to ensure annual sales, but Kent Bradford, a plant scientist at the University of California, Davis, says large-scale commercial growers typically don't save seeds anyway. Corn is a

hybrid of two lines from the same species, so its seeds won't pass on the right traits to the next generation. Cotton and soy seeds could be saved, but most farmers don't bother. "The quality deteriorates—they get weeds and so on—and it's not a profitable practice," Bradford says.

**4) Claim: We don't need GMOs—there are other ways to feed the world.**

GMOs alone probably won't solve the planet's food problems. But with climate change and population growth threatening food supplies, genetically modified crops could significantly boost crop output. "GMOs are just one tool to make sure the world is food-secure when we add two billion more people by 2050," says Pedro Sanchez, director of the Agriculture and Food Security Center at Columbia University's Earth Institute. "It's not the only answer, and it is not essential, but it is certainly one good thing in our arsenal."

**5) Claim: GMOs cause allergies, cancer, and other health problems.**

Many people worry that genetic engineering introduces hazardous proteins, particularly allergens and toxins, into the food chain. It's a reasonable concern: Theoretically, it's possible for a new gene to express a protein that provokes an immune response. That's why biotech companies consult with the Food and Drug Administration about potential GMO foods and perform extensive allergy and toxicity testing. Those tests are voluntary but commonplace; if they're not done, the FDA can block the products.

One frequently cited study, published in 2012 by researchers from the University of Caen in France, claimed that one of Monsanto's corn GMOs caused tumors in lab rats. But the study was widely discredited because of faulty test methods, and the journal retracted it in 2013. More recently, researchers from the University of Perugia in Italy published a review of 1,783 GMO safety tests; 770 examined the health impact on humans or animals. They found no evidence that the foods are dangerous.

**6) Claim: All research on GMOs has been funded by Big Ag.**

This simply isn't true. Over the past decade, hundreds of independent researchers have published peer-reviewed safety studies. At least a dozen medical and scientific groups worldwide, including the World Health Organization and the American Association for the Advancement of Science, have stated that the GMOs currently approved for market are safe.

**7) Claim: Genetically modified crops cause farmers to overuse pesticides and herbicides.**

This claim requires a little parsing. Two relevant GMOs dominate the market. The first enables crops to express a protein from the bacterium Bacillus thuringiensis (Bt), which is toxic to certain insects. It's also the active ingredient in pesticides used by organic farmers. Bt crops have dramatically reduced reliance on chemical insecticides in some regions, says Bruce Tabashnik, a University of Arizona entomologist.

The second allows crops to tolerate the herbicide glyphosate so that farmers can spray entire fields more liberally yet kill only weeds. Glyphosate use has skyrocketed in the U.S. since these GMOs were introduced in 1996. But glyphosate is among the mildest herbicides available, with a toxicity 25 times less than caffeine. Its use has decreased reliance on more toxic alternatives, such as atrazine.

**8) Claim: GMOs create super-insects and super-weeds.**

If farmers rely too heavily on Bt or glyphosate, then pesticide resistance is inevitable, says Tabashnik. That's evolution at work, and it's analogous to antibiotics creating hardier bacteria. It is an increasing problem and could lead to the return of harsher chemicals. The solution, he says, is to practice integrated pest management, which includes rotating crops. The same goes for any type of farming.

**9) Claim: GMOs harm beneficial insect species.**

This has been been partly debunked. Bt insecticides attach to proteins found in some insects' guts, killing select species. For most insects, a field of Bt crops is safer than one sprayed with an insecticide that kills indiscriminately. But monarch butterflies produce the same proteins as one of Bt's target pests, and a 1999 Cornell University lab experiment showed that feeding the larvae milkweed coated in Bt corn pollen could kill them. Five studies published in 2001, however, found that monarchs aren't exposed to toxic levels of Bt pollen in the wild.

A 2012 paper from Iowa State University and the University of Minnesota suggested glyphosate-tolerant GMOs are responsible for monarchs' recent population decline. The herbicide kills milkweed (the larvae's only food source) in and near crops where it's applied.

**10) Claim: Modified genes spread to other crops and wild plants, upending the ecosystem.**

The first part could certainly be true: Plants swap genetic material all the time by way of pollen, which carries plant DNA—including any genetically engineered snippets.

According to Wayne Parrott, a crop geneticist at the University of Georgia, the risk for neighboring farms is relatively low. For starters, it's possible to reduce the chance of cross-pollination by staggering planting schedules, so that fields pollinate during different windows of time. (Farmers with adjacent GMO and organic fields already do this.) And if some GMO pollen does blow into an organic field, it won't necessarily nullify organic status. Even foods that bear the Non-GMO Project label can be 0.5 percent GMO by dry weight.

As for a GMO infiltrating wild plants, the offspring's survival partly depends on whether the trait provides an adaptive edge. Genes that help wild plants survive might spread, whereas those that, say, boost vitamin A content

might remain at low levels or fizzle out entirely.

## The Rise of GMO Crops

In the U.S., farmers have been planting increasing amounts GMO crops since the seeds became commercially available in 1996. Corn, cotton, and soy—which together occupy about 40 percent of U.S. cropland—are the three crops with the highest GMO fraction by area, each more than 90 percent in 2013.

**The GMO fraction by area of corn, cotton, and soy in the top states that grow those crops.** *Data from the U.S. Department of Agriculture. Graphic by Rebecca Lantner.*

## Dinner, Dissected

Very few genetically modified crops end up on plates, but the ones that do can be found in roughly two-thirds of processed foods sold in the U.S. Genetically modified bacteria and yeasts are also critical to the production of some foods, including many wines and cheeses.

### Cheese

Rennet is key in making firm cheeses—specifically, an enzyme called chymosin in the rennet helps harden cheese. Traditionally, cheesemakers use rennet from the lining of cow stomachs to get their chymosin—but an estimated 80 to 90 percent of hard cheeses in the U.S. are made with bacteria modified with the rennet-producing cow gene.

### Corn

Trait: Tolerates herbicides; resists insects
Total U.S. crop, by acreage: 85% herbicide-tolerant; 76% insect-resistant
Found in: Processed foods, such as crackers and cereals; corn on the cob; livestock feed

**Cotton**

Trait: Tolerates herbicides; resists insects
Total U.S. crop, by acreage: 82% herbicide-tolerant; 75% insect-resistant
Found in: Processed foods, including salad dressings; livestock feed

**Papaya**

Trait: Resists ringspot virus
Total U.S. crop, by acreage: More than 50%
Found in: Whole fruit and other products

**Rapeseed**

Trait: Tolerates herbicides
Total U.S. crop, by acreage: More than 50%
Found in: Canola oil; processed foods

**Soy**

Trait: Tolerates herbicides
Total U.S. crop, by acreage: 93%
Found in: Processed foods, such as cereals and breads; food additives, such as lecithin; livestock feed

**Squash**

Trait: Resists various viruses
Total U.S. crop, by acreage: 12%
Found in: Whole vegetables and other products

**Sugar beets***

Trait: Tolerates herbicides
Total U.S. crop, by acreage: 95%

Found in: Refined sugar

**Wine**

Certain wine yeasts have been modified to make wine production easier, and prevent the production of harmful fermentation byproducts. One example is yeast strain ML01 in the U.S., which prevents the production of histamines that can trigger headaches. It also improves flavor and color.

*No modified proteins remain in the final product.

## The Future Of GMOs: Gene Editing

Today's most common GMO technology, recombinant DNA, inserts genes into a plant's cells via bacteria or specialized delivery tools, but it involves some trial and error. A new method called gene editing uses enzymes to snip out a specific bit of DNA to either delete it or replace it. This allows for more precise changes to a plant's genome. Scientists at the University of California, Berkeley are already working with it to create virus-resistant cassava.

Gene editing may also provide fodder for fresh controversy. Current GMO methods leave a trace behind—for example, a bit of the DNA from bacterium used to insert new genes. The enzymes used in gene editing don't leave such a fingerprint, so future genetically modified plants will be harder to detect with tests.

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***Note (7/17/2014, 6:30pm EDT):*** *Due to an editor's mistake, a previous version of this story misstated several details about genetically modified wines and cheeses. We regret the error.*