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Issue Brief

Genetically Engineered Foods – Scientific Miracles or Minefields?

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Americans possess widely disparate views about the presence of genetically modified organisms (GMOs) in their foods. The vast majority are indifferent to them. They may have a vague awareness and understanding of GMOs, but remain unconcerned about their presence in the food supply. But some Americans possess (and express) strong opinions, either for or against GMOs. Congregated at one end of the opinion spectrum are the proponents who regard GMOs as beneficial, safe, benign, and a scientific boon to mankind. At the other end of the spectrum is a vocal group who are passionately opposed to GMOs. They would prefer either to ban them totally or to impose a system of mandatory labeling on all GMO ingredients found in foods.

The objective of this in-brief report is to outline the key issues and concerns that swirl around GMOs. The intent is not to stake out a position for or against GMOs or related issues, but rather to outline the facts and foster a better understanding of the two dueling points of view.

What are GMOs?

Genetic engineering [GE] involves the "manipulation of an organism's genes by introducing, eliminating, or rearranging specific genes using the methods of modern molecular biology."[1] It typically involves splicing a new gene, or genes, into a plant's DNA in order to introduce new characteristics or traits such as enhancing the growth or nutritional profile of food crops. Scientists do this "either by using bacteria to deliver the new genetic material or by shooting tiny DNA-coated metal pellets into plant cells with a gene gun."[2] It's an imprecise method, but scientists can repeat the process until they succeed in implanting the foreign DNA into just the right spot in the genome. Most of the genetically engineered plants currently being marketed are transgenic, which means that the newly added gene comes from the DNA of a different species.

Why are these new GE plants and foods being invented?

Until fairly recently, the foremost reason for altering the genetic make-up of plants was to produce new traits or characteristics that would shore up the plants' defenses against environmental challenges and hazards such as weeds, insect damage, fungal infections, drought, salinity, or extreme weather.

To date, the most common transgenic trait continues to be herbicide tolerance, and this trait is available in all of the major row crops including corn, soybeans, cotton, rapeseed, alfalfa, and sugar beets. Weeds compete with these food crops for nutrients, sunlight, and moisture; and most herbicides cannot differentiate between weeds and food crops. Hence, herbicide-tolerant plants have been engineered to tolerate a specific herbicide such as glyphosate, which is highly effective against most weeds and allows farmers to use just one herbicide to combat their weeds, instead of the many herbicides that they would otherwise typically use. Farmers benefit from herbicide-tolerant plants inasmuch as they require less spraying, fewer pesticides, less tractor traffic in the fields, and lower operating costs.

Insect resistance is the second most common transgenic trait. Absent this trait, insects cause great damage to food crops both in the field and in storage facilities, destroying as much as 25 percent of food crops worldwide. Bacillus thuringiensis, or Bt, is a soil bacterium that produces a protein which is toxic to various herbivorous insects. Bt preparations are widely used in organic farming to control pests, because Bt toxins occur naturally and are safe for human consumption. Genetic engineers have inserted Bt genes into various food crops, enabling the crops to produce their own toxins and defend themselves against specific types of insects. As a result, insect pests cease to be a problem, and crop farmers can stop applying chemical pesticides.

In recent years, genetic engineers have begun altering the DNA of plants in order to cultivate specific traits that are more appealing to consumers – e.g., higher nutrient content or more appealing flavors or appearances. One example consists of Golden Rice, a GE crop where the added trait yields significant amounts of vitamin A. Vitamin A deficiency is a major nutritional problem in many parts of East Asia where rice is a food staple. Other examples include "cooking oils with unique fatty acid profiles and less than 1 percent trans fats, and corn with higher concentrations of amino acids, certain oils and minerals ideal for animal feed."[3] The Arctic Golden and Arctic Granny Smith apples are two new GE varieties which stave off discoloration after being bitten or cut into, due to the insertion of certain genes from other apple varieties that are naturally less susceptible to browning.

How does the second generation of GMOs differ from the first?

The first generation of GE crops was targeted primarily at farmers. It was designed to make their jobs easier, more productive, and more profitable.[4] The first GE product came to market in 1996, when Monsanto introduced its new soybean variety with a bacterial gene that allowed it to tolerate the application of a popular herbicide known as glyphospate, or Monsanto's branded glyphosate called Roundup. Other GE products followed, including Monsanto's Bt cotton, a GE plant modified to produce a bacterial toxin that discourages destructive boll-worms and cuts down on the need for pesticides.

The second generation of GM crops is aimed at consumers, offering them enhanced quality characteristics or traits such as higher nutritional value or longer shelf lives. This generation of GE plants will use "advanced genetic-manipulation techniques that allow high-precision editing of the plant's own genome. Such approaches could reduce the need to modify commercial crops with genes imported from other species – one of the practices that particularly disturbs critics of genetic modification."[5]

The new gene-manipulation techniques afford a high degree of precision in editing genes. "Enzymes called transcription activator-like effector nucleases (TALENs) and zinc-finger nucleases (ZFNs) can cut DNA at specific points chosen by the experimenter. By controlling how this break is repaired, it is possible to introduce mutations, single-nucleotide changes or even whole genes at precise sites. ….This allows researchers to put the new gene in a spot in the genome where its expression is optimal, and reduces the risk of disrupting the plant's genome in undesirable ways."[6]

How many different kinds of GM crops are now being marketed worldwide?

While there are an estimated 300,000 different plant species worldwide, scientists have limited their genetic engineering experiments to just 19 plant species. As of 2013: "A total of 165 GE crop events in 19 plant species (alfalfa [2], canola [20], chicory [3], corn [38], cotton [27], creeping bentgrass [1], flax [1], melon [2], papya [3], plum [1], potato [28], rice [3], rose [2], soybean [19], squash [2], sugar beet [3], tobacco [1], tomato [8], and wheat [1]) have been approved in the United States, although not all of these events are being grown commercially, and no GE animals have yet been approved for food purposes as of the time of this writing."[7] A few more "crop events" have been approved since then, but the total is still well below 200.

At present, the four most prevalent genetically modified crops are corn, soybeans, canola, and cotton. "Globally, only a tenth of the world's cropland includes GM plants. Four countries – the U.S., Canada, Brazil, and Argentina – grow 90 percent of the planet's GM crops."[8]

Nearly all of the corn, soybeans, canola, sugar beets, and cotton grown in the U.S. today are genetically modified. After harvest, these GM plants are typically manufactured into ingredients that are used in processed foods – e.g., cornstarch used in soups and sauces; corn syrup as a sweetener; and cottonseed oil, canola oil, and soybean oil in mayonnaise, salad dressings, cereals, breads, and snack foods. "It has been estimated that at least 70% of processed food items in the supermarket contain at least one ingredient derived from a GE crop, often the additive soy lecithin or various oils."[9]

Very few genetically modified specialty crops have made it to market. One early example was the genetically engineered tomato, developed by Calgene in Davis CA during the 1980s. It was called the "Flavr Savr" tomato and was designed to remain firm after ripening. The Flavr Savr was approved finally by the FDA in 1994, but proved to be a commercial flop, doomed some said by the failure of its developers to prepare the public properly.

The Hawaiian Rainbow papaya is another early example of a genetically modified specialty crop, but this one proved to be a commercial success. In the mid-1990s, Hawaii's lucrative papaya industry was being savaged by the ringspot virus, which caused trees to wither and the papaya fruit to be infected by ugly, ring-shaped spots. Plant scientists developed a transgenic variety of papaya, the Rainbow papaya, which was resistant to the ringspot virus. The Rainbow papaya variety was commercialized successfully in 1998; grocery stores nationwide began to stock the new variety; and Hawaii's papaya industry was rescued from obliteration. Since 2013, however, anti-GMO protestors succeeded in getting the County Councils of three Hawaiian islands (Kauai, Hawaii, and Maui) to pass laws restricting the use of GM plants, including the Rainbow papaya. Within the past few months, the laws enacted by Hawaii and Kauai have been overturned by the courts, while Maui's moratorium on the cultivation of all GM plants is under appeal. Meanwhile, GMO opponents have launched a nationwide campaign to add Hawaiian Rainbow papayas to their do-no-buy lists.

Three new GE specialty crops have been developed recently. The Arctic Golden and Arctic Granny Smith apples are designed to retard browning after being cut or bitten, contain only apple DNA, and were approved recently by the FDA. Similarly, the J.R. Simplot Company's GE potato – the so-called Innate potato – uses only potato DNA. This new GE potato's DNA has been altered so that it produces less acrylamide, a chemical suspected of being a carcinogenic, when these potatoes are fried. In addition, the new Innate potato also resists bruising, a characteristic thought to enhance its consumer appeal and long sought by growers and processors. The Innate potato was also approved recently by the FDA.

The developers of these three new GE specialty crops are hoping that they will receive a better reception from consumers than the Flavr Savr tomato or other foods using GE ingredients. All three of these new GE specialty crops are intragenic, which means that they were developed using conventional genetic engineering techniques but that the inserted genes were derived from the same species of plants as the GE crops. However, it is doubtful that GMO opponents will be any more welcoming to intragenic GE plants than they are toward transgenic GE plants.

Other GE specialty crops are working their way through the R&D pipeline. In January 2015, for instance, Monsanto listed seven new GMO vegetables that were at various stages of testing: phytophthora-resistant peppers, thick-viscosity processing tomatoes, Harper melons, brilliant white cauliflower, bacterial wilt-resistant tomatoes, downy mildew-resistant lettuce, and gemini-virus resistant tomatoes.

How do GMOs differ from conventionally cross-bred plants?

Genetic engineering and conventional cross-breeding techniques are alike in some respects but unalike in others.[10] Both entail the rearrangement and re-sequencing of genes, but differ in the number of genes involved in the manipulation. Genetic engineering modifies just one or a few genes within an organism. In contrast, conventional breeding techniques involve the manipulation of tens of thousands of genes, some of which may end up exchanging positions. Traditional cross breeding pairs two closely related, compatible species or genera to create a new variety, whereas genetic engineering can insert genetic material from any living organism – bacterial, animal, or plant (from the same species or a different one) – into the genome of a plant to create a new variety.

Proponents of genetic engineering maintain that modern molecular biology is an extension of traditional cross-breeding – a distinction without a difference. Opponents disagree. They regard such tinkering with the DNA of a plant as an open invitation to unhealthy, unsafe unintended consequences, particularly when the tinkering involves taking a gene from one species and inserting it into the DNA of a different species. But they don't have any scientific evidence to support these beliefs and fears.

Proponents claim to have history and science supporting their perspective. "The human race has been selectively breeding crops, thus altering plants' genomes, for millennia. Ordinary wheat has long been a human-engineered plant. It could not exist outside of farms, because its seeds do not scatter. For the past 60-some years, scientists have been using 'mutagenic' techniques to scramble the DNA of plants with radiation and chemicals, creating strains of wheat, rice, peanuts, and pears that have become agricultural mainstays. The practice has inspired little objection from scientists or the public and has caused no known health problems."

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Mutagenic techniques involve the large-scale transfer of genes between closely related plants or animals. "GM technology, in contrast, enables scientists to insert into a plant's genome a single gene (or a few of them) from another species of plant, or even from a bacterium, virus or animal. Supporters argue that this precision makes the technology much less likely to produce surprises. Most plant molecular biologists also say that in the highly unlikely case that an unexpected health threat emerged from a GM plant, scientists would quickly identify and eliminate it."[11]

Opponents of genetic engineering remain unconvinced and skeptical. They fervently believe that genetic engineering could result in unintended consequences involving health risks and, furthermore, that these risks would not necessarily be detected by food scientists.

Are GMOs dangerous to human health?

The preponderance of scientific evidence strongly suggests that GM crops are safe to eat. "Hundreds of peer-reviewed publications involve GE feeding studies on a wide variety of species – including laboratory rodents, chickens, quail, pigs, sheep, dairy cows, beef cattle, goats, rabbits, buffalo, and fish – measuring feed intake, nutrient digestion, performance, and health…. These studies, including some long-term research spanning multiple generations and many years, generally support the conclusion that there are no detrimental effects from the consumption of the currently available biotech crops…"[12]

Additional supportive scientific evidence about the safety of GE foods and feeds include:[13]

- "A 2011 summary report from the European Commission, covering a decade of publicly funded research, 130 research projects, and 500 research groups, similarly concluded that there is no scientific evidence of higher risks from GE crops to the environment or for food and feed safety."
- "The U.S. National Academy of Sciences concluded in 1987, and reaffirmed in 2000 and 2004, that GE poses no new or different risks to food safety."
- The American Medical Association has similarly concluded: "There is no evidence that unique hazards exist either in the use of rDNA techniques or in the movement of genes between unrelated species."
- "Although a handful of widely publicized small studies have claimed to find some adverse health impacts of GE foods on animals, these studies have been retracted and/or severely criticized by government and mainstream scientific organizations as poorly designed and unreliable."

Proponents of GE foods also argue that people's ordinary, everyday eating experiences support their belief that GE foods are safe to consume. "[P]eople have consumed as many as trillions of meals containing genetically modified ingredients over the past few decades. Not a single verified case of illness has ever been attributed to the genetic alterations." Although some of this research has been funded by GM companies such as Monsanto, "the European Commission has funded 130 research projects, carried on by more than 500 independent teams, on the safety of GM crops. None of those studies found any safety risks from GM crops."[14]

One common safety fear is that genetic engineering will introduce new allergens into foods where they haven't been before. In fact, the use of bacteria to vector transgenes with beneficial traits into crop plant cells occasionally has had the unintended consequence of also introducing allergenic proteins into the transferred gene. Companies seeking FDA approval for new GE plants must run many different food safety tests including several designed to identify new allergens. The tests are generally rigorous and successful in identifying known allergens. But these tests are regarded as less effective in identifying brand new allergens not previously known. The good news, according to Professor Steve Taylor, co-director of the Food Allergy Research and Resource Program at the University of Nebraska-Lincoln, is that, "the risk of novel allergens in DMOs is actually quite small," and he cites two reasons.[15] First, the number of new proteins in GE foods, where all allergens are proteins, is small, usually just a few for any given GMO. Second, the new genes in transgenic plants generally express low amounts of the new proteins. In short, the risk of new unknown allergens being added to GE plants is low, but it's not zero. Professor Taylor added that, in his opinion, the risk of encountering new unknown allergens is lower for GE plants than for new non-GE foods introduced from another country.

Yet some scientists and nutritionists remain skeptical, even among those who regard GM plants as generally beneficial. In this regard, Ashley Colpart's assessment is particularly relevant: "I don't think the current evidence shows that we should have concern for our safety in eating GE foods, but lack of evidence doesn't prove safety. ….It took many years for us to realize the dangers of hydrogenated oils. Trans fat was a game changer for the food industry, much like GM crops have been for agriculture…Long-term epidemiologic studies are difficult to conduct. My gut feeling, though, is that GM foods, on their own, are safe to consume; it's their coupling with pesticides that we should be concerned about."[16]

In general, critics of genetic engineering plants remain implacably opposed to GE foods and unconvinced by the near-unanimity of the scientific community.

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Have GM crops bred "superweeds?"

While genetically modified crops have contributed to the development of so-called superweeds, they do not bear sole responsibility. In fact, pesticide and herbicide resistance occurs in conventional crops as well as in those that are genetically modified. Nonetheless, some critics contend that, "Overreliance on herbicide-tolerant GE crops has resulted in an acceleration of glyphosate-resistant weeds. Weeds resistant to glyphosate are now present in the majority of soybean, corn, and cotton farms in some U.S. states. Herbicide-resistant weeds are symptomatic of a bigger problem, which is a system of farming that relies on planting huge acreages of the same crop year after year – a system referred to as monoculture. Such a system has provided an especially good habitat for weeds and pests."[17]

"Glyphosate-tolerant plants could be construed as victims of their own success. Farmers historically have used multiple herbicides, which slowed the weeds' development of resistance. They also controlled weeds by plowing and tilling – practices that deplete topsoil and release CO_2 without encouraging resistance. GM crops allowed growers to rely almost exclusively on glyphosate, which is less toxic than many other chemicals and kills a broad range of weeds without plowing. Farmers planted these glyphosate-tolerant crops year after year without varying crops or varying chemical herbicides to deter resistance."[18]

Do GMOs promote herbicide overuse?

Some soil scientists maintain that herbicide-tolerant GMOs have contributed to herbicide overuse. One high-profile critic, Christine McCullum-Gomez, declared that, "Herbicide-tolerant GE crops have made weed management easier for farmers, but overuse of the technology has resulted in an acceleration of weeds resistant to glyphosate [i.e., Monsanto's Roundup-Ready], the world's most popular herbicide. In response to the rise in glyphosate resistance, farmers have turned to using other herbicides, often needing to apply several herbicides in a single growing season, to protect their crops."[19]

Other experts, however, disagree. One well regarded scientific study concluded that "herbicide-resistant GM crops are less damaging to the environment than conventional crops grown at industrial scale."[20] PG Economics, a consulting firm in Dorchester UK, found that the introduction of herbicide-tolerant cotton reduced the overall use of herbicides by 6.1 percent during 1996-2011 from those that would have been used on conventional cotton. Plus, the GM cotton also delivered other environmental benefits.

Monsanto and other biotech companies are already hard at work developing other herbicide-resistant plants that work with different chemicals and take the place of Roundup. But scientists anticipate that these new GM technologies will eventually lose their effectiveness too. Still, no serious scientist is advocating against the use of all chemical herbicides. And it's generally agreed that chemical herbicides are more effective at controlling weeds than plowing and tilling the soil. According to one weed scientist: "When farmers start to use more sustainable farming practices together with mixtures of herbicides they will have fewer problems."[21]

Do GMOs promote farm sustainability?

Many scientists and GMO advocates argue that genetically engineered crops are improving the sustainability of farm practices in several ways. First and foremost, many genetically engineered crops allow growers to produce more food with less water and less land, which conserves fresh water and prevents forests and undeveloped lands from being converted into farmland. Thus, GMOs protect biodiversity. Additionally, GMOs reduce the need for tillage to control weeds, preventing soil erosion and reducing fossil fuel consumption through farm equipment use. Less tillage allows organic matter to accumulate faster, reduces soil compaction, and results in overall healthier soil.

GMO opponents disagree. To them, GMOs diminish the sustainability of farming as GMO crops pollinate and cross-fertilize with non-GMO crops, making it increasingly difficult to segregate and propagate non-GMO plants. Opponents also claim that GMOs encourage monoculture production of crops, which damages the soil. Monoculture farming, they stipulate, also increases insecticide use, whereas other crop management practices such as regular crop rotations, can minimize pest pressures. Opponents also contend that overdependence on the application of glyphosate has accelerated weed resistance, causing herbicide use to continually increase, not decrease.

Who regulates GE crops?

The U.S. established its current system for regulating GE crops during the 1980s. The National Research Council (NRC) investigated the matter and issued a report in 2002 with three key conclusions:[22]

1. That "both transgenic [GE] and conventional approaches (e.g., hybridization, mutagenesis) for adding genetic variation to crops can result in unintended effects on crop traits."
2. That it is the rearrangement of genes that causes these unintended effects, and not the method by which they were altered.
3. "[T]hat there are 'no new categories of risk associated with transgenic [GM] plants.'"

Guided by these NRC conclusions, Congress decided that GE crops would be "regulated under the same federal laws that govern the health, safety and environmental impacts of their counterparts produced through more traditional means." Subsequent investigations and inquiries have reaffirmed these same principles.

Three separate federal agencies are responsible for regulating GE plants – the Food and Drug Administration (FDA), the USDA, and Environmental Protection Agency (EPA).[23] Each agency has its own regulatory purview. The FDA is responsible for the safety and labeling of foods and animal feeds produced from all crops, including GE plants. Its regulatory authority is based on the Federal Food, Drug, and Cosmetic Act (FFDCA) of 1938. The USDA regulates all GE plants prior to their commercial release, and does so through its Biotechnology Regulatory Service (BRA) office of the Animal and Plant Health Inspection System (APHIS). Its main concern is agricultural and environmental safety, and its regulatory authority is derived from the Plant Protection Act of 2000. APHIS's primary responsibility is to control or prevent the spread of plant pests and noxious weeds; oversee the environmental consequences and safety of planting and field-testing GE plants; and ensure that field tests of GE crops are conducted under controlled conditions. APHIS's regulations also provide a petition process for de-regulated status, a necessary pre-condition for commercialization of GMO crops. The EPA is mainly concerned with the environmental and human health effects of pesticides, and the agency regulates GE plants with altered pesticide traits – including those GE crops with a Bt trait.

Not all newly developed GE plants will be reviewed by all three agencies, but all such plants will be reviewed by at least one of these three agencies. Some newly developed GE plants, it was recently revealed, can be commercially released without getting official approval from APHIS. All of these exceptions "rely on either new approaches or new wrinkles on traditional recombinant DNA techniques in their provenance."[24] Nonetheless, the developers of all GE plants, including those not needing regulatory approval from APHIS, must still convince the FDA that the new plant varieties do not pose a risk to human safety.

How does the FDA ensure that GE crops are safe to consume?

The U.S. Food and Drug administration (FDA) regulates the safety of foods and food products from all plants, including those that have been genetically engineered. Toward this end, the FDA has established a voluntary consultative process whereby it works with developers of GE plants to ensure the safety of these products. Foods from GE plants must meet the same requirements, including safety standards, as foods produced from traditionally bred plants.

Developers of GE plants are "encouraged," but not legally required, to consult with the FDA prior to marketing their products. To date, developers of all commercially distributed GE plants have opted to participate in this voluntary consultation. In these consultations, the developers identify the distinguishing attributes of new genetic traits and provide their assessments of whether the new GE plants, when consumed, could be toxic or allergenic.

In addition, the developers also provide comparisons of the levels of nutrients contained in the GE plants – i.e., fiber, protein, fat, vitamins, and minerals – with those contained in traditionally bred plants. In turn, the FDA's Biotechnology Evaluation Team (BET) evaluates this information for safety and compliance with the law. Potentially important issues include, for example, significantly increased levels of plant toxicants or anti-nutrients, reductions of important nutrients, new allergens, or the presence in the food of an unapproved food additive. The FDA will regard this consultation as completed only after the BET's scientists are satisfied with the developer's safety assessments and have no further questions regarding safety or regulatory issues.

The FDA established this consultative process in the early 1990s, just as the development of GE plants was getting started. In 1994, the FDA vetted this process with food and feed safety experts from outside the agency. All agreed that, "based on the types of bioengineered foods and feeds under development, the consultation procedures provide an appropriate level of government oversight."[25]

Opponents of genetic engineering question the validity of the FDA's consultative process in regulating GM foods. After all, in regulating pharmaceutical drugs, the FDA insists upon even more rigorous testing. Opponents question why the regulation of GM foods should be any less rigorous.

Should GMOs be required to be labeled as such?

Whether GE foods should be required to be labeled is a highly controversial, emotional issue. Proponents of labelling maintain that the "right to know what is in their food" ought to be an inalienable right of every citizen of a democratic society. But labeling opponents disagree, on the grounds that mandatory labeling of GE foods would (a) increase the cost of food and (b) confuse some consumers into believing that GE foods entail non-negligible risks to human health and safety when, in fact, there is no science-based evidence supporting such beliefs.

At this point in the ongoing debate, opponents of labeling appear to have both the scientific community and the

FDA on their side. As noted above, the preponderance of scientific evidence indicates that GE crops are safe to eat. There have been hundreds of peer-reviewed scientific studies, and all but a small handful have concluded that GE foods are as safe to consume as their non-GE counterparts. Hence, David Zilberman, an UC Berkeley agricultural and environmental economist and one of the few researchers considered credible by both sides, "argues that the benefits of GM crops greatly outweigh the health risks, which so far remain theoretical. The use of GM crops 'has lowered the price of food …[and] increased farm safety by allowing them to use less pesticide. It has raised the output of corn, cotton, and soy by 20 to 30 percent, allowing some people to survive who would not otherwise have without it. If it were more widely adopted around the world, the price [of food] would go lower, and fewer people would die of hunger.'"[26]

Mandatory labelling of GE foods would impose various costs on food producers. Segregation costs would be incurred as producers establish procedures for ensuring that GE foods will not be commingled with non-GE foods. Food producers would also incur costs for testing, certification, and traceability to authenticate that certain foods have been kept GE-free. Plus, the costs of acquiring non-GE crops for use in processed foods would also be higher than the costs of GE crops, because growers obtain substantially higher yields for GE crops. The total amount of these costs of labelling ultimately would depend on the GE purity standards and tolerances. Virtually everyone who has studied the issue concurs that perfect purity – i.e., zero tolerance – is unattainable. That said, the purer the standard, i.e., the closer to zero tolerance, the higher the costs. And while these costs would fall first on the processed food manufacturers, they would in turn pass along some of this incremental cost, and perhaps even the lion's share, to consumers. The burden of these passed-along costs would fall heaviest on the poorer consumers who spend proportionately more of their take-home pay on food.

Under current law, any decision about mandatory GE labeling at the national level rests with the FDA. The Food, Drug, and Cosmetic Act (FDCA), as passed by Congress and signed into law in 1938, expressly grants authority for food labeling to the FDA. In 1992, the FDA issued a statement that it has no factual basis for concluding that GE foods "differ from other foods in any meaningful or uniform way, or that, as a class, foods developed by the new techniques present any different or greater safety concern than foods developed by traditional plant breeding." Indeed, absent strong scientific evidence that GE foods are unsafe and harmful, the FDA rejects the idea of mandatory labeling of GE foods. With the issue framed in this way, it is difficult to see how the FDA could come to any other conclusion.

Several states, however, do see things differently. Proponents of GMO labeling have succeeded in getting mandatory labeling laws passed in three Northeastern states – Connecticut, Maine, and Vermont. (At least 25 states have considered GMO labeling initiatives in recent years, but those three states are the only ones to date that have actually adopted them.) Connecticut passed its law in June 2013, but it requires that at least four other Northeastern states with a combined population of no fewer than 20 million must approve similar acts before the law takes effect. Maine followed suit in early 2014 with its own mandatory GMO labelling law, but its law will also not go into effect until five nearby states, including New Hampshire, pass similar labeling laws. In May 2014, Vermont's governor signed H.120 into law calling for mandatory GMO labelling to take effect by July 1, 2016, without any provision that other nearby states must also follow suit. But one month later, the Grocery Manufacturers Association filed a lawsuit contesting H.120 on the ground that it violates the U.S. Constitution by compelling manufacturers to "convey messages they do not want to convey." This lawsuit is currently being litigated in the courts.

Do consumers have a right to know what's in their food?

Those who favor mandatory labeling of GE foods are unpersuaded by the arguments against doing so. They still harbor misgivings and anxieties about the safety and healthfulness of GE foods. They don't want to eat GE foods, nor do they want their families or pets to eat them. They assert that, as citizens of a democratic society, they have a right to know what GE ingredients are contained within the food that they consume.

American citizens do have a right to know what kinds of ingredients are included in the foods that they consume, and food manufacturers are required to identify these ingredients on labels. But the FDA does not require food manufacturers to identify whether any of these ingredients were produced from GE crops. Congress could create such a right if it were so inclined, but it delegated the decision about mandatory labeling to the FDA under the FDCA of 1938. In turn, the FDA has opted not to impose mandatory labeling of genetically engineered foods and based its decision on what reasonable people would generally agree is in the citizenry's overall best interest.

Moreover, those who are fearful of the theoretical ill effects of GE foods can avoid such foods today if they so wish. All that they would need to do is to restrict their diets to organic foods – and in particular to those foods certified as organic. Such certification is withheld from GE foods.

Which countries have bans in place on GMO crops?

Few countries impose an outright, blanket ban on the production and consumption of GMO crops. Worldwide, Kenya and Peru are the only two countries that do so.

Elsewhere in the world, GMO crops face varying degrees of restrictions. As of 2013, GMO crops were grown, imported, or field tested in 70 countries, and that number hasn't changed materially since then. The governments of these 70 countries have all instituted their own rigorous GMO certification processes, with the aim of ensuring that GMO crops are safe for both human consumption and the environment. Of those 70 countries, 28 produced GMO crops in 2014, with the U.S. leading the pack by a wide margin.[27] *(See map.)* U.S. growers devoted 181 million acres to GMO crops in 2014, whereas Brazilian growers (the second largest cultivator of GMO crops) devoted 104 million acres.

While the EU is usually depicted as adamantly anti-GMO, the reality is more nuanced. Five of the 28 EU members do permit their growers to plant select GMO crops (i.e., Spain, Portugal, Czech Republic, Romania, and Slovakia); the other 23 members do not permit GMO production. At the same time, GMO crops and food or feed derived from them can be imported into, and marketed within, the EU provided that they meet the appropriate safety and environmental requirements.[28] (Still, the EU has had a de facto moratorium on new GMO approvals since 2001.) But all foods and feeds containing GMO ingredients must be labeled as such to ensure traceability, and the food companies that market their products in the EU have opted to reformulate all of those products to eliminate GMO ingredients. Nonetheless, food products from animals raised on GMO feed are not required to be labeled, and Europeans continue to consume these products.

Has the EU relaxed or lifted its restrictions on GE crops?

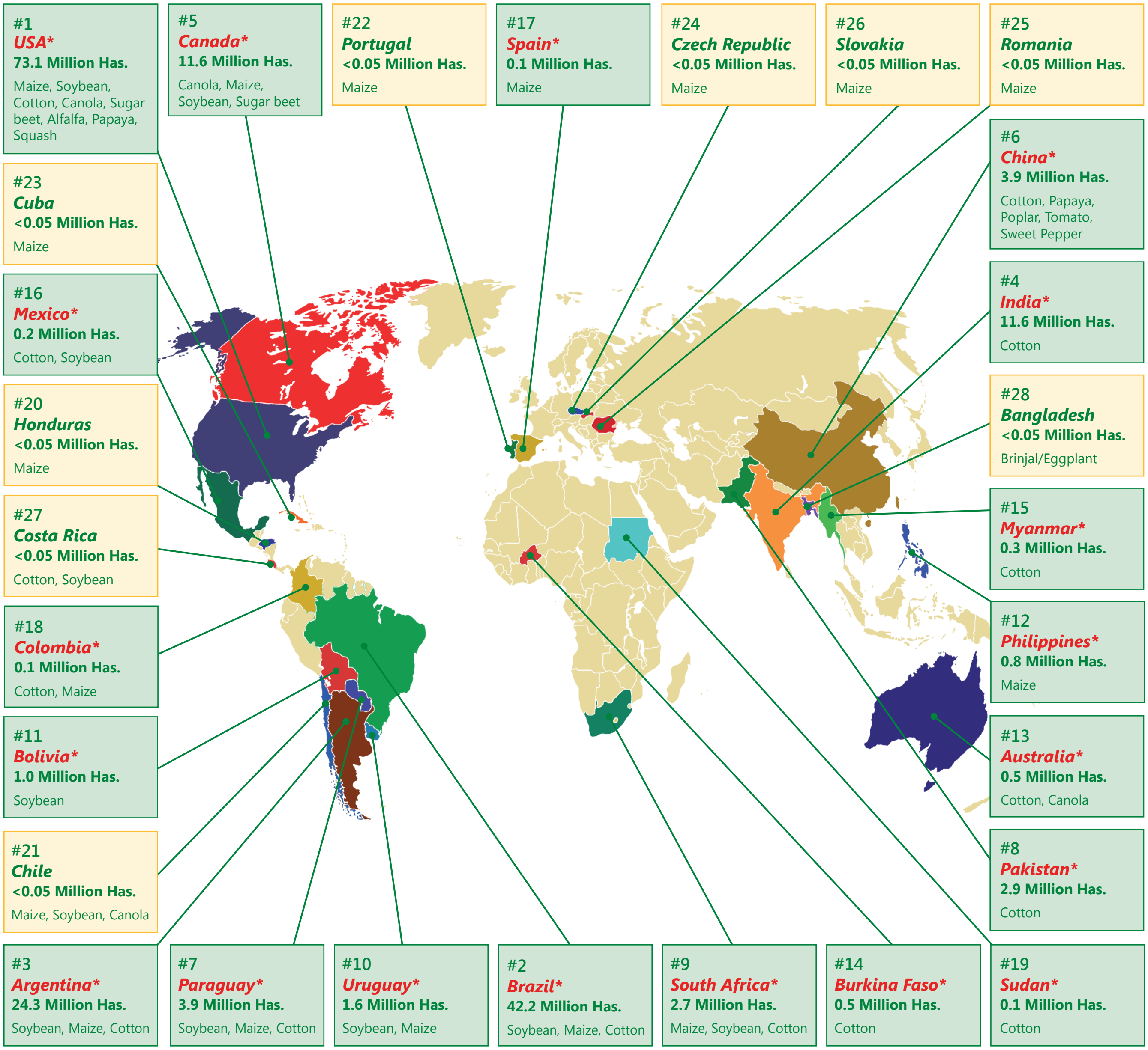
The EU's fervently anti-GMO stance promised to be a major sticking-point in the negotiations regarding the proposed Trans-Atlantic Trade and Investment Partnership, i.e., the EU-U.S. free trade agreement. Hence, on January 13, 2015, the EU Parliament ministers approved a legislative bill enabling EU member states to decide individually whether or not to ban GE crops within their national borders. The new bill takes effect in spring 2015.

The EU's January 13 bill was a compromise. Several European countries including the UK, Sweden, and Spain had urged that the EU's strict GMO rules needed to be relaxed; and under the new law, they can now do so. But many other European nations would prefer to make the EU's GMO rules even stricter; and under the new EU law, they can do so too. The new rules allow EU member countries to ban GMOs on grounds other than risks to health and environment – e.g., town and country planning requirements, socioeconomic impacts, and farm policy objectives.

What role will GMOs play in helping to feed the world in 2050?

Current population projections call for the world to add another 2 to 3 billion people by the year 2050. In addition, the world's population is becoming more prosperous. Those extra 2 to 3 billion people along with the other 6 billion people who inhabit the earth will desire and be able to afford not just more calories, but more varied diets including greater helpings of meat and fish protein. Between now and 2050, the world's agricultural producers will have to increase their output by 50-100 percent to meet the needs of the growing and increasingly prosperous population for food, feed, nutrition, and renewable biofuel sources, and do so in the face of reduced supplies of fresh water, less arable land, shifting climates and frequent droughts, increased global trade, and political unrest and turmoil.

Biotech Crop Countries and Mega-Countries*, 2014



***19 biotech mega-countries growing 50,000 hectares, or more, of biotech crops.**

Source: Clive James, 2014.

Scientific and technological advances of all sorts will be essential to meet these growing needs and demands while also promoting sustainable agriculture. Many scientists and policymakers view genetic engineering as playing a critical role in helping to meet those needs along with other forms of biotechnology, precision agriculture, and conventional agriculture. GM crops have already delivered major benefits, with the promise of many more to come: "GM crops have increased harvests by decreasing losses to pests, decreased input and labor costs, reduced the impact from agrichemical use, helped conserve soil and water resources, and conferred a number of environmental and sustainability gains."[29] GM crops have also increased harvests by creating new plant breeds that require less water and thus are less susceptible to drought.

GMO opponents maintain that the potential costs and risks associated with genetic engineering far outweigh the benefits and gains. However, as discussed earlier, the preponderance of scientific evidence strongly suggests that GM crops are safe to eat and cultivate. Granted, no one can guarantee that GM crops are 100 percent safe. But neither can such a guarantee be given for conventionally grown crops and foods. Meanwhile, the benefits of GM crops are clear-cut. Perhaps, the world's growing population can be fed adequately and affordably without the use of GM crops. But if not, many people will end up going hungry or even starving. Why take a chance, especially when the costs and risks associated with GM crops are so small?

Concluding Thoughts

Few Americans care one way or the other; but among those who do, GMOs remain highly controversial. Proponents and opponents continue to argue, bicker, and disagree about the safety of GMOs for human health and the environment, with no middle ground where the two sides can compromise.

GM crops have already delivered major benefits, with the promise of many more to come.

Proponents of GMOs would appear to have the upper hand in these disputes, considering that virtually all of the scientific evidence that has been amassed about GMOs concludes resoundingly that GE foods are safe to eat and are environmentally benign. Plus, the extensive testing procedures required by the FDA, the USDA, and EPA further validate the safety and healthfulness of GMOs. And finally, never once in the past 25 years has there been a single verified case of human illness attributed to GE plants.

Yet opponents of GMOs remain unpersuaded. They dismiss the findings, conclusions, and pronouncements of pro-GMO scientists and government testing agencies as propaganda and unproven. With GMO opponents unwilling to accept the findings and conclusions of scientists, it's doubtful that they would be willing to believe or agree with anyone else who does not share their belief in the intrinsic harmfulness of GMOs. However, GMO-proponents do bristle at their opponents' determined efforts to limit GMO research or to impose mandatory labeling on society as a whole – thereby imposing their minority views on everyone else.

Endnotes

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