


Genetically Modified Foods

Benefits and Risks



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Genetically Modified Foods: Benefits and Risks

SUMMARY: Genetically modified foods have been around for about two decades and are deemed generally safe, yet they continue to generate controversy. While some studies show that these engineered foods are as safe as traditionally grown foods, other studies show deleterious effects in animals. In a meta-analysis, most of the studies showing genetically modified foods in a positive light were noted to have a conflict of interest. The scientific community is concerned about industry restrictions on testing of genetically modified seeds. Also, there is concern that profit may be fueling the adoption of genetically modified crops. Ongoing independent studies to evaluate safety are needed. Scientific, economic, environmental, social, ethical, and political perspectives will need to be considered.

CONTENTS:

Introduction.....	2
What is Genetically Modified Food?	2
Benefits	3
Safety and Risk Assessment	3
Controversy and Opposition to Genetically Modified Foods	5
Conclusion	6
Appendix.....	7
References	8

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Introduction

Genetically modified foods have seeped into the daily diet in the United States. According to experts, approximately 60–70% of processed foods in the United States contain genetically modified components.¹ The most common genetically engineered foods are soybean, maize/corn, rapeseed oil,^{1,2} tomatoes, potatoes, tobacco, rice, cranberries, raspberries, walnuts, and papayas.³ Thus, common foods containing corn or high-fructose corn syrup (breakfast cereals, snacks, soda), soybean, and canola oil could have genetically modified components.¹

What is Genetically Modified Food?

Several centuries ago, when people started domesticating crops and animals, they began selecting better plants for cultivation and better animals for breeding, initially unknowingly and later intentionally. Over thousands of years, farmers developed plants with desirable traits, such as increased resistance to disease, larger fruit, and greater nutritional content. Scientific discoveries and technological advances have continuously improved agriculture.⁴

Traditional agricultural methods (both conventional and organic) involve modification of genes of plants to develop desirable traits. However, the breeder selects for genes indirectly by selecting parent plants with the desirable traits; there is no direct control at the DNA level because the reorganization of the genetic material occurs in a random fashion. In contrast, genetic engineering leads to highly targeted transfer of genes.⁴ Because the basic structure of DNA is identical in all living things, scientists can take one or more specific genes from almost any organism, including plants, animals, bacteria, and viruses, and insert them into the genome of another organism.⁴ This process is called recombinant DNA technology.^{4,5}

In agricultural biotechnology, recombinant DNA technology is used to change the plant's genome. Once a gene with some desirable genetic trait is identified, it is extracted and inserted into another plant's genome. Plants that contain genes from another organism are called “transgenics,”^{3,4} “genetically engineered (GE) plants,”⁶ or, more broadly, “genetically modified organisms (GMOs).”⁴ Since plants enhanced through traditional methods can also be considered genetically modified, the U.S. Food and Drug Administration (FDA) considers “genetic engineering” to be a more precise term.² The American Medical Association (AMA) also uses the terms “bioengineered” or “genetically engineered” to refer to foods produced through transgenic technologies.⁷ The European Commission

refers to these foods as GMOs.⁸ For the purpose of this paper, GM and GE will be used interchangeably because both American and European articles are referenced.

GM crops are classified into three “generations,” based on the objective of the trait that is being introduced:⁶

1. **First-generation** GM crops are grown from seeds that have been derived with the help of biotechnology to increase production of crops. These seeds have specific traits to make them resistant to herbicides, pests, viruses, etc. The ensuing crops are not significantly different from the traditionally grown crops in terms of appearance, taste, and nutrition. Examples of such crops are herbicide-resistant soybean, insect-resistant maize, and herbicide- and insect-resistant potato.⁶
2. **Second-generation** GM crops have new traits to increase the benefits for consumers, such as increased levels of protein, modified or healthier fats, modified carbohydrates, increased flavor, or increased micronutrients. Examples of such crops include rice with a higher level of beta-carotene, tomatoes with higher levels of carotenoids, maize with increased Vitamin C, soybean with improved amino acid composition, and potatoes with higher calcium content.⁶
3. **Third-generation** GM crops are in the research pipeline. These plants may have traits that can provide increased ability to resist abiotic stress such as drought, increased temperature, or saline soils. Other traits may provide health benefits. Yet another objective may be to create “pharmaplants” to help produce active pharmaceutical products.⁶ In February 2009, the U.S. Food and Drug Administration (FDA) approved the license for a recombinant antithrombin for prevention of blood clots in patients with hereditary antithrombin deficiency. Recombinant antithrombin is the first human biologic drug derived from the milk of goats that have been genetically engineered to produce human antithrombin in their milk.⁹ In April 2013, the Flemish Bio Safety Council approved field experiments for genetically modified crops such as poplar and corn because it believed that the health risks were “virtually non-existent” if strict controls were in place. The Flemish Institute for Biotechnology is overseeing a trial of poplar trees engineered to produce less lignin, a trait that makes it easier to convert the wood into bio-fuels.¹⁰

Like any new technology, the agricultural biotechnology poses benefits and risks. Various economic, environmental, social, ethical, and political issues must be considered.

Benefits

GM foods are developed because of some perceived benefits to the producers and the consumers.¹¹ The World Health Organization (WHO) and the United States Department of Agriculture (USDA) have outlined a comprehensive list of the benefits of GM foods.¹² This list is discussed below.

Insect Resistance

Agricultural biotechnology has been used to make the plants insect-resistant.³ Insect-resistance is achieved by introducing the gene for toxin production from the bacterium *Bacillus thuringiensis* (Bt). This toxin is currently used as an insecticide and is considered safe for human consumption. Plants that produce this toxin thus require lower quantities of external insecticides.¹² Such genetic modification can make the crop production cheaper and more manageable, as well as make pest control safer. Additionally, there is decreased contamination of the groundwater and the environment from pesticides, which benefits farmers, producers, and consumers.¹¹

Herbicide Resistance

Biotechnology is also used to develop herbicide-resistant crops such as soybean, cotton, and corn, which reduce cost and environmental impact. Herbicide-resistant crops decrease or eliminate the need for pre-emptive application of herbicides and for herbicides with greater toxicity. Herbicide-resistant crops also require less tilling of soil and thus preserve topsoil from erosion.¹¹ Herbicide-resistance is achieved by the introduction of a bacterial gene to convey resistance to some herbicides.¹²

Disease Resistance

Plants can also be engineered to resist disease better than natural crops. For example, when a viral disease significantly threatened the Hawaiian papaya industry, the papayas were made disease-resistant through genetic engineering.

Similar research is being conducted to make plants such as potatoes, squash, tomatoes, and other crops disease-resistant.¹¹

Nutritional and Other Enhancements

Genetic engineering can now produce nutritionally enriched plants (e.g., “Golden Rice” has more Vitamin A due to incorporation of genes from a microbe and from daffodils),³ longer lasting plants, and plants with lower levels of naturally occurring toxicants.¹¹

Other Benefits

GM plants can also be used for phytoremediation (use of plants to detoxify soil or groundwater), to conserve natural resources, to decrease nutrient runoff in the rivers, and to help meet the increasing world food demands using a limited

amount of land.¹¹ Hardier crops can be created to better endure harsher climates, lessening the amount of fuel, labor, fertilizer, and water needed. Such innovations can help mitigate the effects of climate change.¹¹

In the future transgenic plants may be used to produce large quantities of inexpensive pharmaceuticals, polymers, enzymes, modified oils with decreased fat content,³ and modified foods with decreased allergens.¹²

Safety and Risk Assessment

The WHO has identified three main issues of concern for human health with respect to genetically modified foods: allergenicity, gene transfer, and outcrossing.¹²

Allergenicity

GM foods have the potential to cause allergic reactions in general; this risk is comparable to the risks associated with traditionally grown foods.¹³ However, the proteins produced by any newly introduced genes have the potential to cause an additional allergic response.¹¹ To prevent such allergenicity, the transfer of genes from commonly allergenic foods is discouraged unless it can be proven that the protein produced by the introduced gene will not be allergenic.¹² Also, tests are conducted to examine the heat and digestive stability of these proteins, and any similarity to known allergenic proteins.^{2,11} It is important to note that the traits that are introduced into a particular plant may be new to that plant but are often found naturally in other plants.¹¹

Another potential risk is the introduction of an entirely new protein that did not previously exist in the food chain. Many, but not all, genes used in GM foods are novel and do not have a history of safe food use. Assessment of potential allergenicity to novel proteins is more difficult because of the lack of definitive tests to determine such risk. To test risk, researchers may compare the sequence of transferred genes to the sequence of known allergenic proteins, study the stability of newly expressed proteins against digestion, and make allergenicity predictions. This is a subject of ongoing scientific research. Numerous agencies at the national and international level have instituted guidelines for premarket risk assessment.¹³ So far, WHO has not found any evidence of allergic response to the GM foods currently on the market.¹²

Even though biotechnology is quite precise, there is the potential risk of random insertion in the host genome. Random insertion of genes may lead to instabilities at the genetic or phenotypic level. However, as yet, there is no clear scientific evidence of such effects.¹³ Of note, random insertion of genes can occur in traditional breeding as well. Gene expression in traditional and GM crops is subject to

environmental factors such as heat or drought, which can turn gene expression up or down. Assessment of such environmental effects is necessary.¹³

Some examples of the potential production of, and response to, allergens include GM soybeans expressing methionine from the Brazilian nut and farm workers exposed to transgenic, insect-resistant Bt crops exhibiting skin reactions.¹⁴

The cellular basis of the immune response is not fully understood and thus ongoing research is required in order to better understand the interaction of the immune system with GM foods, apart from allergenicity.¹³

Gene Transfer

Another potential concern arising from GE foods is the transfer of genetic material from GE foods to the cells of the human body or the bacteria in the intestinal tract.¹² DNA from ingested food is not completely degraded by digestion and small fragments of DNA from GM foods have been found in different parts of the gastrointestinal tract. This could result in horizontal gene transfer due to absorption of DNA fragments by gut microflora or somatic cells lining the intestinal cells. Dona and Arvanitoyannis have cited various studies that detected fragments of transgenic genes in the gastrointestinal tract, muscles, and white blood cells and milk of cows. Other scientists have shown limitations in the detection of GM DNA by currently available tests. Scientists have also postulated that uptake of GM DNA into the cells of the gastrointestinal tract will not have any biological consequences because this DNA will be degraded in the cells. However, it is not clear if people with gastrointestinal diseases will be able to fully degrade this GM DNA.¹⁴ A comprehensive scientific evaluation of this problem is a colossal task because only about 1% of the naturally existing bacteria can be cultured and thus analyzed.¹³

Theoretically, antibiotic-resistant genes introduced into GM plants could be transferred to humans in the same manner. Even though the probability of such an occurrence is extremely low, the Food and Agricultural Organization of the United Nations (FAO) and WHO encourage the use of technology without antibiotic-resistant genes and discourage the use of unnecessary DNA sequences.^{12, 13}

Outcrossing

The movement of genes from GM plants to traditional plants or related species in the wild is known as “outcrossing.”¹² As an example, in 2000, traces of “Starlink” GM maize that was approved only for feed use appeared in the maize for human consumption in the United States.¹³ If GM plants are grown in proximity to related plants there is a potential for exchange of the new traits via pollen.¹¹ After the Starlink case, several

countries adopted strategies to reduce mixing and to clearly separate GM and traditional crops.¹² Farmers may also use buffer zones, pollen barriers, crop rotation, and monitoring during harvest, storage, transport, and processing to manage outcrossing.¹³ In the case of GM plants, the EPA and USDA conduct risk assessments to minimize harm. Risk of transfer of genetic material exists even in traditionally grown plants.¹¹

The USDA Animal and Plant Health Inspection Service (APHIS), Environmental Protection Agency (EPA) and FDA are responsible for ensuring the safety of crops, in collaboration with breeders who evaluate the crops.¹¹ According to WHO, all GM foods should be assessed before being allowed on the market. The Codex Alimentarius Commission (CAC), an intergovernmental body with 185 current members, has established the Codex Standards¹⁵ for risk analysis to protect the health of the consumers and to facilitate the trade of food by setting international standards.¹⁶

In addition to the three main categories of risk with GM foods, there are other potential risks of GM foods:

Pleitropic and Insertional Effects

A single gene can be responsible for or affect more than one phenotypic characteristic. This is called pleiotropy.¹⁷ Introduced genes in GM foods could potentially silence the existing genes, change expression of genes, or turn on genes that were previously not expressed. Transgenic genes could interact with existing genes and biochemical pathways of plants in unpredictable ways and lead to production of toxic compounds. Genes only account for a portion of the control on the biochemical processes of an organism; there are other levels of controls. Thus, the results of GE can be unpredictable and the GM products unstable. It is important that the entire transgenic food, not just the single protein, be tested for toxicity.¹⁴

Increase in Anti-nutrients

Anti-nutrients are substances that interfere with the utilization of nutrients.

The insertion of a new gene may lead to an increase in the existing levels of anti-nutrients. For example, glyphosate-resistant Roundup Ready soybean has been shown to increase anti-nutrients. In sheep and cattle, heat-stable anti-nutrients such as phytoestrogens, glucinins, and phytic acid have been found to cause infertility, allergic reactions, and decreased availability of phosphorus and zinc, respectively.¹⁴

Use of Viral DNA in Plants

Most GM crops utilize the Cauliflower Mosaic Virus 35S promoter (CaMV35S) to switch on the introduced gene. There is controversy as to whether CaMV35S could be horizontally

transferred and cause disease via carcinogenesis, mutagenesis, reactivation of dormant viruses, or generation of new viruses. Some scientists believe that CaMV found in foods is not infectious and cannot be absorbed by mammals. Some scientists also point out that humans have been ingesting CaMV and its 35S promoter in high amounts and it has never caused any disease or recombined with other viruses. Ongoing studies are needed to analyze this issue.¹⁴

Environmental Effects

Beyond the potential direct effects on human health, GM plants also have environmental effects on non-target organisms (organisms that are not pests), such as birds, insects, worms, bees, and fish.^{11,12} Other potential environmental risks are the persistence of the gene after the GMO has been harvested, and the potential for gene instability, biodiversity loss, or increased use of chemicals in agriculture.¹² APHIS and the EPA do review any environmental impacts of GE crops prior to field testing and commercial release.¹¹ While environmental effects are likely to affect humans, an in-depth discussion of the environmental effects of GM crops is beyond the scope of this paper.

Controversy and Opposition to Genetically Modified Foods

Companies that produce GM seeds (such as Monsanto, Syngenta, and DuPont) exert broad control over the use of seeds by mandating that the farmers enter into a “Technology/Stewardship Agreement.” This agreement outlines the conditions under which the seed may be used, where it may be grown, where it may be sold, and the brand of herbicide that may be used. This is known as “bag-tag,” and it also restricts the research on seeds. Scientists working through public grants are no longer free to conduct independent analyses on the seeds. They need to obtain approval from each seed company or gene patent holder.¹⁸

The scientific community has been frustrated by these industry restrictions on independent research. Entomologists are concerned about whether pest insects will become resistant to Bt-derived toxins. Crop scientists are unsure how long glyphosate (known as Monsanto’s Roundup — an herbicide to which plants were genetically engineered to be resistant) will remain effective; meanwhile, weeds are also developing resistance. In 2009, two dozen scientists representing public research institutions in seventeen corn-producing states informed the EPA about industry practices and warned that industry influence had made independent research on transgenic crops infeasible. In response, the seed companies met with the scientists and agreed to research agreements called Academic Research Licenses (ARLs) with public institutions.

ARLs eliminated the need for the scientists to apply for research on a case-by-case basis. However, the bag-tag restrictions were not removed, as seed companies cited reasons of competitiveness. Due to ongoing grievances from the scientific community, in 2012, the industry, through its American Seed Trade Association (ASTA), agreed to allow greater latitude to study the effects of GM crops on soil, pests and pesticide use, and to analyze environmental effects. However, the industry continues to restrict research on engineered plant genes. The studies on patent-protected aspects of cultivation, such as breeding processes, reverse gene engineering, and gene modifications are still restricted by industry.¹⁸

Facing shrinking public funds, scientists are increasingly dependent on seed companies for research funding. Universities must still negotiate the terms of the ARLs with each company. Doug Gurian-Sherman, a senior scientist in the Food and Environment Program at the Union of Concerned Scientists (UCS) feels that the agreement with the industry is vague, voluntary and difficult to enforce. Gurian-Sherman asserts that the improvements in crop yield have occurred by conventional breeding and not as a result of planting GM crops, as claimed by the industry.¹⁸ Gurian-Sherman argues that the vast majority of genetic improvements of crops have occurred through breeding and not through GE, and that GE has provided almost nothing since Bt and Glyphosphate herbicide resistance. Only about 10–15% of the world’s cropland is growing GMOs, consisting mainly of five crops — feed corn, soybean, cotton, canola, and sugar beets. The vast majority of GMOs are not feeding people directly but being used for animal feed, biofuel, or fiber. Additionally, the GM traits being used today are mostly to make plants insect-resistant (Bt trait) and to make them herbicide-resistant (Roundup Ready trait). Farmers have essentially switched from one kind of insecticide or herbicide to another. Gurian-Sherman feels that it is possible that GE will make some contributions in the future but they are likely to be modest and expensive.¹⁹

Bill Freese, science policy analyst for Center for Food Safety, states that even if the agreement with the industry is implemented, it would only affect the crops that have already been commercialized. He believes that it is vital to study the seed before they receive federal approval, because once approved, it is almost impossible to withdraw a crop from the market.¹⁸ He argues that agricultural biotechnology companies such as Monsanto exploit the food crisis by raising the prices of GM seeds and pesticides, and are driven by profits not to feed the world’s poor. Farmers in developing countries cannot afford the seeds and pesticides at these exorbitant prices. U.S. farmers are facing dramatic increases in the prices.²⁰

A report generated by Friends of the Earth states that the vast majority of GM crops is not grown for the world’s poor,

but is actually used as animal feed, biofuels, or for producing highly processed foods consumed in rich countries. It asserts that the agricultural biotechnology industry has not produced a single GM crop with increased yield, drought-tolerance, or salt-tolerance. In 2008, 85% of all GM crops worldwide were planted for the benefit of herbicide-resistance (mainly Monsanto's Roundup Ready crop used with Roundup herbicide). In 2008, the United States, Argentina, and Brazil were responsible for 80% of GM crops. The United States alone produced 50% of the world's GM crops in 2008. Experience in these three countries has confirmed that GM crops have in fact led to increased pesticide use, including the use of toxic chemicals banned in some European countries. In some cases, the crop yield was in fact found to have decreased. Herbicide-resistant crops (mainly soybean) continue to be popular with large growers because they simplify and reduce the need for labor for weed control. The simplification and reduced labor costs make up for the reduced yield and high price of seeds.²¹

Domingo and Bordonaba conducted a literature review on the safety assessment of GM plants. They found that in recent years the number of references to GMOs has increased but the number of studies focused on safety of GMOs was still limited. The authors suggested that the reason for lack of safety studies may be due to the fact that the "substantial equivalence" concept was used for assessment. The "substantial equivalence" concept is based on the principle that "if a new food is found to be substantially equivalent in composition and nutritional characteristics to an existing food, it can be regarded as being as safe as the conventional food." Also, for the first time, there seems to be equilibrium between the studies that suggest that GM plants (mainly maize and soybeans) are as safe and nutritious as conventional non-GMO plants and the studies that raise serious concerns. Notably, most of the studies that showed GM plants to be as safe as conventional plants were conducted by the biotechnology companies, which are also responsible for commercializing GM plants.²²

Diels, et al. conducted a meta-analysis of 94 articles related to GM foods. They found that the existence of either financial or professional conflict of interest was significantly associated with the studies' showing favorable results for the GM foods. While this may not imply an actual intent of these institutional authors, it certainly poses a risk. Diels, et al., postulated that commercial interests can interfere with the outcome of risks and nutritional analyses and other funding sources such as the government or NGOs have the potential to taint the studies as well. Additionally, values held by the scientists conducting research may also affect their results.²³

Conclusion

GM crops have now been in existence for about 20 years. GM crops have numerous potential benefits and risks. Various safety studies have shown both positive and negative results. However, safety and risk are two separate issues. Ongoing long-term studies to analyze the safety and risks are needed.

Obesity has been called an epidemic in the United States. Approximately 35% of adults and 17% of children in the United States are obese. The rise in obesity coupled with an aging society has led to increased incidence of diabetes and hypertension.²⁴ Our food is an important determinant of our health. With the use of pesticides, herbicides, and GE, our food has changed. Corn is extensively used in processed foods and animal feeds, and GM corn now makes up almost the entire U.S. crop. GM soybeans are not far behind.¹⁸ Thus it is important to assess the nutritive value of the food we produce.

There are studies on both sides of the safety issue; however, the studies showing positive results may have a conflict of interest. Scientists have cited numerous studies demonstrating deleterious effects of GM foods in animals. Such deleterious effects have been noticed on growth, gastrointestinal tract, pancreas, hematological system, biochemical parameters, fertility, and mortality. Harmful effects on humans have also been noticed; milk of cows treated with rBGH leads to an increase in IGF-1, which according to some scientists, may stimulate growth of cancer cells.¹⁴ Others have disregarded these studies, stating that "every major international science body in the world" has reviewed hundreds of independent studies and reached a consensus that "GMO crops are as safe or safer than conventional or organic foods."²⁵ A team of Italian scientists has summarized 1,783 studies about the safety and environmental impacts of GM foods, and did not find "a single credible example demonstrating that GM foods pose any harm to humans or animals."²⁵ The authors acknowledge that the European governments, Italy in particular, have not adopted GM foods as enthusiastically as North and South American countries, but they state that the view of the European scientists has been generally positive. They argue that the reason for public distrust of GMOs lies in "psychology, politics, and false debates."²⁵

Ongoing independent studies without any conflicts of interest are needed. Scientists should not be restricted from testing seeds prior to any approval. GM food anywhere in the food chain has the potential to reach humans¹⁴ and any environmental effects will ultimately affect humans. Just as a new drug requires rigorous testing, GM foods should also require such testing. A lack of evidence that GM foods are unsafe should not be regarded as evidence that they are safe.¹⁴ GM foods should also have ongoing surveillance and monitoring.

Appendix

Positions of Various Organizations

American Medical Association (AMA): Bioengineered foods have been consumed for almost 20 years and so far no overt consequences on human health have been reported and/or substantiated in peer-reviewed literature. Federal regulatory oversight of bioengineered crops should continue. There is no scientific jurisdiction for special labeling of bioengineered food and voluntary labeling is without value unless accompanied by consumer education. AMA supports mandatory pre-market safety assessment of bioengineered foods. AMA has urged the FDA to “remain alert to new data on health consequences of bioengineered foods and update its regulatory policies accordingly.” AMA also supports continued research into the potential environmental effects of bioengineered crops and assessment of agricultural impact and the impact on farmers. AMA recognizes the numerous benefits of bioengineered crops and does not support a moratorium on planting bioengineered crops. Lastly, AMA urges the government, industry, consumer advocacy groups, and the scientific and medical communities to educate the public and provide unbiased information on genetically engineered foods.⁷

European Commission: The European Commission has combined the European Union science-based authorization system with freedom for individual member states to decide on the cultivation of GMOs. GMOs are authorized in the European Union on a case-by-case basis depending on the uses defined by the company and the positive health and environmental safety assessment. Member states play a significant role and carry out the initial assessment of the GMO for cultivation. Member states have the right to restrict or prohibit cultivation of GMOs in parts or all of their territory. However, member states cannot prohibit the import and/or marketing in the European Union of authorized GM seeds.²⁶ The European Food Safety Authority (EFSA) is responsible for risk assessment and the Commission is responsible for risk management.²⁷ Several GMOs are cultivated in the European Union. Six member states (Austria, France, Germany, Greece, Hungary, and Luxembourg) have invoked the “safeguard clause” to restrict or prohibit the cultivation of GMOs in their territories.²⁸ Poland has prohibited marketing of all GM seeds.²⁶

Regarding labeling, the European Commission requires that food and feed products containing GMOs be labeled as such, and that the label be clearly visible. However, food and feed products that contain less than 0.9% of GMOs in each ingredient need not be labeled as GMO, provided the presence of the GMO is adventitious or technically unavoidable. Adventitious presence is defined as the presence of trace amounts either accidentally or due to technically unavoidable contamination during growth, harvesting, transport, or processing. It is the responsibility of the farmer to demonstrate that the presence of GMO was adventitious or technically unavoidable.²⁷

FDA: Food from genetically engineered plants must meet the same safety requirements as traditionally bred plants. FDA has a consultation process to encourage the developers of genetically engineered plants to consult with FDA prior to marketing their products. This process ensures that the products are safe and lawful. Foods from genetically engineered plants are released in the U.S. market only after FDA's questions about the safety have been resolved. Evaluations done by FDA have shown that genetically engineered plants are generally as nutritious as traditionally grown plants. FDA supports voluntary labeling, provided such labeling is truthful and not misleading.²

International Service for the Acquisition of Agri-biotech Applications (ISAAA): Despite the current uncertainty over GM crops, biotechnology has the potential to create economically important crop varieties. There are some valid concerns. In order to resolve these issues, decisions must be based on credible scientific information. Policies regarding GM crops must be based on open and honest discussions involving a wide cross-section of the society.²⁹

USDA: “USDA supports the safe and appropriate use of technology, including biotechnology, to help meet agricultural challenges and consumer needs of the 21st century. USDA plays key roles in assuring that biotechnology plants and products derived from these plants are safe to be grown and used in the United States.”¹¹

WHO: GM foods currently available on the international market have passed the tests for risk assessments and are not likely to pose risks for human health any more than their conventional counterparts. Continuous risk assessment and safety evaluation is advised.^{12,13}

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