

UNTESTED, UNLABELED, AND YOU'RE EATING IT: THE HEALTH AND ENVIRONMENTAL HAZARDS OF GENETICALLY ENGINEERED FOOD

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Millions of farmers demonstrate in India, burning down the corporate headquarters of a major agribusiness company. Throughout Europe and the United States thousands take to the streets to demand their "right to know." Activists clandestinely rip up crops and burn them. Courts in Europe and South America order halts to crop plantings. The United States threatens an unprecedented trade war with the rest of the world. What's causing this historic food fight? Genetically engineered foods.

Though in existence for barely more than a decade, genetically engineered (GE) or biotech foods have created an international furor that shows no sign of abating. In recent years, the battle over GE foods has been especially heated in the United States. Virtually all the "developed" countries mandate labeling of biotech foods. However, the U.S. government has refused to mandate safety testing or labeling for gene-altered produce. In this regulatory vacuum, up to 60 percent of processed foods in the United States have some GE ingredient and over 70 million acres have been planted with these crops. This has rightfully angered much of the public, who are deeply concerned about the safety of GE foods and furious that they have been denied their right to know which foods have been engineered. Numerous legal actions have been filed against the government and biotechnology food producers, and hundreds of thousands of people, including many scientists, consumer advocates, and religious leaders, have commented to federal agencies, demanding labeling and testing.

Biotechnology companies purport to be amazed by the massive controversy they have engendered. They continuously claim that these foods "are the same as traditional foods." Further, they argue that these "are the most tested and scrutinized foods in history." However, a close look at GE foods belies these corporate claims. Biotech foods are qualitatively different than any foods we have ever eaten, and the failure to regulate the human health and environmental impacts of these foods has resulted in a virtual "black box" of serious and unanswered questions about their consequences.

WHAT ARE GENETICALLY ENGINEERED FOODS?

While the biotech industry is fond of saying that biotech foods have been around since "beer and yeast," in reality the genetic engineering of seeds is the most radical transformation in food production since the dawn of agriculture more than 10,000 years ago. The history of agriculture is largely defined by the use of naturally

occurring genetics to produce seeds that result in tastier food, more uniform produce, or greater yields. This process of selective breeding reached its height with the increasingly widespread use of hybridization over the last century.

Genetic engineering is, however, completely different from even the most radical breeding techniques of modern agriculture. It involves artificially manipulating the seed, or food animal, at the cellular level. Because it allows DNA from one type of organism to be placed in that of another, completely unrelated type, it allows for the crossing of natural barriers in ways never before imagined. Biotech researchers have shattered kingdom, phyla, and species boundaries almost at will. They have engineered human growth genes into fish and livestock to make them larger and grow faster, fish genes into tomatoes so that they can grow and be stored at lower temperatures, pesticide genes into corn and other vegetables to resist pests, and firefly genes into tobacco plants, causing the plants to glow 24 hours a day. This process clearly challenges the very integrity of seeds, and much of the earth's other life forms. As noted by the author Michael Pollan, "The introduction into a plant of genes transported not only across species but whole phyla means that the wall of that plant's essential identity — its irreducible wildness you might say — has been breached."

But exactly how do the engineers accomplish this feat? How do they get those flounder genes into tomatoes? The industry claims this process of genetic transfer represents a dramatic increase in "accuracy" over traditional breeding. Such assertions are simply wrong. The current technology being used to genetically engineer seeds is anything but precise. The initial problem facing agricultural biotech was how to "invade" the seed's cell wall and deposit the desired new genetic component in the cell. The current favored solution is to attach the gene to a "vector" that is good at cell invasion. The best candidate vectors to accomplish this cell invasion are, not surprisingly, bacteria and viruses. Most plant biotechnology relies on bacteria to carry the foreign genetic construct into the cell. Viral vectors are more commonly used on animals, including humans. Even when the cell invasion is accomplished, there are still other difficulties in engineering a seed. The host's cells often reject the foreign genetic invader, and often the new genetic material does not produce the desired proteins at the hoped for volume. To resolve these problems viral promoters are added to "turn on" and promote the activity of the foreign genes.

Once all this has been done, a final problem remains. How do the scientists know that the new genetic construct has become a component of the cell? How do they know they have been successful? To ascertain when their engineering has succeeded, biotech food producers include in the genetic "cassette" being inserted into the cell an antibiotic-resistant marker system. This involves attaching genes resistant to antibiotics such as kanamycin or ampicillin to the genetic construct.

Later the plant tissue is flooded with bacteria, and if the antibiotic reacts they know that the genetic construct has been successfully inserted.

There are two critical concerns about this “engineering” at the cellular level that are rarely noted or discussed. Most obviously, it is important that when we speak of GE foods, we refer not only to the insertion of novel genetic material into a cell but to the invasion by the entire “cassette” — the bacterial vector, the new genetic construct, the viral promoters, and the antibiotic marker system. As we shall see, each one of these components being added to our food brings with it potential health threats to consumers.

It is also important to note the imprecision of this process of cell invasion. At this time researchers do not know precisely where this “cassette” will end up in the host organisms, nor do they know enough about the genome (the genetic make-up) of the host organism (be it tomato, corn, or fish) to pinpoint a “safe place” for their genetic additions. Therefore, the very process of genetic engineering creates instability in the seed and resulting foods, and this can lead to health and ecological problems. A reporter visiting a Monsanto lab and witnessing the process described the uncertainty of the engineering process:

The whole operation . . . is performed thousands of times . . . largely because there is so much uncertainty about the outcome. If the new DNA winds up in the wrong place in the genome, for example, the new gene won't be expressed, or it will be expressed only poorly. . . . I was struck by the uncertainty surrounding the process, how this technology is at the same time both astoundingly sophisticated yet still a shot in the genetic dark. (Michael Pollan, *The Botany of Desire*)

HUMAN HEALTH RISKS

These “shots in the genetic dark” are being taken more and more often. In 2001, there were more than four dozen GE foods and crops being grown or sold in the United States. A majority of processed food items “test positive” for the presence of GE ingredients. In addition, dozens of new GE crops are in the final stages of development and will soon be released into the environment and sold in the marketplace. According to the biotechnology industry, almost 100 percent of U.S. food and fiber will be genetically engineered within 5 to 10 years. The menu of these unlabeled GE foods and food ingredients includes soybeans, soy oil, corn, potatoes, squash, canola oil, cottonseed oil, papaya, and tomatoes. The large-scale consumption of these genetically engineered crops raises several unprecedented human health risks.

Toxicity. As described above, GE foods are inherently unstable. Each insertion of a novel gene, and the accompanying “cassette” of promoters, terminators, enhancers,

antibiotic marker systems, and vectors, is random. As a result, each gene insertion into a food amounts to playing food safety “roulette,” with the companies hoping that the new genetic material does not destabilize a safe food and make it hazardous. Each genetic insertion creates the added possibility that formerly nontoxic elements in the food could become toxic.

The U.S. Food and Drug Administration (FDA) has been well aware of the “genetic instability” problem for more than a decade. In the early 1990s, FDA scientists warned that this problem could create dangerous toxins in food and was a significant health risk. The scientists specifically warned that the genetic engineering of foods could result in “increased levels of known naturally occurring toxicants, appearance of new, not previously identified toxicants, and increased capability of concentrating toxic substances from the environment (e.g., pesticides or heavy metals).” These same FDA scientists recommended that long-term toxicological tests be required before the marketing of GE foods.

FDA officials also were aware that safety testing on the first GE food, the Calgene Flavr Savr[™] tomato, had shown that consumption of this product resulted in stomach lesions in laboratory rats. Even more significantly, the FDA had already concluded that genetic engineering was a possible cause for the 37 deaths and 1,500 disabling illnesses caused by consumption of the dietary supplement L-tryptophan. Showa Denko, a Japanese company, had begun using genetic engineering to produce the dietary supplement in the late 1980s. Apparently, the genetic engineering of this particular lot of the supplement may have created a toxic contaminant by-product that caused these deaths and illnesses.

The FDA’s response to the potential toxicity problem with GE foods was, and continues to be, to ignore it. It has disregarded its own scientists, the clear scientific evidence, and the deaths and illnesses that may have resulted from this problem. The agency refused to require pre-market toxicological testing for GE foods or any toxicity monitoring whatsoever. The FDA made these decisions with no scientific basis and without independent scientific review. The agency’s actions can only be seen as a shameful acquiescence to industry pressure and a complete abandonment of its responsibility to assure food safety.

Allergic Reactions. Toxicity is not the only health hazard associated with GE foods. In the United States, about a quarter of the population reports some adverse allergic reaction to food. At least 8 percent of children have physically identifiable allergic reactions to food. The genetic engineering of food creates three separate and serious health risks involving allergenicity. First, it may increase the levels of allergy-causing proteins already found in the plant to the point where they prompt strong human allergenic response. Second, genetic engineering can transfer allergens from foods to which people know they are allergic to foods that they think are safe. This risk is not simply hypothetical. A study published in *The New*

England Journal of Medicine showed that when a gene from a Brazil nut was engineered into soybeans, people allergic to nuts had serious reactions to the engineered product. At least one food, a Pioneer Hi-Bred International soybean, was abandoned because of this problem. Without labeling, people with known food allergies have no way of avoiding the potentially serious health consequences of eating GE foods containing hidden allergenic material.

There is yet a third allergy risk associated with GE foods. These foods could be creating thousands of different and new allergic responses. Each genetic “cassette” being engineered into foods produces a number of novel proteins that have never been part of the human diet, some of which could create an allergic response in some consumers. The FDA was also well aware of this new and potentially massive allergenicity problem. The agency’s scientists repeatedly warned that genetic engineering could “produce a new protein allergen.” Once again, the government’s own scientists urged long-term testing, but the FDA again ignored its own experts. As these foods are allowed on the market without mandatory allergenicity testing, millions of unsuspecting consumers have been regularly exposed to a potentially serious health risk. The negligence of the government’s failure to address this concern is highlighted by the StarLink corn fiasco in 2000 — a situation where a strain of potentially allergenic genetically engineered corn not approved for human consumption was found in the human corn supply. As a result, hundreds of food products were recalled and taken off supermarket shelves. The widespread contamination involved in the StarLink incident — in addition to the failure on the part of the FDA to act appropriately — portrays the agency’s negligence, especially when the potential consequences of food allergies can include sudden death, and the most affected population is children.

Antibiotic Resistance. Another hidden risk of GE foods is that they could make disease-causing bacteria resistant to current antibiotics, resulting in a significant increase in the spread of infections and diseases. As explained, virtually all GE foods contain antibiotic-resistance markers, which help the producers identify whether the new genetic material has actually been transferred into the host food. Industry’s large-scale introduction of these antibiotic marker genes into the food supply could render important antibiotics useless in fighting human diseases. For example, a genetically engineered maize plant from Novartis includes an ampicillin-resistant gene. Ampicillin is a valuable antibiotic used to treat a variety of infections in people and animals. A number of European countries, including Britain, have refused to permit this Novartis corn to be grown, due to health concerns that the ampicillin-resistant gene could move from the corn into bacteria in the food chain, making ampicillin far less effective in fighting a wide range of bacterial infections.

For the past seven years, FDA officials have ignored their own scientists’ concerns over the antibiotic resistance problem. During the same time, medical professionals around the world have become increasingly alarmed at how GE foods are leading to

a massive infusion of antibiotic genes into the human diet. In 2000, the British Medical Association (BMA) addressed this problem in its study of GE foods. The BMA's conclusion was unequivocal: "There should be a ban on the use of antibiotic resistance marker genes in GE food, as the risk to human health from antibiotic resistance developing in microorganisms is one of the major public health threats that will be faced in the 21st century."

Immunosuppression. In 2000, the well-respected British medical journal *The Lancet* published an important study conducted by Drs. Arpad Pusztai and Stanley W. B. Ewen under a grant from the Scottish government. The study examined the effect on rats of the consumption of potatoes genetically engineered to contain a version of the biopesticide *Bacillus thuringiensis* (Bt). The scientists found that rats consuming genetically altered potatoes showed significant detrimental effects on organ development, body metabolism, and immune function. The biotechnology industry has launched a major attack on Dr. Pusztai and his study. However, they have as yet not produced a single peer-reviewed study of their own to refute his findings. Moreover, 22 leading scientists recently declared that animal test results linking GE foods to immunosuppression are valid.

Loss of Nutrition. Genetic engineering can also alter the nutritional value of food. The genetic instability of these foods can be a major culprit in reducing their nutrients. In 1992, the FDA examined the problem of nutrient loss in GE foods. The scientists involved specifically warned the agency that the genetic engineering of foods could result in "undesirable alteration in the level of nutrients" of such foods. They further noted that these nutritional changes "may escape breeders' attention unless genetically engineered plants are evaluated specifically for these changes." Once again, the FDA ignored findings by their own scientists and never subjected the foods to mandatory government testing of any sort.

PROTECTING THE CONSUMER'S RIGHT TO KNOW

Much of the current controversy over GE food surrounds the important issue of labeling. However, the labeling issue is actually a secondary one. Clearly, given the seriousness of the potential risks, all GE foods should be removed from the market and all seeds quarantined until long-term tests have determined that such foods are safe for human consumption. We do not label unsafe food; we take it off the supermarket shelves. Only after the foods are found safe through proper testing should they be allowed to be sold and labeled.

Not surprisingly, FDA's "no testing, no labeling" policy is opposed by the vast majority of Americans. Each day, tens of millions of American infants, children, and adults eat GE foods without their knowledge. The public clearly believes it has a right to know if food has been genetically engineered. Opinion polls consistently show that more than 90 percent of Americans strongly support the labeling of GE

foods. A 1999 Time poll revealed that close to 60 percent would avoid such foods if they were labeled. In 1998 more than 275,000 angry consumers protested the Clinton administration's proposal that GE foods could be certified as "organic." More recently, more than a half million people wrote to the FDA to support a legal petition filed by the Center for Food Safety (on behalf of itself and numerous other organizations), which demanded mandatory labeling and testing of biotech foods.

ENVIRONMENTAL RISKS

GE foods require us to reexamine our concept of pollution. When most of us think about pollution, we envision a power plant's smokestacks spewing toxic fumes into the air; or automobiles choking us with their exhaust and the resulting smog; or, perhaps, a pipe from a chemical plant pouring out dangerous compounds into a river. Such chemical pollution illustrates a "contamination" model of pollution. Biotechnology creates a very different sort of pollution problem — biological pollution. This is a "disease" model of pollution, in which a living organism invades and causes unexpected havoc to the environment. Just as bacteria and viruses invade us and create illness, biological organisms can invade an ecosystem and cause massive problems. We have seen this in the past with "exotic" organisms such as the imported fungi which caused chestnut blight and Dutch elm disease. We have also been invaded by thousands of other exotics, from the highly destructive kudzu vine to the killer bees working their way up from South America. Now we are releasing hundreds of thousands of genetically altered "exotic" organisms into the environment, and the results could be catastrophic. Because they are alive, genetically altered crops are inherently more unpredictable than chemical pollutants — they can migrate and mutate. They will not dilute over time like chemical pollutants; rather they will reproduce, and the problem will only intensify. Once they have been released, it is virtually impossible to recall genetically engineered organisms back to the laboratory or the field. Thus, the rapid adoption of GE crops presents numerous irreversible ecological risks. A research report from Purdue University on fish genetically engineered with growth genes underscores the new biological pollution threat. Scientists found that the GE fish, because of their greater size, had a significant advantage in reproduction. Unfortunately, the new growth genes caused a one-third greater mortality in the offspring as compared to non-GE fish. As a result the researchers predicted that if just 60 of these GE fish were introduced into a population of 60,000 wild fish, the species would become extinct within only 40 generations. Yet, even with independent scientists warning of the dire threat genetic engineering poses to the environment, we do not have a single law in the United States that addresses this new biological pollution risk.

Increased Pesticide Residues. Besides creating bio-pollution, biotech foods also contribute to chemical pollution. "Herbicide-resistant" plants, which accounted for over 70 percent of all GE crops planted in 1998, are genetically engineered to withstand the indiscriminate use herbicides. Normally, if a farmer overuses herbicides, both weeds and the crop are killed by the application. Now, thanks to

genetic engineering there can be massive herbicide use without hurting the crop. These GE crops have helped make Monsanto's Roundup the best-selling herbicide ever.

Biological Pollution. With the impending introduction of genetically engineered fish and insects being added to the use of biotech crops, biological pollution is sure to become a major environmental problem in coming years. Bio-pollution from biotech crops has already begun to wreak havoc in farmers' fields and in the larger environment. Vectors such as insect pollinators, wind, and rain are carrying genetically altered pollen into adjoining fields, polluting the crops of organic and conventional farmers. There have been numerous cases where organic and conventional farms in the United States and Canada have been contaminated with genetic drift from GE crops on a nearby farm. As a result many farmers are unintentionally growing GE crops and finding that they cannot sell their product domestically as certified organic or to foreign markets that are looking for GE-free produce. Unless halted, this biological pollution of non-GE crops by the biotech varieties could mean that future generations will have no choice but to buy and consume GE foods. Biological pollution is also affecting the soil and wildlife. In the late 1990s, Cornell University researchers found that pollen from genetically engineered Bt-corn was poisonous to the larvae of Monarch butterflies. This study, published in the journal *Nature*, and several follow-up reports add to a growing body of evidence that GE crops could adversely impact a number of beneficial insects, including ladybugs and lacewings, as well as beneficial soil microorganisms.

“Superweeds” and “Superpests.” As noted, we are now growing tens of millions of acres of crops that have been genetically engineered to be herbicide resistant or to produce their own pesticide. Recent research has shown that these crops, because of the way they are genetically altered, could create unprecedented long-term environmental problems. Scientists are finding that pests and weeds are beginning to emerge that are resistant to these new GE crops, which means that stronger, more toxic chemicals will be needed to get rid of the strengthened plant pests. The emergence of the first “superweeds” has been reported as GE herbicide-resistant crops such as rapeseed (canola) spread their herbicide-resistance traits to related weeds such as wild mustard plants. Several laboratory and field tests also reveal that certain common plant pests, including cotton bollworms, living under constant pressure from GE crops, will soon evolve into “superpests” completely immune to Bt sprays and other environmentally sustainable biopesticides. This could pose a significant danger to organic and sustainable farmers whose biological pest management practices may be unable to cope with increasing numbers of superpests and superweeds.

New Plant Diseases. It should not surprise us that when biotechnologists “play God” with the genetic code of food, unanticipated and dangerous outcomes result. This has been especially true of research involving the engineering of viruses and

other disease-causing agents into plants. Biotech researchers at Michigan State University have found that when they engineered a weakened virus into a plant to “vaccinate” it, the weakened virus in the plant mutated into new, more virulent forms. Other researchers have discovered that the genetically engineered version of a soil microorganism, *Klebsiella planticola*, completely destroyed essential soil nutrients.

OTHER IMPACTS

Socioeconomic Hazards. The patenting of GE foods and widespread biotech food production threaten to eliminate farming as it has been practiced for more than 10,000 years. Patents such as Delta & Pine Land’s so-called “terminator” technology, designed to render seeds infertile, could force hundreds of millions of farmers who now save and share their seeds to purchase increasingly expensive GE seeds and chemical inputs from a handful of global biotech/seed monopolies. Already Monsanto controls 60 percent of all utility soybean patents and almost 30 percent of all utility corn patents. If the trend is not stopped, the patenting of transgenic plants and food-producing animals will soon lead to universal “biosefdom” in which farmers will lease their plants and animals from biotech conglomerates such as Monsanto and pay royalties on seeds and offspring. Family and indigenous farmers will be driven off the land, and consumers’ food choices will be dictated by a cartel of transnational corporations. Rural communities will be devastated. Hundreds of millions of farmers and agricultural workers worldwide will lose their livelihoods.

Erosion of Biodiversity. For thousands of years, farmers and plant breeders have attempted to maintain access to a wide range of plant varieties to develop healthier plant strains and meet the changing conditions of agricultural ecosystems. Now much of this diversity is being lost as companies focus plant research on a few selected genetic traits. The rapid adoption of these new, uniform GE crops represents the most radical step in industrial agriculture’s trend toward monoculture. As the critics Craig Holdrege and Steve Talbott have elegantly described, first single crops replaced a diversity of crops; then a single variety replaced a diversity of varieties; and now, monocultures are being erected upon a single, genetically engineered trait.

Ethical Hazards. Traditionally, many of our food choices have been governed by principles that allow the consumer to determine whether a particular food or production system comports with his or her ethical or religious beliefs. Every one of us is probably aware of well-established dietary restrictions that flow from either religious practice or personal ethical choice. However, GE foods threaten to rob many people of their ability to abide by their personal religious or ethical beliefs. For example, ethical vegetarians and religious practitioners of certain faiths may be unknowingly consuming crops containing genetic material from animals. And all of us could soon face the disturbing ethical dilemma of genetically engineered farm

animals containing human genetic material. Since current government policy does not mandate the labeling of any such GE food, people with ethical or religious concerns are stripped of their capacity to avoid such foods and adhere to their personal beliefs.

CONCLUSION

If only a few years ago some pundit had predicted a world where the pollen of corn plants could poison caterpillars, where taco shells would carry a genetically engineered allergen, where our popcorn was a registered pesticide, where the crops of the world were being genetically programmed to commit “suicide” after one growing season, where farmers by the hundreds were being sued by Monsanto and other corporations because they violated patents on crops, where we purposely created plants that could withstand countless applications of pesticides — we would have thought it bad science fiction. Yet all these scenarios have become science fact.

Clearly, decisions about the path of our food system are at a critical juncture. While GE foods may be an advance for laboratory science, they do not represent “progress” for the farmer or consumer. The GE food future will grant the purveyors of chemical companies greater control over our food supply at the expense of our farm communities, our environment, and even our free exercise of ethical and religious beliefs. Only by initiating a complete moratorium on the production and sale of genetically engineered foods can we hope to forestall the unprecedented risks presented by these foods.