



Crossroads

Genetic Engineering at a Historic

The Sierra Club Genetic Engineering Committee Report April 2000, revised March 2001

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The last four years of the twentieth century witnessed the most rapid adoption of a new technology in history. Since 1996, millions of acres of farmland have been planted with genetically engineered (GE) crops—mainly corn, soybeans, and cotton. This means that genetically engineered organisms (GEOs) are being released to the environment on a massive scale, an event unprecedented in the 3.8 billion year history of life on this planet. This technological upheaval happened virtually without public debate, while our government played the role of enthusiastic promoter, rather than cautious regulator, of this radically new and environmentally hazardous technology.

Genetic engineering is a new technology that combines genes from totally unrelated species, in combinations not possible using conventional breeding methods. Genes from an animal, say, a fish, can be put into a plant, a strawberry for instance. In fact this is an actual example of an attempt to "improve" strawberry plants. The fish gene is supposed to make the strawberries more resistant to frost by causing the strawberry plant to produce a form of antifreeze which the fish normally produces to endure cold ocean conditions.

Over 60 percent of all processed foods purchased by U.S. consumers are manufactured with GE ingredients. Some corn and potatoes have even been genetically engineered to contain a gene from Bt bacteria which causes every cell of the plants to produce an insecticidal toxin. Yet there is no labeling of these or any GE foods as being genetically engineered, because the U.S. Food and Drug Administration (FDA) considers the GEOs from which these foods are made to be "substantially equivalent" to the non-genetically engineered plant from which the GEOs are derived.

The doctrine of substantial equivalence is pure pretext and rationalization with no basis in science. Yet, in a remarkable display of arrogance, the supporters of genetic engineering accuse their critics of not basing their objections on "sound science."

The FDA also uses this "substantial equivalence" rationalization as an excuse to avoid any effective testing of GE foods to determine their safety. Such testing might seriously delay or even prevent the introduction of GE crops into the marketplace.

From the time in the early 1970s when advances in molecular biology led to the development of the techniques we call genetic engineering, until the mid 1990s, the organisms produced by genetic engineering were nearly all confined to laboratories or controlled factory settings. During this time there were almost no releases of genetically engineered organisms to the environment, as genetic engineering was used in basic research and to produce medically useful substances such as insulin. The unrestrained expansion of genetic engineering into agriculture during the past four years changed all that. By 1999 almost 80 million acres of North American



farmland were planted with genetically engineered seed. This means massive releases of GEOs to the environment are now taking place. Genetic engineering now poses a very grave threat to the natural environment.

Historic turning point

We are now at a turning point in history. We can continue to allow the virtually unrestricted release of genetically engineered organisms to the environment, or we can bring this technology under strict control.

If we continue on our present path of unrestricted releases of GEOs, we will eventually live in a genetically engineered world, as the genome of each species now on earth is either deliberately altered by genetic engineering or indirectly altered by inheritance of transgenes from a genetically engineered organism. In such a world there would be nothing left of living nature,

as every species would have been deprived of its genetic integrity, and every ecosystem would thereby have been irreversibly disrupted.

Of special concern to environmentalists should be the fact that trees are now being genetically engineered, and that it is proposed that entire forests be planted with these trees. One such proposal is for trees which produce no seeds, but divert the energy from seed production to more rapid growth of wood. A forest of such trees would wreak havoc on the food chain. Other GE trees that do produce seeds could cross with native varieties and damage forest ecosystems. Engineered trees which produced pollen (as might happen despite scientists' attempts to create sterile subspecies) could cross with native varieties miles away and damage forest ecosystems.

Fish, as well as other animals, are also being genetically engineered to grow more rapidly. If they are released to the environment (fish culture tanks often discharge during storm conditions), they may out-compete native species and thereby disrupt ecosystems.

There is evidence that soil organisms may be adversely affected by genetically engineered crops. The Bt corn plant is engineered to contain a bacterial gene that causes production of an insecticide in every cell of the corn plant, including the edible corn ear and the roots. This toxin has been found to persist in the soil for months. The promoters of genetic engineering show no sign that they are willing or able to impose limits on their applications of this new technology. It will therefore be left to the institutions of civil society—governments working with non-governmental organizations representing the concerned public (such as Sierra Club)—to set limits to how much further genetic engineering will be allowed to alter the earth's species.

Medical uses

Promoters of the use of genetic engineering outside the laboratory claim that a moratorium or other controls on the planting of genetically engineered organisms as agricultural crops would mean an end to the uses of genetic engineering in the production of medically useful products. This is untrue. As long as proper precautions are taken to assure that the genetically engineered microorganisms used in production of pharmaceuticals or in scientific experiments are not released to the environment, such uses need not be prohibited. However, all applications of genetic engineering, including medical uses, carry some risk. Medical applications of genetic engineering should be approached with caution and not rushed to market. We believe that simpler, more traditional strategies for problem solving should always be considered when evaluating the production of transgenic organisms. This is especially relevant with respect to agricultural applications, as will be discussed in the topic below.

Feeding the world's hungry?

Medical uses of genetic engineering may be prudent, but agricultural applications of GE are not. Yet the argument is being made by the biotech industry that if the genetic engineering of farm crops is not allowed to proceed, the poor people of the world will starve.

In fact there is more than enough food produced by conventional agriculture, without genetic engineering, to feed all of the world's people. One cause of hunger is the ineffective distribution of food. Genetic engineering may actually lead to more food insecurity and hunger because in poor countries it will lead to the planting of monoculture crops, highly vulnerable to disease and pests, in the place of resilient, diverse range of crops, and it will make farmers dependent on corporations that will demand payment for basic inputs such as seed, chemicals, and fertilizers.

Terms of trade between developed and less developed nations have often resulted in the best land in the poor countries being used to grow cash crops for export rather than food for consumption at home. Issues of equity and fairness have not been addressed by trade agreements. Certainly these problems call out for redress, but their solution isn't to increase the monopoly power of "life science" companies in the richest nations.

As Indian writer and activist Vandana Shiva summarized, "Millions of farmers in third world countries want to breed and grow the crop varieties that adapt to their diverse ecosystems. Plant biodiversity is essential for a balanced diet. Yet numerous crops are pushed to extinction with the introduction of GE crops."

Terminator technology

Any claim by the corporations promoting agricultural biotechnology that they have the interests of the world's poor people at heart are refuted by the facts in the case of Terminator seed technology. This technology would



protect the intellectual property interests of the seed company by making the seeds from a genetically engineered crop plant sterile, unable to germinate. Terminator would make it impossible for farmers to save seed from a crop for planting the next year, and would force them to buy seed from the supplier. In the third world, this inability to save seed could be a major, perhaps fatal, burden on poor farmers. The Sierra Club's Genetic Engineering Committee (GEC) believes that Terminator is a tool by which seed companies are trying to engineer their monopoly power into the genetic code.

Adding insult to injury in the Terminator technology story is the fact that our own tax dollars were used to develop Terminator. The U.S. Dept. of Agriculture played a major role in the development of Terminator technology. The USDA is actually part owner of the patent on this immoral technology.

The Genetic Engineering Committee

The Sierra Club's Genetic Engineering Committee (GEC) was formed in May 1999 to explore ways to mobilize the strength of Sierra Club, the largest grassroots environmental organization in the U.S., for the work of public education and regulatory reform that will be necessary to protect the natural environment and human health from the threats posed by the release of genetically engineered organisms.

An Educational Challenge

Genetic Engineering Committee members have found that the need for public education is great. Because of inadequate reporting by the U.S. media, many otherwise well educated people simply have not been told what genetic engineering is. We hear statements like, "If there is a moratorium on planting genetically engineered crops, doesn't that mean that no crops at all will be planted?" And, "Aren't all farm crops these days genetically engineered?"

The supporters of genetic engineering gladly fill this information vacuum with false statements. They claim that the selective breeding of plants and animals that has been done for centuries is genetic engineering. Supporters claim that modern genetic engineering is nothing more than an improved, more precise, high-tech form of conventional plant and animal breeding. Michael Khoo, in a letter published last year in the Toronto Globe and Mail, called this claim ". . . biotechnology's public-relations line that genetic engineering is no different from traditional breeding." His letter continued, "A potato can cross with a different strain of potato but, in 10 million years of evolution, it has never crossed with a chicken. Genetic engineering shatters these natural species boundaries, with completely unpredictable results. As a result of these risks, the British Medical Association has recently called for an open-ended moratorium on GE planting."

Gene transfers occur in conventional breeding, but these transfers can only take place between individuals of the same species, or, in the case of hybridization, between individuals of closely related species. This is because conventional breeding relies on the normal reproductive processes of the plants or animals. Plants can be conventionally bred only with plants of the same species or, to make a hybrid, with closely related species. And animals can only be bred with other animals of the same or, in some instances, closely related species.

Genetic engineering is not bound by these limits in the possible exchanges of genes that can be made to occur using its techniques, which include the use of viruses as "vectors" to move foreign genes into host organisms. By means of genetic engineering, genes can be transferred from a plant to an animal; from an animal to a plant; from a bacteria to a plant, and between numerous other combinations of donor and recipient organisms. There have even been attempts to put human genes in plants and animals that are used as human food.

Why is this important?

The changes caused by genetic engineering can be inherited by subsequent generations of the affected organism, and, once released to the environment, these organisms cannot be recalled—they will continue to pass on their spliced-in genes, or transgenes, to future generations. Many of the gene changes may turn out to have unexpected secondary effects. Serious errors in judgement might prove unrecallable as trillions of copies are broadcast via pollen and seed. Wild relatives of crops will also be affected, with possibly profound effects on the environment. For instance, genetically engineered cereals may cross with various grasses. Once this process begins, it will be for all practical purposes uncontrollable and unpredictable.

Biodiversity and endangered species

As environmentalists, one of our most basic concerns is the preservation of species. We live in a time when the rate of species extinction has increased drastically, primarily as a result of human activities. Now a new form of human activity, genetic engineering, may pose the ultimate threat to the survival of all species.

Many of those who are promoting genetic engineering give every indication that they regard life as a form of information technology: that genes are mere bundles of information to be transferred from one species to another on the basis of expediency and potential corporate cash-flow; that the natural barriers to genetic transfer that protect the integrity of species are mere inconveniences to be overcome; and that the very concept of species is an anachronism which it is now time to discard.

Because these principles are being put into application—genetically engineered organisms are now being made and released to the environment—we have to conclude that genetic engineering threatens the continued existence of all species as life-forms that are distinct from one another.

Genetic engineering should be considered an environmentally dangerous technology that is breaking down the barriers that have protected the integrity of species for millions of years. There are probably good reasons why it is impossible for a conventional plant breeder to combine plant genes with animal genes. Those reasons have to do with the very survival of life on earth, and we ignore them at our peril.

Another threat to biodiversity from genetic engineering is from toxins produced by GE crops. The finding last May that Bt corn pollen might be a threat to monarch butterflies provides an example. Genetically engineered Bt crops have the gene spliced-in from the Bt bacteria that codes for the production of the toxin that kills insect larvae. A Cornell study showed that this toxin kills the larvae of certain species of moths and butterflies. Other studies have indicated reduced viability of other nontarget beneficial insects, such as ladybugs and lacewings. Bt toxin also persists in the roots of the crops and in plant residues for a considerable time after the crop is harvested, which may have major adverse consequences for the millions of soil organisms that help maintain soil fertility.

Yet another threat to biodiversity is the out-crossing of herbicide resistance traits to native plants. There is already evidence of "superweeds" created by the spread of pollen carrying the herbicide resistance trait.

A threat to organic farming

The standards established by organic farmers categorically exclude genetically engineered crops from the organic food system. A problem arises from pollen drift from fields of GE crops planted too close to organic crops. The organic plants may become crossed with the GE plants and thereby contaminated with the spliced-in gene (transgene) from the GE crop. Then the crop grown next season from seed saved from what was an organic field will no longer be acceptable as organic—it will contain the transgene and will have to be considered genetically engineered. And in the case of crops in which the harvested portion of the plant is the seed, the presence of a transgene will immediately, in the first generation, make the crop not acceptable as organic. This problem of outflow of transgenes to organic crops is considered by organic growers to be very serious.

Another negative impact on organic farming is the expected resistance that insect pests will develop to Bt toxin. Organic farmers have been using Bt bacteria applied to crops in a spray as an organic method of controlling damaging insects. But genetically engineered Bt crops have the gene that codes for Bt toxin production spliced-in. By applying Bt bacterial sprays only occasionally, and because of the naturally limited quantity of the toxin present in the bacteria, organic farmers have avoided pest resistance problems. Now, with massive quantities of Bt toxin present in fields throughout the growing season, most of the insects susceptible to the toxin will be killed off, leaving a proportionately greater number of resistant insects alive. These Bt-resistant survivors will pass resistance traits into future generations. It is expected that resistance problems caused by genetically engineered Bt crops will render Bt sprays useless to organic farmers within a few years.

Health issues

While Sierra Club is an environmental organization, we are concerned also with potential human health impacts of this new technology. Among the issues are the possible spread of allergens, the invitation which herbicide tolerant crops give to over-use of herbicides, possible adverse effects of new toxins (such as the Bt endotoxin) on some people, and the emergence of antibiotic resistance which may be fostered by the use of antibiotic resistance genes in almost all transgenic crops. New genes also alter the expression of native genes and so may change the nutritional benefits of foods and may also result in the overproduction of previously low-level natural toxins which exist in most foods. Health risks add to the environmental reasons for exercising caution.

The Precautionary Principle

The Genetic Engineering Committee strongly supports application of the precautionary principle to biotechnology issues and recognizes the limits inherent in present systems of risk assessment. Here is cogent statement of the precautionary principle from the Wingspread Consensus Statement on the Precautionary Principle, Jan, 1998: "When an activity raises threats of harm to the environment or human health, precautionary measures should be taken even if some cause and effect relationships are not fully established scientifically."

The participants at the conference said the following about risk assessment: "We believe existing environmental regulations and other decisions, particularly those based on risk assessment, have failed to protect adequately human health and the environment, the larger system of which humans are but a part."

Carolyn Raffensperger offered further commentary on risk assessment: "Participants [at the Wingspread conference] noted that current policies such as risk assessment and cost-benefit analysis give the benefit of the doubt to new products and technologies, which may later prove harmful. And when damage occurs, victims and their advocates have the difficult task of proving that a product or activity was responsible." (email by Ms. Raffensperger, 1/28/98)

The precautionary principle is of the greatest importance when the damage from a new technology would be irreversible. This is the case with genetic engineering. Once they are released into the environment, genetically engineered organisms cannot be recalled. The Genetic Engineering Committee believes that genetically engineered farm crops are wrongly given the benefit of the doubt in the regulatory process, and that, under the precautionary principle, they should not be released into the environment or allowed to be part of the food supply.

The regulatory process

The federal government decided early in the development of genetically engineered crops that this was a technology where U.S. producers had an advantage which could be used to help them compete successfully in world markets. It was decided during the first Bush administration that the regulatory process for approval of

GE crops would be streamlined. The Clinton administration continued this policy, with both President Clinton and Vice President Gore being strong supporters of agricultural biotechnology.

The regulatory inadequacies in the case of Bt potatoes are illustrative. The U.S. Food and Drug Administration (FDA) does not test the toxin in Bt potatoes for safety as a food additive because the toxin is a pesticide and therefore the U.S. Environmental Protection Agency (EPA) has the responsibility to assure its safety. But the EPA tests only the Bt toxin, not the potatoes containing the toxin. So no one tests Bt potatoes for their safety as food, yet they become part of our food supply. The FDA does not require labeling of Bt foods, because the agency is prohibited from requiring any information about pesticides on food labels, and because they consider GE foods to be substantially equivalent to conventional foods. Meanwhile, the U.S. Dept. of Agriculture pursues a role primarily of promotion of genetic engineering in agriculture, spending only a tiny fraction of its budget on safety testing of biotech foods.

As for testing GE crops for environmental hazards, there has been no environmental impact statement (EIS) done for a release of any genetically engineered crop. This is in violation of the National Environmental Policy Act (NEPA), which the EPA has the responsibility to administer.

Proposed Legislation

Laws are needed to require safety testing and labeling of GE crops. Also needed are mandatory environmental impact statements for every ecosystem into which any new GEO is to be introduced, and when applicable, involvement with the U.S. Fish and Wildlife Service. Liability issues also need to be addressed: clarification is needed as to who is responsible for the downstream effects of a company's product, including damage to organic producers and damage to the environment. Funding for agricultural research and development should be directed towards sustainable methods, rather than methods that perpetuate dependence on the chemical treadmill and agricultural biotechnology.

Moral and Religious Issues

In the book *My First Summer in the Sierra*, by the Sierra Club's founder, it becomes more clear with each page that John Muir regarded the study of nature as an act of worship. Although Muir provides glorious images of inanimate nature in the Sierra—the mountains and rock formations; the clouds, storms, and waterfalls—most of the book is devoted to careful descriptions of plants and wildlife, with frequent mention of how all these living things are loved by their Creator. Muir tells us that to be in a place like the Sierra Mountains is to be closer to God than is possible in any human-built church.

Not all Club members will hold the same religious convictions that John Muir held. But most of us probably share his belief that ethical principles are a part of our relationship with nature; that there is a moral dimension to our task of protecting nature. Those ethical principles lead us to respect and protect the natural world.

To Muir, the more one knows about nature, the more one is inclined to protect nature. Using our knowledge of living organisms in order to better protect wild nature is the opposite of using that knowledge to bring living things into the realm of human technology and human control.

There is not a shred of evidence that John Muir would have regarded the release of genetically engineered organisms to the environment with anything but shock and outrage. We can be certain that Muir would be fighting those powerful corporate forces that are trying to control and commodify the very basis of life. We can be certain that Muir would commit to this fight the same energy and spirit that he gave to his last battle, the struggle to save the Hetch-Hetchy Valley. We believe that Sierra Club today should commit major resources to save what remains of living nature from this new technology of genetic engineering.

Respectfully submitted,

The Sierra Club Genetic Engineering Committee

What you can do—

Write to your members of Congress urging them to support the bills discussed above.

Start biotechnology committees within your own region.

Make sure the public understands what genetic engineering is. If a statement appears in the media repeating the myth that genetic engineering is nothing more than what conventional plant and animal breeders have been doing for centuries, write a letter to the editor stating that genetic engineering is a new and dangerous technology that combines genes of unrelated species. See [letter writing tips](#).

Definitions of key terms:

Biotechnology - A term now widely used to mean genetic engineering. In a larger sense, biotechnology is any use of biological processes to produce a desired result. Thus, the use of yeast to bake bread is a form of biotechnology which is not genetic engineering and which has been in use for centuries.

Genome - The complete set of genes of an individual organism, or the complete set of genes of all the individuals of a species.

Genetic engineering (GE) - The transfer of genes from one organism to another organism in ways that are not possible using conventional breeding methods. Genetic engineering bypasses the reproductive barriers that prevent genetic transfers between unrelated species, thus allowing transfer of genes from an organism of one species to another, completely unrelated species. Genetic engineering also includes methods of gene deletion and gene manipulation that are not possible using conventional breeding methods.

Genetically engineered organism (GEO) - Any living thing that has had its genetic structure altered by genetic engineering. A genetically engineered organism is also called a genetically modified organism (GMO), a genetically altered organism, or in certain cases, a transgenic organism.

Recombinant DNA technology - The technique, also called gene splicing, that made possible the first application of genetic engineering, in 1973. A section of DNA molecule which constitutes a gene, the basic unit that determines an inherited trait, is cut from the molecule and spliced into another DNA molecule in another organism. The two organisms need not be of the same species or even closely related. Thus, using recombinant DNA techniques, genes from bacteria have been spliced into corn plants and DNA from a fish has been spliced into strawberry plants. It is also possible to splice plant DNA into an animal.

Transgene - A gene from one organism transferred into another (usually unrelated) organism by means of genetic engineering.

Transgenic organism - An organism containing a transgene.

Vector - In the context of genetic engineering, a virus or plasmid used to transfer genetic material into a cell.

Photos: corn courtesy Warren Gretz, strawberries courtesy USDA, seeds courtesy Warren Gretz, fish courtesy US Fish & Wildlife Service, farmer courtesy www.imagesoftheworld.org