

Biotech Crops and Foods

The Risks and Alternatives

Carmelo Ruiz-Marrero

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The Oakland Institute

P.O. Box 18978, Oakland, CA 94619

www.oaklandinstitute.org

Carmelo Ruiz-Marrero, a Fellow at the Oakland Institute, is a journalist and an environmental educator. Ruiz-Marrero is also a Senior Fellow at the Environmental Leadership Program, and was a Senior Fellow of the Society of Environmental Journalists from 2002-2004. He frequently writes and lectures on the social and environmental impacts of genetic engineering and industrial agriculture and strategies for social justice and environmental sustainability. His articles have appeared on *Alternet*, *Corporate Watch*, *One World*, *IPS News*, *E Magazine*, *Grist*, *IRC Americas Program*, *New York Daily News*, *Yes! Magazine*, *La Jornada* (Mexico), and in many other Spanish-language media.

“Biotech Crops and Foods: The Risks and Alternatives,” is based on his forthcoming book, *Transgenic Ballad: Biotechnology, Globalization and the Clash of Paradigms*.

“Monsanto should not have to vouchsafe the safety of biotech food.... Our interest is in selling as much of it as possible. Assuring its safety is the FDA’s job.”

— Phil Angell, Director of Corporate Communications, Monsanto, quoted in the *New York Times Magazine*, October 25, 1998

“Ultimately, it is the food producer who is responsible for assuring safety.”

— FDA, “Statement of Policy: Foods Derived from New Plant Varieties”, (GMO Policy), Federal Register, Vol. 57, No. 104 (1992), p. 22991

The raging worldwide controversy over genetically engineered (GE) crops and products continues to grow.

Proponents claim these novel crops are helping feed the hungry, improve the economic situation of farmers and make agriculture more environmentally sound. “Biotechnology can address environmental degradation, hunger, and poverty in the developing world by providing improved agricultural productivity and greater nutritional security,” claims AgBioWorld, a pro-biotechnology organization. “The next generation of products promises to provide even greater benefits to consumers, such as enhanced nutrition, healthier oils, enhanced vitamin content, longer shelf life and improved medicines.”

But a growing number of critics, which include environmentalists, farmers, intellectuals, indigenous peoples, students, academics, biologists, agronomists and people from all walks of life and from all over the world, hold that genetic engineering presents serious social and ecological questions that the proponents have not addressed adequately. They state that GE crops and foods are not safe, that biotechnology has inherent risks, and that it brings new forms of dependence and domination to farmers and consumers. Furthermore, they claim that GE crops are not necessary at all and that ecologically sound and socially equitable alternatives do exist.

What is the truth then? Are GE foods safe? Are GE crops environmentally benign? Can biotechnology mitigate poverty and fight world hunger? After ten years of commercial use, what is the track record of this new technology?

Some Basic Facts

Genetically engineered organisms, also called transgenic or genetically modified (GMO), are those that have had their genetic code, or genome, altered through genetic engineering. Genetic engineering is a biotechnology that allows the introduction of foreign genes into a genome. This technique is used to create gene combinations that would be impossible through natural processes like sexual reproduction - for example, introducing flounder genes into tomatoes, bacterial genes into corn, or even human genes into rice.

Genetic engineering depends on the assumption (now realized to be too simplistic) that one gene equals one trait. Therefore, favorable traits, such as increased nutritional content or pest resistance, can be introduced into food crops in the hope of improving agriculture. Both proponents and opponents of this new technology often refer to it generically as “biotechnology”.

Since the US government's approval of biotech crops for commercial production in 1996, Americans and people all over the world have been unwittingly eating genetically engineered foods. There were no public

hearings or environmental impact statements. In the US there was no public debate or notification of any kind and furthermore, GE foods are not labeled.

INHERENT RISKS?

According to the pro-industry AgBioWorld, “Crops improved through biotechnology have undergone more safety and environmental testing than any crop varieties in history, and have been produced and consumed by humans and animals in millions of tons around the world for years. They have been proven as safe as the scientific method permits, by every valid method known to science and medicine. There is, to date, not a single solitary confirmed case of human or animal illness or disease associated with a biotech crop. Nor has a single negative environmental impact been credibly attributed to biotech-improved varieties.”

Is that so? The following cases show that there is reason to be concerned about the safety of GE foods.

- Practically all GE crops in the market now are soy, corn, cotton or canola.
- The majority of these (soy and canola) were engineered by the Monsanto corporation to be resistant to Roundup, a herbicide made by the same company, and are known as Roundup Ready crops. The rest (corn and cotton) were engineered to be pest-resistant and are known as Bt crops.
- Over 90% of farm acreage devoted to GE crops in the world is in the Americas. Three countries alone account for most of this acreage: The United States, Canada and Argentina.
- US-based Monsanto is the undisputed world leader in agricultural biotechnology, accounting for 90% of the world's GE crops.
- In the United States, 85% of all soy acreage, 45% of all corn acreage and 76% of all cotton is genetically engineered.
- It is estimated that 70% of processed foods sold in American supermarkets are either GE or contain GE ingredients.
- Industry is adamantly opposed to labeling GE products, and has invested substantially in the US and internationally to this end.

Pusztai's Potatoes

Questions over the safety of GE foods were raised as far back as in 1998, when renowned scientist Arpad Pusztai, of Scotland's Rowett Research Institute, tested an experimental GE potato on laboratory rats. At the time of this experiment, there was very little in the peer-reviewed scientific literature on the safety of GE foods (a full two years after their introduction into the market!); Pusztai's was the first independent study to that end.

The rats fed on the GE potatoes suffered substantial damage to their immune systems, plus abnormal weight loss in various organs, including the brain, testicles and liver. Some also had abnormal growth in their intestinal cells, which could indicate a prelude to cancer. Despite a long and concerted industry campaign to discredit Pusztai, part of the results of his GE potato study were duly peer-reviewed and published in the scientific literature. However, despite the industry and scientific establishment dismissing his work, there has been little attempt made to independently repeat and confirm the study, as is usually the case in science. Pusztai has published other results of his experiments since, which raise serious question over the safety of GM foods.

The Independent Science Panel

In 2003, Pusztai joined over a dozen colleagues with expertise in agroecology, agronomy, botany, medical chemistry, ecology, microbial ecology, nutritional biochemistry, physiology, toxicology and virology, to form

the Independent Science Panel. The group released a report on GE crops and foods that reviewed the literature and concluded that:

- Contrary to the claims of proponents, these crops have not been proven safe. The regulatory framework was fatally flawed from the start. It was based on an anti-precautionary approach designed to expedite product approval at the expense of safety considerations.
- By far the most insidious dangers of genetic engineering may be inherent in the process itself.
- There have been very few credible studies on GE food safety. Nevertheless, the available findings already give cause for concern.
- There is already experimental evidence that transgenic DNA from plants has been taken up by bacteria in the soil and in the gut of human volunteers.
- Transgenic DNA is known to survive digestion in the gut and may jump into the genome of mammalian cells, raising the possibility for triggering cancer.
- There has been a history of misrepresentation and suppression of scientific evidence in the promotion of agricultural biotechnology. Key experiments were not performed, or were performed badly and then misrepresented.
- Sufficient evidence has emerged which raises serious safety concerns, that if ignored could result in irreversible damage to health and the environment. GE crops should be firmly rejected now.

The Mon 863 Report

On May 22, 2005 the British daily *The Independent* reported the existence of a secret Monsanto report about its genetically engineered Mon 863 corn variety. According to the 1,139-page report, rats fed this corn for 13 weeks had abnormally high white blood cell counts, something that happens normally in cases of cancer, poisoning or infection. The rats also had kidney weight loss, liver necrosis and high blood sugar, among other negative effects. Alleging “confidentiality”, Monsanto initially published an 11-page summary. The report was made public only after a court order in Germany.

Various specialists consulted by the newspaper agreed that the data in the summary was significant and alarming. Genetics expert Michael Antoniou, of Guy's Hospital Medical School, said the findings were very worrying from a medical standpoint.

It must be pointed out that this information was first made public only because of some anonymous whistleblower. And yet, Mon 863 was approved for planting and human consumption by the US authorities. Monsanto knowingly fed this product to humans despite information about its hazards and had initially kept it confidential.

How many more similar reports exist? Could there be other GE products, equally or more hazardous, out in the market? It is difficult to know, considering scientists employed by the biotech corporations are forced to sign non-disclosure agreements.

The Australian Pea Study

In 2005, a GE pea developed by Australia's Commonwealth Scientific and Industrial Research Organization provoked a strong immune response in laboratory rats when tested by scientists from the John Curtin Medical Research School in the city of Canberra. The tests carried out on the pea were of the kind normally undertaken on drugs, not on food, and are not required by US law. This means that this pea would have made it right through the approval process of the Food and Drug Administration (FDA) and the Department of Agriculture (USDA) and entered the US market.

The tests carried out on the Australian GE pea are not the norm, anywhere in the world. In fact they were unprecedented. According to Pusztai and other experts, such thorough testing had never been done before on a biotech product.

The FDA “does not regulate GE foods,” according to the environmental group Friends of the Earth USA. Instead, the FDA has a ‘voluntary consultation’ process that allows biotechnology companies to decide which, if any, safety tests to conduct and how they will be performed. “The company determines which data, if any, are shared with regulators. In fact, the company even determines whether it will consult with the FDA at all.”

One of the Friends of the Earth's main experts on biotechnology, William Freese, is co-author of “Safety Testing and Regulation of Genetically Engineered Foods,” a paper published in *Biotechnology and Genetic Engineering Reviews*. According to the paper's authors, safety assessment for GE products in the US is inadequate, as it is based on wrong assumptions and poor research.

According to the Union of Concerned Scientists, the FDA has little power to compel companies to submit food safety data and does not carry out independent and scientifically rigorous reviews of new transgenic food products.

The *New York Times* reported in 2001 that according to data from the Center for Disease Control, food was now responsible for twice the number of illnesses in the US as scientists thought seven years earlier, a period that coincides with the massive introduction of GE foods into the market. The cases reported include 5,000 deaths and 325,000 hospitalizations. Whether these cases are linked at least in part to GE foods is an open question, since no one has looked into it. Meanwhile in England, soy allergy cases went up 50% during a period that matches the introduction of GE soy, according to studies done by the York Nutritional Laboratory. No thorough attempt has been made to see if GE foods have indeed contributed to greater allergies.

CONTAMINATION

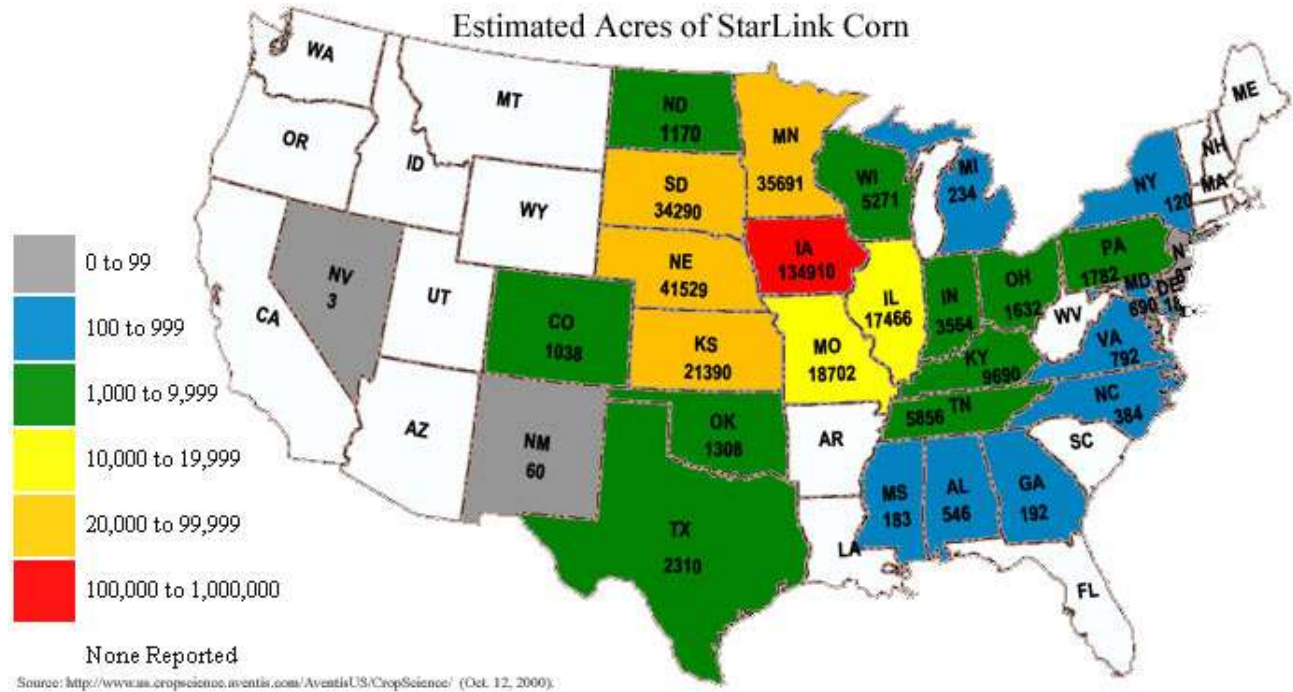
Another point of contention in the debate over agricultural biotechnology is the issue of genetic contamination. The products of genetic engineering are living organisms, which reproduce, move, and in general, behave in ways that are not entirely predictable. Spokespersons for the biotech industry have repeatedly claimed that GE organisms would not proliferate and spread out of control, and would not appear where they are not supposed to be. They said that the precision of the industry's technologies, the accuracy of its inventories, and allegedly strict federal regulations would prevent genetic contamination. But the reality is different.

Starlink

In 2000, Genetically Engineered Food Alert, a non-governmental advocacy coalition, tested corn products sold in US supermarkets and found that some were contaminated with Starlink, a variety of GE corn that the FDA had deemed unfit for human consumption. Back in 1998, regulatory authorities had permitted its planting, as long as it was used only for animal feed, and by 2000 it was being planted by some 2,500 farmers on 300,000 acres.

Within a month, the US government had confirmed GE Food Alert's finding and eventually discovered traces of Starlink in hundreds of supermarket products, triggering the first recall of a GE product, and certainly not

the last. According to government documents obtained by the Center for Food Safety through the Freedom of Information Act, both the government and the Aventis corporation, owner of the Starlink patent, knew the human food supply was contaminated with Starlink at least since 1999, but perhaps as early as 1997, when it was being grown on 3,000 acres of experimental plots in 28 states. In 2001 Aventis reported that 430 million bushels of stored corn from 1999 contained Starlink traces. Dozens of Americans reported severe allergic reactions from eating Starlink-contaminated corn products.



Even though Starlink planting has been altogether prohibited since this episode, it still keeps appearing in American exports and in food aid shipments. “Part of the explanation may be that the seed supply for corn is still contaminated,” suggests the Union of Concerned Scientists. “It may be that inbred lines remain contaminated with Starlink genetic sequences and every time these inbreds are used to produce hybrid corn seed, the Starlink sequences are reintroduced into the seed supply.”

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Mexican Corn

In 2001, University of California researchers Ignacio Chapela and David Quist discovered that traditional varieties of corn had been contaminated with GE transgenes, in rural southern Mexico. Local environmentalists and scientists had been warning about such a possibility since the 1990's.

“This is pollution in the very center of origin of a crop of major importance for world nutrition. This pollution can spread not only to native and traditional maize, but also to wild relatives,” wrote Silvia Ribeiro, of the Action Group on Erosion, Technology and Concentration (ETC Group). This gene flow “is polluting and degrades one of Mexico's major treasures.”

“The pollution was no chance act, but a well thought-out and conscious strategy which simply took a little while to play itself out,” accused Genetic Resources Action International (GRAIN), a Barcelona-based organization that advocates the sustainable use of biodiversity. “None could deny that the natural course of

any seed is inevitably to spread. That is what makes a seed a seed. Nor could anyone deny that maize is naturally an open pollinator. Any farmer knows that. Put a genetically-modified maize variety into a highly diverse, maize-intensive small-farmer area and it will be just a matter of time for the new variety to join the pool and for contamination to occur.”

The contamination of maize in Mexico affects us all, according to GRAIN. “It hits first of all the Mexican and Meso-American peoples for whom maize is a staple food, a key factor in their economies and an essential part of their spirituality. It affects all the Latin American peoples who have adopted, cared for and given form to their own varieties of maize, many of whom have also incorporated maize into their spiritual lives. It

According to Oaxaca indigenous leader Aldo González, “Native seeds are for us a very important element of our culture. The (Mayan) pyramids could be destroyed, but a fistful of corn is the legacy that we can pass on to our children and grandchildren, and today we are being denied that possibility.”

affects all those who still grow crops with care and affection, because if maize was polluted on purpose, this will certainly happen to other crops as well. And finally, it affects us all as witnesses of a process whose consequences we can barely imagine. As humanity, we see how a small group of people moved by arrogance and driven by profit, with the support of various forms of power, are shamelessly playing God.”

In view of what happened with the Mexican corn, biotech industry consultant Don Westfall spoke perhaps a little too candidly when he let out that “The hope of industry is that over time the market is so flooded that there's nothing you can do about it. You just sort of surrender.”

The industry and its advocates engaged in a persistent and prolonged campaign to discredit Chapela and Quist and to pressure *Nature* magazine, where their study was published, to retract it. Faced with a barrage of criticism from pro-industry scientists, *Nature* published in its April 4, 2002 issue, an editorial note on the Chapela-Quist study stating that “evidence available is not sufficient to justify the publication of the original paper.” Biotech advocates celebrated that editorial note but they neglected to mention the editorial in *Nature's* June 27, 2002 issue, which said that the Chapela-Quist study “was not formally retracted by its authors or by *Nature*.”

Tainted Seed

According to a 2004 report by the Union of Concerned Scientists (UCS), laboratory tests showed that corn, soy and canola varieties in the US that are supposed to be GE-free are actually contaminated with transgenic genetic material. This research led the UCS to believe that the levels of contaminated seed oscillate between 0.05% and 1%. This may not seem like much. But if only 0.1% of the non-GE corn seed supply is contaminated, that's the equivalent of 25,000 50-pound bags of seed corn, or 24 large tractor-trailer trucks full of corn seed.

“Seeds will be our only recourse if the prevailing belief in the safety of genetic engineering proves wrong,” advises UCS. “Heedlessly allowing the contamination of traditional plant varieties with genetically engineered sequences amounts to a huge wager on our ability to understand a complicated technology that manipulates life at the most elemental level. Unless some part of our seed supply is preserved free of genetically engineered sequences, our ability to change course if genetic engineering goes awry will be severely hampered.”

Field Tests

Further contamination is caused by experimental open-air field tests of GE crops. Over 47,000 of these field

tests have taken place all over US territory (including Hawaii and Puerto Rico) since 1987, and include GE varieties of corn, soy, tobacco, tomato, rice, peanuts, wheat, strawberry and many more species. According to a 2005 report by the Texas Public Interest Research Group (TexPIRG), these outdoor experiments constitute a real contamination hazard, and the government's supervision of these outdoor experiments is inadequate.

The “USDA has failed to require adequate data collection on field tests of genetically engineered crops, leaving the true impacts of these new creations still largely unknown,” decried TexPIRG. “Although the USDA has authorized more than 47,000 field tests of genetically engineered organisms, the USDA, the EPA (Environmental Protection Agency) and the FDA have not adequately answered fundamental questions about the human health, environmental, social and ethical implications of this technology.”

More recently, a report issued by the USDA’s auditor, the Office of Inspector General, found that the department has failed to properly oversee field trials of genetically engineered crops, including plants designed to produce chemicals for medical and industrial uses. The report found that biotechnology regulators did not always notice violations of their own rules, did not inspect planting sites when they should have and did not assure that the genetically engineered crops were destroyed when the field trial was done. In many cases, the report said, regulators did not even know the locations of field trials for which they granted permits.

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These field tests include plantings of so-called biopharmaceutical or pharm crops, which produce pharmaceutical and industrial chemicals in their tissues. These plants, which include corn, soy, rice and tobacco, have been engineered to make products like growth hormones, blood clotting agents, vaccines-both for humans and farm animals-, human antibodies, industrial enzymes, and even contraceptives. “Just one mistake by a biotech company and we'll be eating other people's prescription drugs in our corn flakes,” said Larry Bohlen, of Friends of the Earth.

“Most noteworthy are problems of cross-pollination, and unknown deleterious effects on insects, soil microbes and other native organisms,” according to the biologist Brian Tokar from the Institute for Social Ecology. “Further, we may soon see biologically active enzymes and pharmaceuticals, only found in nature in minute quantities -- and usually biochemically sequestered in very specialized regions of living tissues and cells-- secreted by plant tissues on a massive commercial scale.”

“The consequences may be even more difficult to detect and measure than those associated with more familiar GM crop varieties, and could escalate to the point where those now-familiar problems would begin to pale by comparison,” Tokar warned.

Terminator

The industry has proposed the use of sterile seed technology to address the problem of genetic contamination. Such a technology, dubbed Terminator by its critics, would however make it impossible for farmers to save seed and would force them to buy it year after year.

“Terminator poses a threat to our welfare and food sovereignty and constitutes a violation of our human right of self-determination,” said Mariano Marcos Terena of Brazil on behalf of the International Indigenous Forum on Biodiversity in January 2006.

“Terminator technology is an assault on the traditional knowledge, innovation and practices of indigenous and local communities,” said Debra Harry of the Indigenous Peoples Council on Biocolonialism, and member of the expert group that examined the potential impacts of Terminator on indigenous peoples, smallholder farmers and Farmers' Rights. “Field testing or commercial use of sterile seed technology is a fundamental violation of the human rights of Indigenous peoples, a breach of the right of self-determination,” said Harry. “Terminator is a direct assault on farmers, Indigenous cultures and on the food sovereignty and well-being of all rural people, primarily the very poorest,” declared Chukki Nanjundaswamy of India from La Via Campesina, an organization representing tens of millions of peasant farmers worldwide.

In February 2006 over 300 organizations declared their support for a global ban on Terminator Technology, asserting that sterile seeds threaten biodiversity and will destroy the livelihoods and cultures of the 1.4 billion people who depend on farm-saved seed. These organizations are from every region of the world and include peasant farmer movements and farm organizations, Indigenous peoples organizations, civil society and environmental groups, unions, faith communities, international development organizations, women's movements, consumer organizations and youth networks.

As for the industry's assertions that Terminator can stop genetic contamination, “Terminator crops will still produce pollen and could cross with neighboring non-genetically engineered or organic crops. So gene flow could still occur, with potentially catastrophic impacts on agrobiodiversity and biodiversity, and on seed saving,” warns biosafety expert Lim Li Ching, of the Third World Network and a Senior Fellow at the Oakland Institute.

INTELLECTUAL PROPERTY

Genetically engineered crops also imply a variety of hazards of social, economic, political and cultural nature, as they are always accompanied by intellectual property rights (IPR). In the last two decades, high-technology industries, including biotechnology, have lobbied aggressively and successfully in changing IPR laws in their favor and at the expense of public interest. These changes have happened not only at the national level, but also regionally and worldwide through treaties like the North American Free Trade Agreement (NAFTA) and institutions like the World Trade Organization. Because of these changes it is now possible to patent, that is to privatize for monopoly purposes, genetic sequences, proteins, trees, staple crop varieties and even human cells.

Claiming private property rights over the basic building blocks of life entails vast negative ethical, political and socioeconomic consequences, and threatens environmental protection, the sovereignty of nations (especially those of the South), farmers' rights, academic freedom, the integrity of scientific research, food

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security worldwide and the most elemental human rights, as biotech critics and civil society organizations have denounced repeated times. Patents on seeds threaten to criminalize the ancient practice of saving and sharing them, and flatly contradict biotech companies' pretension of ending world hunger. New national legislations on seed patents are all repressive and coercive, and constitute ever-lengthening lists of prohibitions that limit farmer's options and prerogatives, and grant broad monopoly rights to an ever smaller number of corporations. This tendency is particularly alarming in light of the fact that 30 years ago there were around 7,000 seed companies and none of them had even 0.5% of the world market. Today, ten corporations control 49% of the world seed market. Of these, the biggest is the biotech giant Monsanto.

The Schmeiser Case

The combination of patents and genetic contamination is leading many farmers to situations that look like a sci-fi nightmare. Canadian farmer Percy Schmeiser found his organic canola crop invaded by Monsanto's GE canola. The company took him to court accusing him of piracy, of using its patented product without paying royalties. The case made it to the Canadian Supreme Court, which ruled largely in Monsanto's favor in 2004 (although only by a majority of one, indicating how controversial the issues are).

"In Monsanto's world, we're all criminals unless a court rules otherwise," observed Silvia Ribeiro, commenting on the Schmeiser verdict. "This will come as shocking news to indigenous farmers in Mexico, whose maize fields have been contaminated with DNA from genetically modified plants, and to farmers everywhere who are fighting to prevent genetically modified organisms from trespassing in their fields," said Ribeiro. Monsanto's newspaper ads in Chiapas, Mexico, are already warning peasants that if they are found using transgenic seed illegally, they risk fines and even prison.

The Agro-Police State

Schmeiser's case is in no way unique. In a 2005 report titled "Monsanto vs. US Farmers," the Center for Food Safety documented numerous cases of farmers that have been harassed, bullied and sued by Monsanto after their crops had been contaminated with GE seeds and/or pollen.

"Monsanto has used heavy-handed investigations and ruthless prosecutions that have fundamentally changed the way many American farmers farm," warns the CFS. "The result has been nothing less than an assault on the foundations of farming practices and traditions that have endured for centuries in this country and millenia around the world, including one of the oldest, the right to save and replant crop seed... Since the introduction of genetically engineered crops, farming for thousands of America's farmers has been fundamentally altered; they have been forced into dangerous and uncharted territory and have found they are the worse for it."

ON THE FARM

Roundup Ready Soybeans

One of Monsanto's main rationales for its Roundup Ready (RR) crops is that the Roundup herbicide is allegedly relatively benign for human health and the environment. But such assurances are contradicted by recent findings. An epidemiological study carried out in Ontario, Canada, found that exposure to glyphosate, Roundup's active ingredient, almost doubles the risk of miscarriages in advanced pregnancies. More recently in France, a team led by Caen University biochemist Gilles-Eric Seralini discovered that human placental cells are very sensitive to Roundup, and that even in very low doses glyphosate can disrupt the endocrine system.

According to the Independent Science Panel, "children born to users of glyphosate had elevated neurobehavioral defects. Glyphosate caused retarded development of the foetal skeleton in laboratory rats, (it) inhibits the synthesis of steroids, and is genotoxic in mammals, fish and frogs. Field dose exposure of earthworms caused at least 50% mortality and significant intestinal damage among surviving worms. Roundup caused cell division dysfunction that may be linked to human cancers."

A 1998 Iowa farmer survey found RR soy to yield 4% less than conventional soy – yet costs were \$26.42 per acre on RR soy seeds, whereas conventional varieties cost \$18.89 per acre.

One of the main problems with RR crops is the development of herbicide-resistant superweeds. As decades of experience show, when weeds are exposed to a poison, i.e. glyphosate, they become more resistant to it with each passing generation. If anything, the widespread use of RR soy and canola has led to a drastic increase in the use of Roundup and a corresponding increase in glyphosate tolerance on the part of weeds. As far back as 1996, a weed that could resist five times the recommended Roundup dosage was found in Australia, and in 2000 scientists discovered a herbicide-tolerant canola plant that cross-pollinated with a related weed. That same year, canola weeds resistant to three herbicides, were reported in western Canada. Since then, reports of glyphosate-tolerant weeds have only increased.

Has Roundup Ready soy been a good deal for the American farmer? In Illinois the use of RR soy has resulted in the most expensive weed control system in modern history: between \$40 and \$60 per hectare. Before the introduction of RR seed, such costs averaged \$26 per hectare. In addition, RR soy yields are on average no larger than those of non-RR varieties, and in fact are sometimes lower. A 1998 Iowa farmer survey found RR soy to yield 4% less than conventional soy. And then there's the seed's cost. An Iowa farmer can spend \$26.42 per acre on RR soy seeds, whereas conventional varieties cost \$18.89 per acre.

Bt Crops

The industry claims that Bt crops have greatly reduced pesticide use. But whether less pesticide is actually used because of Bt crops is an open question.

A 1999 study by the USDA's Economic Research Service showed no statistically significant difference in pesticide use between Bt and non-Bt crops. In fact, it found that in the Mississippi Delta, significantly more pesticides were sprayed on Bt crops. But the greatest problem is the development of pest resistance to the Bt toxin, warns UC Professor Miguel Altieri, "No serious entomologist questions whether resistance will develop or not. The question is, how fast?"

In Makhathini Flats, South Africa, the majority of small-scale farmers that used Bt cotton have stopped planting it because they could not repay their debts. A five-year study by Biowatch South Africa showed most farmers that planted Bt cotton had not benefited. In India, Bt cotton failed huge numbers of farmers in Andhra Pradesh and Madhya Pradesh, many of whom were driven to suicide as a result of heavy debts from purchasing Bt cotton seed, which was 3-4 times the price of conventional cotton.

The UK Royal Society's four-year study of GE crops confirmed that herbicide resistant crops harm wildlife, including wild flowers, bees and butterflies.

Bt crops can also harm beneficial insects and adversely affect soil ecology. Adverse effects of Bt crops on beneficial insects were known at least as far back as 1999, when research led by Charles Losey of Cornell University discovered that Bt corn pollen was toxic to monarch butterflies, under laboratory conditions. Losey came under withering attack by pro-industry scientists, as were Pusztai, Chapela and Quist in their moment, but Losey's critics ignore that subsequent research confirmed that Bt crops indeed are a hazard to "non-target" species.

"The potential of Bt toxins moving through insect food chains poses serious implications," warns Altieri. "Recent evidence shows that the Bt toxin can affect beneficial insect predators that feed on insect pests present on Bt crops... the toxins produced by the Bt plants may be passed on to predators and parasitoids via pollen. No one has analyzed the consequences of such transfers on the myriad of natural enemies that depend on pollen for reproduction and longevity."

Research shows that Bt crops adversely affect ladybugs that eat Colorado potato beetles, a major potato pest, and lacewing larvae that fed on pests that were fed Bt corn had a strikingly high mortality rate. Furthermore, the Bt toxin persists in the soil for months, by binding to clay and soil particles. It has been found to persist for as long as 234 days.

Losey got further vindication in 2005 when the UK Royal Society unveiled the results of a four-year study of GE crops. The study, carried out in 266 farm plots all over the country, confirmed that herbicide resistant crops harm wildlife, including wild flowers, bees and butterflies.

Golden Rice

As a last line of defense, biotech proponents argue that GE crops can help end world hunger, and point to the so-called “golden rice,” which was genetically engineered to contain vitamin A. But critics remain unimpressed, and hold that even if it works as advertised, golden rice would still not feed the hungry or address the root causes of hunger.

“The lower-cost, accessible and safer alternative to genetically engineered rice is to increase biodiversity in agriculture,” argues Indian activist, physicist, and scholar Vandana Shiva. “Further, since those who suffer from vitamin A deficiency suffer from malnutrition generally, increasing the food security and nutritional security of the poor-- by increasing the diversity of crops and therefore diets of poor people -- is the reliable means of overcoming nutritional deficiencies.”

ALTERNATIVES DO EXIST

Alternatives to GE crops and industrialized chemical-intensive agriculture do exist. An agroecological revolution is sweeping the world, in poor and rich countries alike. Civil society groups, grassroots movements and indigenous peoples are organizing, educating and mobilizing against GE crops and for a socially just and ecologically sound agriculture. They are in Bangladesh and France, as well as in Brazil, South Africa and the United States, struggling for food sovereignty, agrarian reform, for the preservation of seed as inheritance of the world's peoples, for an alternative globalization based on solidarity, and to demonstrate that another future is indeed possible. This silent revolution manifests itself in home and community gardens, seed exchanges, community-supported agriculture, farmers’ markets, food co-ops, and in the success of organic agriculture.

Advocates of GE and industrialized agriculture claim that organic farming does not deliver the yields needed to feed the world. But any yield reduction in organic agriculture is more than offset by ecological and efficiency gains. Research reviewed by the Independent Science Panel (ISP) demonstrates that the organic approach can be commercially viable in the long-term, producing more food per unit of energy or resources. As a matter of fact, production costs for organic farming are often lower than for conventional farming, bringing equivalent or higher net returns even without organic price premiums. When the premiums are incorporated into the equation, organic systems are almost always more profitable.

The Independent Science Panel (ISP) demonstrates that the organic approach can be commercially viable in the long-term, producing more food per unit of energy or resources.

A review of sustainable agriculture projects in developing countries showed that average food production per household increased by 1.71 tons per year (up 73%) for 4.42 million farmers on 3.58 million hectares, bringing food security and health benefits to local communities. “Increasing agricultural productivity has been shown to also increase food supplies and raise incomes, thereby reducing poverty, increasing access to food, reducing malnutrition and improving health

and livelihoods,” said the ISP. “Sustainable agricultural approaches draw extensively on traditional and indigenous knowledge, and place emphasis on the farmers’ experience and innovation. This thereby utilizes appropriate, low-cost and readily available local resources as well as improves farmers’ status and autonomy, enhancing social and cultural relations within local communities.”

Furthermore, studies show that, on average, organic food has higher vitamin C, higher mineral levels and higher plant phenolics – plant compounds that can fight cancer and heart disease, and combat age-related neurological dysfunctions – and significantly less toxic nitrates.

“Sustainable agricultural practices have proven beneficial in all aspects relevant to health and the environment. In addition, they bring food security and social and cultural well-being to local communities everywhere,” concludes the ISP. “There is an urgent need for a comprehensive global shift to all forms of sustainable agriculture.”

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