TRANSCRIPT

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Special Presentation
HARVEST OF FEAR
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NARRATOR: It was the eve of a new Century and Catherine Ives left her home near the quiet Michigan State University Campus.

CATHERINE IVES, Michigan State University: I was walking into downtown East Lansing to go out for New Year's Eve and we saw the fire trucks and the engines moving onto campus and we said oh, gee, I wonder what is going on here. And I looked up and I counted the floors and I said that's my office.

NARRATOR: The fire completely destroyed Ives' department. It was arson... but investigators had no clue why an agricultural center devoted to helping developing countries would be a target.

CATHERINE IVES, Michigan State University: The issue was did we have any ex-boyfriends or girlfriends that would be mad at us.

NARRATOR: Then, a communiquŽ arrived. It came from a basement office in Portland, Oregon. From a representative of an underground group--the Earth Liberation Front.

CRAIG ROSEBRAUGH, Spokesperson, Earth Liberation Front: There was an ELF action at Michigan State University on December 31st this last year and it was a fire that burned down part of a building where a genetic engineering research project was going on run by a woman named Catherine Ives. It did about $900,000.00 worth of damage.

NARRATOR: From burning buildings to destroying crops, the Earth Liberation front has declared war on biotechnology.

CRAIG ROSEBRAUGH, Spokesperson, Earth Liberation Front: I think the motives behind biotechnology are sickening. We know right now that there are problems associated with biotech and weÕre not going to know the extent of those problems for years to come.

NARRATOR: The ELF are at the extreme end of a movement passionately

opposed to genetically modified food.

Environmentalists call it Frankenfood and want it banned.

CHARLES MARGULIS, Greenpeace: We feel that this is a mass genetic experiment that's going on in our environment and in our diets.

NARRATOR: But giant multinationals who have bet their future on this technology insist it's safe.

HUGH GRANT, Chief Operating Officer, Monsanto: These are products, they're technologies that have been more widely tested than any other food product that came before them in history.

NARRATOR: There are scientists on both sides of the debate.

CHARLES ARNTZEN, Cornell University: We haven't has do much as a headache from any genetically modified food.

JANE RISSLER, Union of Concerned Scientists: We know very little about the long term impacts of genetically engineered food, so as a general matter they should be subject to more scrutiny.

NARRATOR: At once exciting and scary, this may be the future of our food.

From corn that makes its own pesticide...

To bananas that contain medicine.

to fast growing fish...

JEREMY RIFKIN, Author, "The Biotech Century": This revolution affects the most intimate aspect of life on earth, our own biology, the biology of our fellow creatures. If ever there was a time when we human beings had to take personal responsibility for the future, this is it.

ANNOUNCER: Tonight NOVA and FRONTLINE disentangle the fight about genetically modified food, the risks, the benefits, the hopes and the fears.

NARRATOR: In the early 1990s, on the big island of Hawaii, there was a disaster brewing. Like many farmers, Rusty Perry's livelihood was based on the papaya, a sweet-tasting fruit and one of Hawaii's most important crops. Then a lethal disease - the papaya ring spot virus - began decimating the plantations.

RUSTY PERRY, Papaya Farmer: We first found it in- I think it was late '93, and by '94 it was starting to become a real problem. And by '95 we had lost most of our fields. We had about 14 non-family employees. We went down to one.

NARRATOR: Dennis and Carol Gonsalves, two Hawaiian molecular biologists working at Cornell University, came to see the damage for themselves.

DENNIS GONSALVES, Cornell University: It's amazing. Look at that tree over there, typical symptoms of papaya ring spot. These are the shoe-stringing of the leaves over here. Look at this ring spot here. This is why they call it papaya ring spot

CAROL GONSALVES, Cornell University: Boy, those fruit are

terrible.

DENNIS GONSALVES: Yes, this farmer's not going to make any money.

NARRATOR: Nothing seemed to stop the virus - not physical barriers, not chemical pesticides. And most farmers were resigned that within a few years, the $45 million papaya industry would be gone forever.

Back in New York state, at Cornell University, Dennis and Carol Gonsalves searched for a solution. They wondered if the cutting-edge technology of genetic engineering might help. Genes are the chemical instructions in each cell that govern how plants and animals reproduce and grow. The Gonsalves's colleagues had been manipulating them since the '70s. Many medicines, from insulin to AIDS drugs, were now genetically engineered. Perhaps, he thought, the same techniques could help plants, as well. Even though plants don't have immune systems, Gonsalves thought it might be possible to protect them against a future infection.

Among the many genes making up the ring spot virus, Gonsalves identified one that made a harmless protein in the virus's outer coat. If he could splice this gene into the papaya chromosome, making a transgenic papaya, then perhaps the papaya would be protected - in effect, vaccinated against future infection.

But how do you get genes into plants? Scientists at Cornell had invented a crude but effective way called the "gene gun." The ammunition is genes, the target a plant. The shot is propelled by compressed gas.

Magnified many times, the process works like this. First, tens of thousands of copies of the desired viral gene are made. Next they're mixed with tiny tungsten balls to which the genes stick. When the balls are fired, the genes are carried along into the leaf. As the balls pass through the plant, some of the genes get inserted into some of the cells. These transformed cells can be grown in culture to become new plants, transgenic plants.

Gonsalves grew hundreds of transgenic papaya plants in dishes and subjected them to chemical tests. In a few, the new viral gene appeared to be working. Now came the moment of truth. Would genetically modified papaya plants be killed by the ring spot virus or would they resist?

CAROL GONSALVES: The real severe and the best test is after the gene is in, you rub the plants with an isolate of the virus to see if it actually indeed withstands infection.

DENNIS GONSALVES: This here is a virus-infected plant. The effect of the virus is on the leaves and also the fruit. On the leaves- the leaves, instead of being full, are narrow, and they also show this yellowing here, as opposed to the genetically engineered papaya here. This leaf is a normal-looking papaya leaf. It's fully green, and the growth is very good. Now, the only difference here is that this one plant has the one gene making it resistant to the virus.

NARRATOR: A decade of work had produced a breakthrough and perhaps saved an industry.

If genetic engineering could protect a papaya from a lethal virus, why stop there? At Cornell, a world center of agricultural science, researchers were hard at work genetically engineering crops. Some were working on getting medicines into plants. Others were striving to make crops like rice more

nutritious. But the early '90s was also a time when scientists speculated about exotic possibilities which might never make it into commercial products.

For example, by splicing a gene from a firefly into a tobacco seed, scientists could produce tobacco plants that would glow whenever they needed watering. Another idea was to splice a gene that enables an Arctic flounder to tolerate cold into a strawberry to protect it from frost damage.

While such speculations did not turn into commercial products, the new science of agricultural biotechnology had attracted the attention of some large corporations. Monsanto, an agro-chemical company, realized that biotechnology might offer a way out of the pesticide business, which had become increasingly unprofitable.

HUGH GRANT, Chief Operating Officer, Monsanto: Further development of pesticides was no longer a viable business opportunity and, from an environmental point of view, didn't really make sense, either. So we stopped all chemical investment and really redirected our energy towards biotech.

NARRATOR: Hiring hundreds of researchers, Monsanto set out to build a new industry. The first products were aimed squarely at their traditional customers, the same farmers who had bought their herbicides, pesticides and fertilizers, farmers like Gerald Tumbleson, who farms in southern Minnesota.

Eighty-five percent of the food we eat comes from large farms like this. On 2,700 acres, Gerald Tumbleson grows only two crops, corn and soy. Americans have come to expect cheap food, so to stay in business, Tumbleson is continually looking to technology to cut his costs - satellite navigation, the latest combine harvesters, and heavy use of pesticides and fertilizers. He was hoping that Monsanto's genetic technology could help him get rid of a big pest, the European corn borer caterpillar.

GERALD TUMBLESON, Minnesota Farmer: They burrow into the stalk, and then it rots the inside of the stalk. They burrow into the shank that holds the ear, and it rots that, and the wind comes up and the corn falls off. Now, to keep that from happening, we spray our field with an insecticide, but we can't get selective. We spray for an insect, and we might get four or five that we don't want dead, and we've killed them.

NARRATOR: Monsanto had a solution to sell, corn which made its own pesticide.

Scientists had long known that a humble soil bacterium called Bacillus thuringiensis, or Bt, produced toxins that killed caterpillars. Monsanto scientists spliced the bacterial gene that made the toxin into corn. Now every cell of the modified corn makes its own pesticide, a chemical protein harmless to most insects and to humans, whose bodies rapidly break it down, but lethal to the corn borer caterpillar.

In Monsanto's greenhouses, scientists put Bt genes into other crops: soy, potatoes, and into the most intensively sprayed crop of all, cotton. Because Bt crops replace pesticides, many scientists believed genetic engineering could help save the environment.

SUSAN McCOUCH, Cornell University: Cotton is the world's number-one user of pesticides. It is ironic to me that we think of cotton as a natural fiber, and we don't understand that it is a major pollutant environmentally. And Bt cotton presents us with an opportunity to reduce the amount of pesticides that

we're spraying on our crops. That not only has an environmental implication, but it has a major implication for the people who actually have to handle pesticides and do the spraying.

GERALD TUMBLESON, Minnesota Farmer: If you've ever been around here when you've sprayed an insecticide, if you've ever used that- we put it on- we put, you know, leather gloves on and coveralls on so it doesn't get on us. That is not a fun thing. That is not something I even want to dream about. I don't even want the thing in my machine shed when my grandkids are around. But those are the types of things we don't have to have with this Bt corn.

NARRATOR: Along with soybeans, which were genetically modified to manage weeds with much less herbicide, the Bt crops were received enthusiastically. Within a couple of years, the majority of soy and cotton and a third of all corn were genetically modified. Farmers like Gerald Tumbleson were convinced that biotechnology had the power to transform agriculture.

GERALD TUMBLESON: We're going to be raising things on this land, on this soil, that we haven't even dreamt of in 10 to 15 years. I envy my sons because they're just getting started in a time which, I think, to me is very important.

NARRATOR: By 1996, grain handlers were treating GM crops like any other grain. They mixed them in with non-GM crops and shipped them to food processors all over America. Because corn and soy are used in hundreds of products, these genetically modified organisms, or GMOs, rapidly found their way into everything from cereals to sodas and into the stomachs of millions of Americans.

Consumers had no idea this had been happening to their food. Even environmental groups had said little about the issue. One exception was Jeremy Rifkin, a long-time critic of biotechnology. For two decades he had tried to get the public interested.

JEREMY RIFKIN, The Foundation on Economic Trends: It seemed to me we needed to have a thorough and thoughtful global discussion on the potential environmental implications of reseeding the earth with genetically modified organisms.

NARRATOR: Rifkin would get his debate, but only when GM food left the U.S. loaded on ships bound for other nations, like Japan and the countries of the European Union. Within months of arriving in Europe, it was clear that the fortunes of GM food were about to change.

DAVID BOWE, European Parliament: You started to see it, first of all, in Germany and Austria, where there was almost a paranoia about anything to do with genetic modification. Eugenics as an issue is a very, very sensitive one because of recent history in Germany, and I think it was there that you first started too see real public concern. It was from Germany and Austria that the ball really started to roll, and it didn't stop there.

NARRATOR: Environmental groups - like Greenpeace International - staged demonstrations in country after country, even dumping GM soy in front of the British prime minister's residence.

DOUG PARR, Greenpeace UK: The public are becoming quite skeptical about the ability of scientific evidence to tell us all we need to know about potentially irreversible innovations. And genetic engineering seems to be

crossing those boundaries of what we can know and should do.

NARRATOR: Europe was already reeling from another, unrelated food crisis. Mad cow disease was condemned as a disastrous failure of science and regulation.

DAVID BOWE: The confidence in government agencies to stand up for people, and not roll over to private companies who are trying to make a profit, was just not there.

NARRATOR: Farmers had their GM crops pulled up. Food companies had their brands targeted. Supermarkets were pressured to dump GMOs from their shelves. There was now a broad-based popular movement, angry that GM food had been introduced without consultation.

JEREMY RIFKIN: In Europe there's a seamless web between culture and cuisine. The way food is grown, the way the agricultural areas are preserved, the way food is processed and served, all of that is a deep statement of the values of each country in which that food is grown. The Europeans were saying, "We don't want a handful of life-science companies to undermine the cultural values behind our food and food policies in Europe."

GORDON CONWAY, President, The Rockefeller Foundation: There's no benefit to European consumers, and there are risks, of course. And so it's quite logical, if you buy up the fact there are no benefits and there are risks, that you will be against them. At the moment, all the benefits are going to American farmers, and I think that isn't appreciated in Europe.

NARRATOR: As public opinion hardened, the European Union voted for a ban. No new genetically modified organisms would be commercialized until further notice, and all imported GMOs would have to be labeled.

The scale of the European opposition called into question the entire future of GM food. U.S. exports would be affected, but far more important to U.S. companies was the risk that American consumers might turn against GM food, which had now penetrated throughout the $600 billion U.S. food industry.

At the University of New Mexico, political scientist Hank Jenkins-Smith has embarked on a major opinion survey about genetically modified organisms

> **TELEPHONE POLLSTER:** Do you currently eat any genetically modified foods or foods that include genetically modified ingredients?

NARRATOR: He wants to know if we are likely to reject GMOs, like the Europeans.

HANK C. JENKINS-SMITH, University of New Mexico: The stakes are high. Food is such an intimate thing for most people. We consume those items. We take them into our bodies. We're dependent on the producers of those foods to make sure that they're safe, that they are of high quality. That is what makes this such a fascinating public policy question.

NARRATOR: In designing surveys, researchers use focus groups to get an idea of what snippets people have picked up about a controversy.

> **HANK C. JENKINS-SMITH:** Have any of you eaten genetically modified foods, to the best of your knowledge?

FOCUS GROUP PARTICIPANT: No.

FOCUS GROUP PARTICIPANT: Not knowingly.

FOCUS GROUP PARTICIPANT: There were taco shells.

HANK C. JENKINS-SMITH: Only roughly 20 percent of the people we talked to would say, yes, that they do eat genetically modified organisms. A fair number simply say they don't know. And then the majority say no, they don't.

Any of you ever consume any of that?

FOCUS GROUP PARTICIPANT: Yes.

HANK C. JENKINS-SMITH: We're getting close to home here?

FOCUS GROUP PARTICIPANT: Uh-oh.

HANK C. JENKINS-SMITH: This is soy oil. It's cheese.

NARRATOR: The research is clear. Most Americans have no idea they've been eating GM foods for over five years. And when they find out, they get upset.

FOCUS GROUP PARTICIPANT: And why weren't we allowed to be in on that? Yeah.

FOCUS GROUP PARTICIPANT: What's it going to do to my daughter? What's it going to do to my 8-year-old little boy when he- you know, for reproducing later on? Is there going to be a problem?

NARRATOR: A key element of any controversy is trust. Europeans didn't trust their regulators. What about Americans?

HANK C. JENKINS-SMITH: The department of Agriculture, interestingly, gets quite high ratings of trust. On a scale of zero to 10, where zero is not at all trusted and 10 is completely trusted, they rank close to a 7. And we don't see agencies that get that high very often. Not far behind them comes the FDA.

TELEPHONE POLLSTER: Suppose a spokesperson from the U.S. Environmental Protection Agency said the-

NARRATOR: But as happened in Europe with mad cow disease, trust in regulators can be lost overnight. It's a critical time.

HANK C. JENKINS-SMITH: If there were to be some event that galvanized public concern, you can change an issue like this substantially, as Three Mile Island did, for example, with the nuclear technology policy debate. We haven't seen such a thing yet. If it were to happen, it could be devastating.

TELEPHONE POLLSTER: To the best of your knowledge, have most scientists concluded that genetically modified foods are unsafe for human consumption, safe for human consumption, or they haven't yet reached a conclusion?

Are GMOs safe to eat?

NARRATOR: Unraveling the truth about GM foods means confronting some difficult questions. Are scientists tampering with nature? Will genetically

modified organisms damage the environment? Does the world really need GMOs?

But first a more fundamental question. How do we know they're safe to eat?

In the coming years, biotech companies have plans to introduce dozens of new genetically modified organisms - vegetables, fruits, nuts and more. What guarantees do we have that these GMOs will be safe to eat?

[www.pbs.org: What's coming in GM foods?]

JEREMY RIFKIN, The Foundation on Economic Trends: We've spent a long part of our history testing various things we could eat, and a lot of people have died as part of this grand experiment to see what we could consume. Here, for the first time in history, because we're introducing genes from novel sources, we're introducing genes that code for proteins we've never put in the human body. Many of them will be safe, I am sure. Will most of them be safe? Nobody knows.

GORDON CONWAY, President, The Rockefeller Foundation: You cannot prove that it's safe. You can't prove that any new technology that we have in the world today is absolutely safe. Whether you have a mobile phone that you're listening to, whether that affects you, whether overhead power lines affect you, whether you are a woman and you take a birth control pill or take hormone replacement therapy, we cannot in any of those circumstances prove that it's absolutely safe. What you can do is try and minimize the risks by doing proper testing, and that's what we have to do with genetically modified foods.

NARRATOR: Biotech companies argue that's just what they've done. The new crops are tested for toxicity by feeding the genetically engineered proteins to mice in doses 1,000 times greater than humans would receive. According to Monsanto's chief operating officer, Hugh Grant, such tests have failed to find any evidence of harm.

HUGH GRANT, Chief Operating Officer, Monsanto: These are products, these are crops that the technologies have been more widely tested than any other food product that came before them in history.

NARRATOR: To test that the GM foods are substantially the same as their non-GM equivalents, company scientists compare the chemistry in minute detail. Molecule by molecule, they analyze the GM and non-GM crops. If the resulting graphs from a mass spectrometer line up exactly, the two products are chemically identical. This is what the regulators call "substantial equivalence," and it is one reason GM foods normally do not require special labels.

JANE HENNEY, Former Commissioner, FDA: Most of these foods that are being changed are foods we know very well- corn, soybeans and the like. And what is being changed is usually something that is very- today has been something of very small difference.

NARRATOR: The regulation of GMOs is shared between three agencies that treat them in the way they treat regular crops. The USDA checks that they're safe to grow, the FDA checks they're safe to eat, and the EPA also gets involved with crops, like Bt corn, that contain pesticides.

DAN GLICKMAN, Former U.S. Secretary of Agriculture: I don't think we're going to have the same problems here they have in Europe, and the simple reason why is because our food safety regulatory system is head and

shoulders above anybody else's in the world.

NARRATOR: But critics worry that in regulating GMOs no differently from traditional foods, the agencies may be exposing the public to unknown risks, like allergies.

JEREMY RIFKIN, Author, "The Biotech Century": We know that 8 percent of children and 2 percent of adults have allergenic reaction to traditional foods. What we're dealing with is the introduction of new genetic foods that have genes that code for proteins that we've never consumed. We just don't know what the reaction's likely to be.

NARRATOR: At Cornell's Department of Food Science, scientist Joe Hotchkiss is an expert on food safety.

JOSEPH HOTCHKISS, Cornell University: Allergenicity is very, very difficult to predict. Probably the most allergenic food is peanuts. There is a protein in peanuts which is a very serious allergen for a very, very small portion of the population. It's very difficult to find out who that population is unless they have had a very bad accident or episode.

[www.pbs.org: Read the full interview]

NARRATOR: People can avoid peanuts by looking at the labels the FDA insists upon. But the ability to manipulate individual genes presents new challenges. One biotech company actually engineered a gene from a Brazil nut into a soybean, making the soybean allergenic. If the soy had ended up in hundreds of products, individuals allergic to Brazil nuts might have unknowingly consumed a life-threatening food. But it never made it to supermarket shelves. The allergy was picked up by a laboratory test.

Scientists like Charles Arntzen of Cornell believe the public should have confidence in GMOs because they are based on three decades of research.

CHARLES ARNTZEN, Cornell University: We've been working on this stuff since the '70s. We haven't had so much as a headache from any genetically modified food, and I think that's because we thought about these things. In the U.S., it's been science-driven. We've had great cooperation between federal agencies, but we've had the scientists who understand this and who've developed it working on this all the way through.

NARRATOR: Despite such assurances, watchdog groups like the Union of Concerned Scientists believe this technology deserves special scrutiny. Their spokesperson is former EPA scientist Dr. Jane Rissler.

JANE RISSLER, Union of Concerned Scientists: You've heard industry say there's no evidence these foods are harmful, and after all, people in the United States have been eating them for several years now. Do you believe that statement? I mean, how are you affected by that? Isn't it a bit disingenuous? How would we know if someone had gotten ill from genetically engineered food if it's not labeled?

I mean, how could there be evidence if they haven't allowed the food to be labeled? They're now saying, "Well, there's no evidence of harm." That's because they haven't allowed any way to track any harm.

NARRATOR: There is perhaps no better example of the difficulties of keeping track of GM food than the story of a corn called Starlink. Developed by

Aventis, one of Monsanto's competitors, Starlink was intended for America's breakfast tables. But things didn't work out as planned.

Starlink is identical to regular corn except that it was engineered to make a toxin called Cry9C, one that Aventis had to prove was not an allergen. To test for this, scientists recreate in a test tube the chemical conditions of the human gut and time how long a new protein takes to break down. The longer it takes, the more likely it will be an allergen.

Since Cry9C broke down relatively slowly, the EPA concluded it was a potential human allergen and approved it only for animal use. Convinced it was safe for humans, Aventis conducted more tests. Meanwhile, they decided to go ahead and sell it to farmers strictly for animal feed.

The environmental group Friends of the Earth routinely checks agency releases for news of GM crop approvals. In July, 2000, on an EPA Web site, they noticed Starlink and realized it might be very important.

> **LARRY BOHLEN, Friends of the Earth:** What are the potential health effects here?
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> **COLLEAGUE:** Well it looks like it produces this protein that could be a food allergen.

LARRY BOHLEN: We learned that the Starlink corn that has the bacterial toxin Cry9C in it was not approved for human consumption, only for animal consumption. We were in conversations with farmers who were telling us that most farmers do not separate genetically engineered corn from conventional corn. Given that very little of the corn is separated and there's a type of corn not approved for human consumption, I thought there is a good chance that it had made it into our food.

I went into my local Safeway, and I bought 23 different corn-based products- boxes of corn flakes and taco shells and tortilla chips, I had a corn muffin mix, some corn meal and also a couple of enchilada TV dinners.

NARRATOR: He took them back to the office and shipped them off to a laboratory with a single question: Do any of them contain the unapproved protein Cry9C? The lab found Starlink corn in one product, taco shells, made by Taco Bell.

LARRY BOHLEN: We double and triple-checked the tests, knowing that consumer confidence, millions of dollars and the fate of farmers were all on the line here.

> **PETER JENNINGS, ABC News:** Today government officials say they are investigating reports that they are investigating that Taco Bell uses genetically modified corn that is only fit for animals.

NARRATOR: The next day, tacos were all over the news, and accusations were flying.

> **BARRY SERAFIN, ABC News Correspondent:** The biotech industry says before any action is taken, the test results must be verified, noting that the lab that was used in this case has been wrong before.
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> **VAL GIDDINGS, VP, Biotechnology Industry Organization:** These results have been alleged by a company that has a history of finding

things that aren't there.

BARRY SERAFIN: The Food and Drug Administration says it will conduct its own tests and order a recall if the taco shells do indeed contain the unlicensed corn.

JANE HENNEY, Former Commissioner, FDA: We have confirmed within our own labs that, yes, this did enter the food supply. Whether it posed a true safety issue or a real health issue for the American consumer I think is still very much in question.

JANE RISSLER, Union of Concerned Scientists: Suppose Friends of the Earth had never done this testing? Suppose that there are people who, in fact, are allergic to Cry9C? Would we have known? Was someone who was eating a taco shell who got ill- would that person say, "Oh, my. There's genetically engineered corn in the taco shell"? Well, how would a person know? The absence of evidence is not absence of harm.

JANE HENNEY: I don't think that it demonstrates that the whole system is flawed. Clearly, this was an issue that has been a very strong lessons learned for, I think, all of us.

NARRATOR: But how did corn meant for animals find its way into American stomachs?

JIM MARYANSKI, Food and Drug Administration: The company that developed this particular plant believed that they had a management program that would ensure that the growers of this corn would channel that product into feed use and keep it out of the food supply. Obviously, it didn't work.

LARRY BOHLEN, Friends of the Earth: Aventis made a big mistake by assuming that thousands of people making decisions every day on their farms would be able to separate the Starlink corn from conventional corn. But harvest days last for 14 hours. Farmers are driving late into the night. They're under a lot of pressure. Farm prices are really low. There's even pressure for some people to sell the Starlink into the food system to get a higher price. There's so many reasons that the Starlink corn can get into the food supply that it was a risk that wasn't worth taking.

NARRATOR: At a cost of $500 million, Aventis has now withdrawn Starlink corn from the market, but not before it had spread all over the world.

LARRY BOHLEN: Starlink corn was found in Japan in a baking mix. It was found in Korea and in the U.K. and in Denmark. So contamination is worldwide.

Are we tampering with nature?

DAVID BOWE, European Parliament: An underlying concern about GM is that perhaps it's not quite right, it's against the will of God, it's manipulation of the natural order of things in a way that's against religious feeling, almost.

NARRATOR: But scientists argue humans have been tampering with nature for a very long time.

JOSEPH HOTCHKISS, Cornell University: I don't like the word "genetically modified food." Virtually all of our foods have been genetically modified. If you take the apple, for example, there are literally dozens of

varieties of apples. How did we get those dozens of varieties? We genetically modified the apple through conventional breeding. We crossed one kind of apple with another apple, and we produced very different apples- different color, different flavor, different functions.

NARRATOR: The fruits and vegetables we take for granted, scientists say, are not the way nature made them. They have all been genetically modified for our benefit.

MARTINA McGLOUGHLIN, University of California, Davis: People think when they go to the store and buy potatoes or tomatoes or grapes that this is the way they always were in nature. In fact, that's not the case. Here we have a wild variety of potato, in fact, which very much looks like the ancestor of this modern potato. It's the same potato, except for a few genes difference that were introduced through breeding and selection. This is the same for tomato. And it really is difficult to believe that using just basic selection and cross breeding over hundreds of years that you went from this ancestor to modern-day tomatoes.

NARRATOR: If crops bred by traditional methods are not natural, neither are they necessarily safe.

JOSEPH HOTCHKISS, Cornell University: The potato contains a naturally occurring chemical that's quite toxic, called a glycoalkyloid. Those glycoalkyloids in some potatoes, as a matter of fact, have caused severe human poisonings and near death. When you breed potatoes, it's possible to breed in high levels of that toxin into a potato. And as a matter of fact, there are a number of breeds of potatoes that have high levels. Fortunately, they did not make the marketplace for that reason.

Another great example of the risks of traditional breeding is celery. Celery naturally contains a chemical, when it hits sunlight, becomes toxic. There was a case in California where a new variety of celery was bred. It had, unknown to the people who bred it, high levels of this toxin in it. It was planted, and the workers who harvested this came out with a very severe skin rash. So normal kind of breeding can produce risks, just as any other genetic or other kinds of breeding can produce risks.

NARRATOR: So is GM technology simply a high-tech version of the tampering traditional breeders have been doing for centuries?

Everyone agrees there are some significant differences. Classical breeders can only cross related plants, like two varieties of potato. And a cross involves mixing tens of thousands of genes at a time.

[www.pbs.org: Engineer a crop yourself]

Genetic engineering, by contrast, is much more precise, moving individual genes into plants. And it can also do something traditional breeders have never managed to do: move genes between different life forms, putting not just plant genes into plants but genes from insects, animals, fish.

JEREMY RIFKIN, The Foundation on Economic Trends: You can cross a donkey and a horse in classical breeding - they're very close relatives - and you can get a mule. But you can't cross a donkey and an apple tree in classical breeding. What the public needs to understand is that these new technologies, especially recombinant DNA technology, allow scientists to bypass biological boundaries altogether. This is something we've never seen in 10,000 years of

classical breeding.

NARRATOR: Moving genes across species to produce so-called transgenic life forms seems to many a radical step. One experiment, proposed but never carried out, to splice a flounder gene into a strawberry to protect it from frost, has caught the public imagination. It's the stuff of fear and myth. What have we created, fish or strawberry?

CHARLES ARNTZEN, Cornell University: You can almost see their nose wrinkling up because there's something about a fishy smell to a strawberry. And it's a mental image. It's more then anything else just, "Oh, I wouldn't like that." It has nothing to do with the science, I believe. It's just the way we're wired in our brain. A fish is supposed to smell like a fish and a strawberry like a strawberry, and just superimposing words on each other gives us- we back off. We don't like that.

NARRATOR: The modern scientific view of nature holds that all living things - be they plants, animals, insects - are controlled by DNA. All are based on thousands of tiny genes that control the way things grow, genes that are similar across all species, from humans to the food they eat.

MARTINA McGLOUGHLIN, University of California, Davis: We probably share about 50 percent of our genes with plants. Take an example. There is a protein, Cytochrome C, which is a very important component of our respiratory machinery, if you like. And this product, Cytochrome C, is identical in you, in a pea, in a cow- the total- the absolute same gene. That gene is just a coding sequence. You do not find the whole essence of an organism in that gene.

NARRATOR: Scientists argue that since tens of thousands of genes go into making most animals and vegetables, moving a single gene doesn't change the essence of a life form. A tomato with, for example, a single pig vitamin gene is still only a tomato.

Back in Hawaii, Dennis Gonsalves had to make a similar argument to U.S. regulators, that his transgenic papaya with a single gene from the ring spot virus is substantially the same as a regular papaya. For the USDA, he needed to field-test his GM papaya and prove it didn't harm other plants and animals.

> **DENNIS GONSALVES, Cornell University:** Do they have enough water going?
>
> **RUSTY PERRY, Papaya Farmer:** The weather's been real good.
>
> **DENNIS GONSALVES:** And how many acres do you have over here?

NARRATOR: He'd asked farmer Rusty Perry to carry out this trial.

> **DENNIS GONSALVES:** This is a big growth for one month.

NARRATOR: Next he had to submit data to the EPA that the GM papaya wouldn't adversely damage the environment. Finally, he had to convince the FDA that the papaya was safe to eat.

DENNIS GONSALVES: We had to show FDA that our papaya was substantially equivalent to a non-transgenic papaya. That means the vitamin levels were about the same. It did not have any unusual properties except virus resistance.

By the end of 1997, we had approvals from USDA, EPA and FDA.

NARRATOR: The GM papayas were thriving. For Gonsalves and his collaborators from the University of Hawaii, it was a moment of relief. But they still had one other hurdle. The papaya they'd engineered wasn't theirs to use.

While the GM papaya looked and tasted like a regular one, it owed its existence to years of sophisticated technology costing millions to develop, technology that universities and corporations had patented. It was time to hire a lawyer. Gonsalves had invented the GM papaya, but he needed intellectual property lawyer Mike Goldman to get it to market.

> **MICHAEL L. GOLDMAN, Esq., Nixon Peabody LLP:** -companies that hold those patents, so I'm going to need you to explain to me what is in the transgenic papaya and how it was made.
>
> **DENNIS GONSALVES:** OK. Well, let me show you briefly this genetic map that we have here. Our main component, basically, was the co-protein gene. And both Cornell and Upjohn have filed patents. Now, the other component we have is the 35S promoter here, to drive the gene. And this one here, as I understand it, is patented by Monsanto. And right in here, we have the leader sequence, and to tell you the truth, I don't know if anybody owns the patent on this.

NARRATOR: This practice of patenting genes attracted considerable criticism.

JEREMY RIFKIN, The Foundation on Economic Trends: We have less than 10 life science companies in the world that have a virtual lock on the seeds upon which we all depend for our food and survival. The issue here is, can companies like Monsanto use their control of intellectual property to force the rest of humanity to accept their terms in the commercial arena?

NARRATOR: Monsanto was sitting on a mountain of intellectual property. They held 28 percent of all U.S. agricultural biotech patents. This knowledge had cost them an estimated $7 billion in research, and anyone wanting to use this technology had to negotiate a license.

Lawyer Mike Goldman thinks that's fair.

MICHAEL L. GOLDMAN: Our patent system in this country is based on the Constitution, which rewards those that invent with the opportunity to use that technology as they see fit. So in my view, given the amount of money and effort that goes into research that is needed to develop this very complicated and important technology, there should be a return for that.

NARRATOR: But this defense of intellectual property, some critics argue, appears to contradict the claim that genetic engineering is merely a continuation of traditional plant breeding.

DOUG PARR, Greenpeace UK: I think the problem the biotech companies have got is that they want to say they're extremely different so that the genetic material can be patented and that it's very novel, whilst at the same time saying, "Well, they're pretty much the same" in order to get the foods through on the basis of substantial equivalence.

And I think that really doesn't wash. Either they're different, or they're very similar. But it seems like the biotech companies really want to have it both

ways.

NARRATOR: Urged by Gonsalves that time was running out, Goldman began the job of getting licenses.

DENNIS GONSALVES, Cornell University: I had my doubts that we would be able to get the intellectual property rights, especially from Monsanto. Monsanto was dealing with big issues- soybeans, cotton and so forth. And papaya was just one of them. It just so happened that they had intellectual property rights, and we put it into papaya, and they really were not interested. So in as far as them thinking about it and so forth, it was not in their priority, but it was in our priority.

NARRATOR: But Monsanto was distracted by other things, for there were signs that the European concerns about GMOs were spreading to America.

Do GMOs damage the environment?

NARRATOR: From the GM papaya to the gene gun, Cornell University was on the frontier of biotechnology. Most of its scientists were excited about the possibilities that GMOs offered. Then in 1999, the campus became embroiled in a bitter controversy involving one of the most celebrated symbols of nature.

Every year the Monarch butterfly makes a long journey to Mexico and back. On the way home, it stops to feed and lays its eggs on milkweed, for milkweed leaves are the only food young Monarch caterpillars eat. In thinking about the Monarch, a young Cornell entomologist, John Losey, realized that the only milkweed available in the vast American corn belt grows in and around corn fields, many of which now contained Bt corn designed to kill caterpillars.

Losey was curious whether the closeness of the milkweed to the Bt corn would affect the Monarch caterpillars, so he decided to do an experiment. Losey took milkweed leaves and dusted half of them with regular corn pollen and half with one variety of Bt corn pollen. Then he placed Monarch caterpillars on the leaves and let them eat their fill

JOHN LOSEY, Cornell University: What we found was the caterpillars feeding on those leaves dusted with the Bt corn pollen, they ate less, they grew more slowly and they suffered higher mortality. More of them died than in the other two treatments. Forty-four percent died over four days, and none of the others died, the ones eating the regular corn pollen or the no pollen. None of those died over the four days of the treatment.

NARRATOR: Losey published a letter in the British scientific journal Nature.

JOHN LOSEY:: We thought that it certainly probably would generate some interest. What we certainly weren't prepared for was the level of reaction to the paper, and I don't think I could have ever been prepared for that.

NARRATOR: For the first time in the history of GM food, the American press paid attention, from local newspapers to Time magazine.

CHARLES MARGULIS, Greenpeace: It was the first time I think that the public had an image of what could be the consequences of genetic engineering, you know, sort of a user-friendly, family-friendly butterfly which most Americans are very familiar with.

NARRATOR: Greenpeace's U.S. office had been waiting for something like

this to ignite the GM issue in America. Their coordinator was Charles Margulis.

CHARLES MARGULIS: We feel that this is a mass genetic experiment that's going on in our environment and in our diet. Nobody knows what the consequences are going to be, and the untoward side effects will be irreversible. You can't recall genes once they're released into the environment.

NARRATOR: The Monarch scandal energized Greenpeace USA. They began looking for dramatic ways to tell consumers that their food had been changed.

CHARLES MARGULIS: We pulled food products off of the shelves and tested to see if they contained genetically engineered material. And one product in particular, Gerber Baby Food, tested positive for genetically engineered corn and soybeans. We sent Gerber a letter and let them know that Greenpeace had concerns about genetic engineering and we thought consumers would share those concerns.

Gerber didn't respond to us. So we decided to go public with our findings, and a few weeks later Gerber announced that they would stop using genetically engineered ingredients in their products. I think it showed consumers that when they want to, these big companies can move overnight. It doesn't take years of government regulation. What it takes for these companies to fear that they're going to lose a little bit of their market share.

NARRATOR: At press conferences, Greenpeace exposed other food companies that routinely used GM corn and soy.

CHARLES MARGULIS: Well, it took Kraft a potential loss of a $50-million-a-year product to call for some more regulations.

NARRATOR: After Gerber, they zeroed in on Kraft, Campbell's, and Kellogg's. As in Europe, they staged stunts, targeting brands built up over generations. As in Europe, they filmed the events themselves.

CHARLES MARGULIS: Is Mr. Gutierrez in today?

RECEPTIONIST: You need to have an appointment.

CHARLES MARGULIS: I understand.

RECEPTIONIST: You need to have an appointment, and they would be glad to take care of you.

CHARLES MARGULIS: I see.

MAN IN TIGER SUIT: What have you done to my cereals? They're fake!!

RECEPTIONIST: Sir, you can't say that here.

CHARLES MARGULIS: See, this is Frankentony. He's very upset because he's genetically modified.

RECEPTIONIST: Hold on a sec.

SECURITY GUARD: I'll ask you guys to wait out here, please. Please.

MAN IN TIGER SUIT: What have you done to my cereals? They're fake!!

NARRATOR: Such demonstrations haven't so far attracted much media attention.

CHARLES MARGULIS: Creating public awareness has been harder here. But recently the public awareness has increased, and I think the situation in the U.S. now is very similar to the situation in Europe a year ago.

> **MAN IN TIGER SUIT:** I was a little disappointed that we didn't get to talk to anybody in the executive suite. It would have been nice to be able to let them see what they have done to me, what kind of a monster they've turned Tony into.
>
> **SECURITY GUARD:** Call Bill Duggan and tell them they are over here in Cereal City and get the police over here.
>
> **POLICE OFFICER:** This is a city sidewalk, and I need your driver's license, sir.

NARRATOR: Small though some of these demonstrations were, they seemed to scare the $600 billion food industry. No one wanted their brands to be tarnished with the image of Frankenfood.

> **GREENPEACE DEMONSTRATOR:** Greenpeace is here to send a clear message to the Kellogg's Corporation that we need pure food. We need pure food on our breakfast tables, and we need pure food for our children. Stop the use of genetically modified organisms.

NARRATOR: While the U.S. food industry hasn't been hit here as hard as in Europe, no one wants to be targeted. None of the major food companies was willing to participate in the making of this program.

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KELLOGG'S STATEMENT: "We can't grant an interview because we do not want to be singled out."

GERBER STATEMENT: "It's not our issue to fight. It's an industry-wide debate."

SAFEWAY STATEMENT: "It is an industry-wide debate, and it's not in our best interest to participate."

GENERAL MILLS STATEMENT: "Biotech is a very promising science. We don't see any evidence that the technology is unsafe. However, we do not want to be singled out."

PROCTER AND GAMBLE STATEMENT: "We cannot confirm whether or not we use GMOs in our products."

NARRATOR: Instead, the companies chose Gene Grabowski of the Grocery Manufacturers of America to speak for them.

GENE GRABOWSKI, Grocery Manufacturers of America: Food companies have learned that the groups are not intent on having a reasoned debate about biotech or helping consumers find out about biotech. It seems that their motive is to scare people. I don't dispute some of their research. I don't dispute their motives.

What I dispute, and I think what the industry questions, is the tactics, the street theater, the antics, the attempts to gain publicity at the expense of truth. It gets a lot of attention. That shouldn't be confused with how broad the movement is. We have not seen any indications through any surveys that they represent the vast majority of consumers or even near a majority of consumers.

> **PROTESTERS:** [singing] Where have all the Monarchs gone? Died because of genetic crops. When will they ever learn, when will they ever learn-

NARRATOR: The Monarch had become a powerful symbol, but how much science was there behind the rhetoric?

Back at Cornell, Losey had been dragged into the contentious debate surrounding biotech food, and he was forced to defend his conclusions, point by point, against his own scientific colleagues. In the lab, Monarch caterpillars fed leaves with Bt pollen died. But out in the field, things were more complicated.

TONY SHELTON, Cornell University: The real question is what is the effect out in the field. There's a whole series of events that have to occur to really make this a significant risk. Bt corn pollen is fairly heavy, so it doesn't travel very far.

JOHN LOSEY, Cornell University:: That's certainly true, and that's one thing that I think has been shown since our paper came out, is that the pollen really doesn't go very far. So if there's going to be an effect on the Monarch, it's going to be probably within the corn field or within a few yards of the corn field.

TONY SHELTON: You got to realize milkweed is a weed, and growers try and control it. It's actually on the federal list of noxious weeds. So you don't find a lush population of abundant milkweed inside a corn field.

NARRATOR: But Losey disagrees, saying that in most corn fields there's plenty of milkweed.

JOHN LOSEY: A substantial proportion of the milkweeds that exist anywhere actually exists in corn fields, so this idea that there is not milkweed in corn fields- that's just not true.

NARRATOR: Challenged by Losey's paper, researchers are trying to discover if, out in the field, Monarch caterpillars really do eat enough Bt pollen to do them harm. This has turned out to be a very complex task, and so far there are no conclusive results. However the science turns out, Losey believes more tests should have been done before the EPA approved Bt corn for widespread use.

JOHN LOSEY: Where the system fell down a little bit is that there weren't more tests done on these non-target butterflies. There should have been more data collected.

NARRATOR: But biotech companies counter that the press had missed the most important factor: Bt pollen is certainly less damaging than traditional ways of controlling the corn borer, like massive spraying of chemical pesticides, killing not just caterpillars but every insect in the field, including Monarch butterflies.

TONY SHELTON: If crops like Bt corn are banned, then I think there will be increased pesticide use that'll have some deleterious effects.

NARRATOR: Even Losey accepts this would be a bad thing.

JOHN LOSEY:: If you have the choice between putting out the Bt, which is very specific to just lepidoptera, or butterflies, and spraying with an insecticide which is generally fairly broad, you know, is going to almost kill all the organisms that are out there, then you are having less environmental impact almost undoubtedly by using the Bt then by using the insecticide.

NARRATOR: From corn to cotton, biotech companies have tried to portray GM crops as highly beneficial to the environment.

HUGH GRANT, Chief Operating Officer, Monsanto: Bt cotton has really been a breakthrough in how insects are controlled in the crop. Historically, the crop is sprayed 8 to 10 times with insecticide, usually flown over the top of the crop. Today the cotton crop is grown with one or two applications.

NARRATOR: But the biotech industry will first have to earn the trust of environmentalists.

GORDON CONWAY, President, The Rockefeller Foundation: One of the things you have to realize is that the big biotech companies were originally agro-chemical companies making pesticides. They still do. The reason why they got into biotechnology is that they could see the end of the market for pesticides.

JANE RISSLER, Union of Concerned Scientists: Now, of course, the argument is, "Well, this is not as bad as the synthetic pesticides." Well, I don't think it is, but do we really- do we want to replace one technology that is harmful to the environment with another technology that is harmful to the environment?

NARRATOR: Pesticides weren't always thought to be harmful. To the contrary. In 1947, Time magazine carried an advertisement claiming DDT was good for people, homes and farms. It took 20 years before scientists realized how dangerous it was.

JANE RISSLER, Union of Concerned Scientists: So if you just replace that with "Biotechnology is good for me"- see, these same people who once told us that pesticides were good for us are now saying, "Well, those pesticides, they're dangerous. But you take these biotech products. They're much safer."

I think that there are a lot of people that finally believe that we're not farming the right way, we're not producing food in the right way in this country.

[www.pbs.org: Should we grow GM crops?]

NARRATOR: Welcome to Full Belly Farm. It's very different from most modern industrial farms. Instead of two crops, California farmer Paul Muller grows 70 on just 200 acres. And everything is grown organically.

PAUL MULLER, Organic Farmer: This is a field that's one of our fall plantings, and it's not a very big field. It is about six acres. It has a variety of things that we grow in here for harvest and marketing all fall. We have broccoli. We have cabbage. We have different kales, hardy winter greens. There's some beets over there and some red cabbage. On this side, we have lettuce and onions and chard and things like that.

NARRATOR: Muller sells fresh produce to people who share his belief that

farming should be done in a sustainable way, in harmony with nature. Although more expensive and accounting for less than 2 percent of all food produced, it's a growing trend.

CHARLES MARGULIS, Greenpeace: When people are given the choice if they'd rather eat food produced with toxic chemicals and pesticides, food produced with genetic engineering or food produced organically, people choose organic food time after time in survey after survey.

NARRATOR: What is organic farming? Instead of herbicides, Muller uses sheep to clear the weeds. He has no chemical fertilizer. Instead he uses compost.

PAUL MULLER: It's not a natural process, what farming is. It's far from it. And so we're trying to minimize the amount of harm done and maximize the amount of health in the system over the long haul. And that's why we believe some of these tools are better tools then chemical fertilizers.

NARRATOR: But there is one product that Muller uses from time to time to control pests, something that's pitted him against the biotech industry: the organic pesticide known as Bt.

A hundred years ago, Japanese silk farmers discovered that a soil bacterium, Bt, produced toxins that killed their silk worms. Organic farmers later realized that this bacterium might be useful in killing caterpillars. Today they spray a Bt formulation on their leaves.

PAUL MULLER: The Bt that we use is very specific. It doesn't have a very long life. And we use it sparingly. We may spray only a field like this once, once a year, once a season. And we don't use it unless we have to.

NARRATOR: For a long time, organic farmers had Bt more or less to themselves. Then a decade ago, the biotech industry began splicing various Bt genes into crops like cotton and corn. Companies like Monsanto thought environmentalists and organic farmers would be happy.

JEREMY RIFKIN, The Foundation on Economic Trends: Monsanto says, "This is a leap forward. We're ending pesticides." Well, yes and no. Yes, they're ending the use of the pesticides, but now they're introducing more toxin then they ever introduced with pesticides. You have to think of that corn now as a factory producing toxin.

NARRATOR: And, say critics, this toxin will cause a worse problem: resistant pests.

It's not a new problem. Pesticides have never killed every last pest in a field. There's always a small number with genetic variations that resist the poison. Because these survivors eventually repopulate the entire field with resistant descendants, over time pesticides stop working.

A field of Bt corn potentially makes this situation worse. Seven days a week, 24 hours a day, the corn puts out Bt, killing most but not all corn borers. The resistant survivors soon repopulate the field. The Bt is now ineffective against those pests.

PAUL MULLER: By engineering Bt into corn, they're taking a tool away from farmers. Over the long haul, that Bt will disappear as an effective tool for a farmer like me to use. And it'll be something like Monsanto or whoever has

developed the corn that has the Bt gene in it, will have captured the profits, captured all the future benefits and put that into their pocket in a very short period of time.

HUGH GRANT, Chief Operating Officer, Monsanto: Resistance is something we take very, very seriously. We've made investments in these technologies for a decade, so it's in our interest to make sure that they last for another 10 or 20 years.

NARRATOR: To stay ahead of the resistance problem, companies like Monsanto say they've identified dozens of other bacterial genes for future use.

CHARLES MARGULIS, Greenpeace: You're going to be stuck going back to that biotech company for the next generation of genetically engineered crops, and they're going to be more and more costly and keep you more and more dependent. It's the same kind of treadmill that farmers have seen from the pesticide industry for 50 years.

NARRATOR: The EPA has mandated another solution to the resistance problem. It's called a refuge. For every field of Bt crops, farmers must plant a section with non-Bt crops, a place where non-resistant pests can live. Because these pests will mate with resistant pests, the refuge should ensure continuing generations of susceptible bugs.

But are farmers really setting aside valuable land to be devoured by insects? It's the EPA's job to check up on them.

STEPHEN JOHNSON, Environmental Protection Agency: We hold the biotechnology companies responsible. They have to provide us with reports. They have to monitor. And if we found that they were not complying with the terms of conditions, then we would revoke their license.

HUGH GRANT, Chief Operating Officer, Monsanto: The growers themselves self-police the system. They recognize the long-term value in insect control without insecticides.

NARRATOR: But given the ease with which Starlink corn got into the human food supply, critics argue it's unrealistic to expect overworked farmers to comply with onerous and costly regulations.

JEREMY RIFKIN: How many farmers are actually creating these refuges? I know that they have licensing agreements where they're supposed to, but you cross America and ask how many farmers are actually spending the time to build these elaborate refuges in their farms. Maybe in some of the test farms that you're in they will say they are. But I know that I've talked to enough farmers that say it's too much time and trouble to do it.

NARRATOR: Even if the refuge system works perfectly, genetically modified agriculture may pose another threat to organic farmers: pollen drift. The organic food industry prides itself on being pure, but contamination by GM pollen makes it difficult to guarantee their food is truly GMO-free.

CHARLES MARGULIS: The biotech industry knows that their crops will contaminate neighboring fields, and that will make it difficult, if not impossible, for organic farmers to provide their consumers with food that's free of genetically modified material.

NARRATOR: Muller believes that all technology-based farming is a mistake.

He admits it's produced cheap food, but only at the expense of the environment and the American farmer.

PAUL MULLER, Organic Farmer: There's been over-production for years. Prices are low. The farmers' only response is to grow more at that low cost. But everybody's doing the same thing. So we're producing more. The price goes down further, and then you look for another technology to allow you to produce more. So there's a treadmill going on there.

And what's not being accounted for? What's not being accounted for is the whole environment, you know, from the beneficial insects to the Monarch butterflies that fly through, to the waterways that have to deal with what runs off his field, whether it's nitrate fertilizers or pesticides. I would like to see more organic farms. I would like to see all agriculture be organic.

NARRATOR: But how feasible is this? With its fertile soil, good climate, cheap labor and affluent customers, California is perhaps the ideal place to grow organic food. But can organic farming work for the rest of the world?

NORMAN BORLAUG, Texas A&M University: This organic movement is ridiculous. For those who want to go the organic route, God bless them. Let them spend more money for their food. But looking at the world at large, this is an impossibility.

NARRATOR: Norman Borlaug won the Nobel Prize for his work on the green revolution. He used chemical agriculture and crop genetics to save parts of the developing world from starvation.

NORMAN BORLAUG: Most of the people who are opposing biotechnology, they've never known hunger. These people say that the little farmer should permanently accept that he's gong to stay on that three-acre farm with a hoe and a machete. That's fine in Utopia, but don't give the world the false idea that they can produce the food that's needed for six billion people.

Do we need GMOs to feed the world?

NARRATOR: In Africa, virtually every farmer is an organic farmer. Here it's called subsistence agriculture. At the mercy of the weather, but blighted with year-round pests and poor soil and unable to afford fertilizers and pesticides, most barely grow enough to feed their families. But Florence Wambugu, a Kenyan scientist, wants to change this.

FLORENCE WAMBUGU, Kenyan Scientist: You see, the farmer is very intelligent. What he is rejecting is virus-infected. He is calling it burnt, sun-burnt, [unintelligible] sclerotic, whatever. But that is indigenous wisdom. That is the way he has kept his crop growing

NARRATOR: This farmer grows sweet potato, a very important staple but one that is under constant attack from weevils and the feathery mottle virus.

FLORENCE WAMBUGU: This one is a typical symptom of feathery mottle virus, the canking here, the reduction in size. So the poor quality. This is not the color of the sweet potato. The normal color should be this. So you can see, the color has been destroyed by the disease.

This is one hectare? You've got two hectares.

From this area, he should be harvesting probably four times what he is getting

right now.

NARRATOR: Traditional methods of farming have so far prevented the virus from wiping out the sweet potato crop. But this type of subsistence agriculture cannot raise Kenyans out of poverty or feed the rapidly growing population. To break the cycle, Wambugu believes, Kenyan farmers must greatly increase productivity. And the quickest way to do this, she thinks, is to use biotechnology.

So in 1992, she traveled to St. Louis to spend three years at Monsanto, where the company supported her research to make a genetically modified sweet potato. What were they expecting in return?

ROB HORSCH, Monsanto: Projects like the sweet potato for Africa we will never make any money from, have no expectation to. The reason to do it is several-fold. To my mind, the most important one is because we can. And it doesn't cost us that much to do it. In the longer term, as poorer farmers do better, they become richer farmers. And at some point, those richer farmers can start buying our other products.

NARRATOR: Returning home to Kenya, Florence Wambugu set out to test the GM sweet potato to see if it would resist the feathery mottle virus. The Kenyan Agricultural Research Institute set up field trials at a number of sites. The results were striking. While the diseased plant had small damaged leaves, the GM variety grew tall and lush.

And underground, the difference was even more pronounced. The GM variety was large and healthy. Unmodified sweet potatoes, grown with traditional organic methods, could not compete.

FLORENCE WAMBUGU: May I say that organic farming has not worked in Africa, and it is not going to work. It is not the answer.

NARRATOR: Ironically, says Wambugu, the answer for the least developed people in the world may be the most advanced technology. In contrast to complicated and costly chemicals, GM technology is built into the seed. All the farmer has to do is plant it.

FLORENCE WAMBUGU: What farmers need is technology that is packaged in the seed, the seed that actually is resistant to the pests and diseases, and plant it the way they have always planted. That to me is sustainable. The GM technology is appealing, and to me, I say it's user-friendly. It does not demand the farmer go out to be educated on how to use it.

NARRATOR: But can a poor country like Kenya oversee this powerful new technology without the equivalents of the USDA, EPA and FDA?

CATHERINE IVES, Michigan State University: We have trained some of their researchers. We have also supported training of a number of their regulators to develop a Kenyan national regulatory system, which they have done. And we have trained their extension workers, so when it comes time to field test these plants in a number of different locations, which is currently ongoing, that they will know how to do that.

NARRATOR: Catherine Ives runs a program at Michigan State University to help developing nations produce more food.

CATHERINE IVES: People understand that if they can produce more food,

they can feed their families and keep their children healthier. They understand that if they can make their land more productive, maybe they can send their children to school, as opposed to have them out in the field all day.

NARRATOR: One of the biggest obstacles poor farmers face, especially in the tropics, is poor soil, loaded with excess minerals like aluminum or salt. Near Irapuato, Mexico, for example, toxic aluminum greatly reduces productivity of crops like corn. Scientist Luis Herrera wondered whether GM technology might offer a solution.

LUIS HERRERA-ESTRELLA, Plant Geneticist: This maize is not growing very well because it has problems of soil acidity, which leads to aluminum toxicity and low nutrient availability. So what happens is that the root system of the plant doesn't grow, and it cannot make- it cannot supply the plant with enough nutrients to grow. And what the farmer finds is that the productivity of the plant is not good. Usually, you should have this big, and you have very little production.

NARRATOR: In his laboratory, Herrera genetically modified the maize so it would produce a natural chemical called citrate, which binds to the toxic aluminum, keeping it in the soil and away from the plant. The results were dramatic.

LUIS HERRERA-ESTRELLA: So you can see here that the root formation of a normal plant in an acidic soil is not very good. And in plants that we produce citrate, the root growth is much better. And this is a way we have to demonstrate the system is working.

NARRATOR: When word of Herrera's research got out, Greenpeace arrived in Mexico, protesting that his GM maize was unsafe. Under pressure, the Mexican government halted his field trials.

LUIS HERRERA-ESTRELLA: We are not sure whether, because of the pressure of these groups, the government will ever allow us to field test our technology or they will not allow us to provide it to the farmers for commercial use. These people speak selectively, only the negative thing, and they totally ignore the positive benefits not only to humans but also to the environment.

The potential benefit is so important that this technology cannot be stopped. It must not be stopped.

NARRATOR: Herrera says there's much more at stake than his own research.

LUIS HERRERA-ESTRELLA: We need more food. There is people daily dying because of lack of food.

> **PROTESTER:** We have more food today on this planet per person than ever before in human history!

NARRATOR: But environmental groups reject the whole premise that GMOs are needed to feed the world.

JANE RISSLER, Union of Concerned Scientists: I think it's a ploy. It's playing on the guilt of relatively well-off people that, somehow, if they don't approve of this technology by agreeing to buy the products, that somehow the result will be people dying of starvation in the developing world.

INTERVIEWER: You don't believe that this technology can help people in

the developing world.

JANE RISSLER: The biggest problem behind hungry people is lack of money. It's not technology.

CHARLES MARGULIS, Greenpeace: We live in a world today where 800 million people a year are going hungry, in a world that produces enough food for almost 9 billion people. Yet we only have 6 billion people on the planet. Why isn't that food being distributed more equitably? It's because people who can't afford to buy food simply aren't being given it. It just isn't being given to them.

FLORENCE WAMBUGU, Kenyan Scientist: They don't have a clue what they're talking about because most of those people who talk like that get all of their food from the supermarket, and they just think how it is going to appear in another place in another supermarket.

The transport costs in this country are huge. Even if that food was donated for free, it would have to cost something when it arrives here. And there is the pride. If you cannot feed your family, if you cannot feed yourself, you have a mentality that makes you feel you are useless. People have pride in feeding their family. People have pride in being able to purchase. Everybody- how would anybody like to be a beggar? How would you like to be there waiting that until some food comes, you are going to stay hungry?

GORDON CONWAY, President, The Rockefeller Foundation: Whether or not people in developed countries like biotechnology, they should not deny those potential benefits to the developing countries. We've got 800 million chronically undernourished people. We've got 1.5 billion more people who will be added to the world population by the year 2020. That's an enormous number of people to be fed. And we believe that biotechnology, along with agriculture ecology, is going to be able to feed that population.

NARRATOR: Are the dreams of raising Africa out of poverty on a collision course with the concerns of people living in rich nations half a world away?

FLORENCE WAMBUGU: To build this house where we are today, there was a designer, there was an architecture, there were people. It took some time to build this house. It needed expertise. To build GM technology has taken years, has taken resources, has taken time. Now, if you want to destroy and bring down this house, you don't need expertise. All you need is some people from the streets, hooligans. Give them hammers, they will beat this house down within a day. And I believe that's what is happening. Greenpeace and many of those activists are just beating down a house that took years to build, years of research.

NARRATOR: One of the universities that supports Florence Wambugu's work in Africa is Michigan State University. They were largely unaffected by the GMO controversy until New Year's Eve, 1999.

CATHERINE IVES, Michigan State University: I was walking into downtown East Lansing to go out for New Year's Eve, and we saw the fire trucks and the engines going towards the area where we worked on campus and saw smoke. And we said, "This is a real fire." And I looked up, and I counted the floors. And I said, "That's my office."

Our offices were totally destroyed. I mean, they were pretty much reduced to ash. We assumed that there was an electrical fire, but it became clear to the

investigators that it was an arson. The initial investigation issue was did we have any ex-boyfriends or girlfriends that would be mad at us.

NARRATOR: After three weeks, police still had no idea who was behind it. Then a communique arrived from an underground group, the Earth Liberation Front.

CRAIG ROSEBRAUGH, Spokesperson, Earth Liberation Front: There was an Earth Liberation Front action at Michigan State University on December 31st this last year, and it was a fire that burned down part of a building where a genetic research project was going on, run by a woman named Catherine Ives. It did about $900,000 worth of damage.

Her program was to try, in my view, to coerce people in developing nations into believing they should give up sustainable agricultural practices that have been practiced for years and years, throughout many generations, and rely on Monsanto's genetically engineered crops because that's going to end world hunger. And that's what Catherine Ives herself said, is "My project- how could the ELF do that? My project is going to end world hunger." That's ludicrous. It's not going to end world hunger, it's going to make more profits for Monsanto.

NARRATOR: As Ives and her colleagues got the center up and running again, they struggled to comprehend the motives of their attackers.

CATHERINE IVES: I would wonder how much time has been spent by people in this organization in developing countries. I see women hiking for miles to bring firewood in because they've cut down everything around them and have no productive soils. I see children who are malnourished. They do not have sustainable agricultural practices in place in many parts of the world. That is what we are trying to help them develop.

NARRATOR: Ives also wondered whether the ELF was aware that Monsanto's contribution to a $20 million budget was only $2,500 dollars.

CRAIG ROSEBRAUGH: I know it wasn't millions and billions of dollars for that project, but it was some money. And I don't care if it's 50 cents or $500,000, it's still coercion, I think, to some degree, that a corporation is funding a project, I think, for their own benefit. And she's playing into it. It's not the money, it's the morals involved.

CATHERINE IVES: "It's the morals involved." Interesting. I don't think there's ever any justification for violence, and certainly not for an attack that very easily could have killed a student on a college campus.

NARRATOR: The FBI has not managed to catch the people responsible for the arson attack. And despite several appearances before a grand jury, Craig Rosebraugh insists he's just the ELF spokesman, he doesn't know who did it.

CRAIG ROSEBRAUGH: I received, I believe, a total of six subpoenas to either testify or supply information, give fingerprints, to that grand jury. So far, I have been able to steer myself away from any formal charges by the grand jury.

NARRATOR: Mainstream environmental groups like Greenpeace disavow the actions of ELF both for their violence and their secrecy.

CHARLES MARGULIS, Greenpeace: Greenpeace has never supported

random acts where the activists don't take responsibility. If there's an injustice in your community, it's your responsibility to point that injustice out and to make it public and to take responsibility for taking that action.

NARRATOR: Undaunted, the ELF has continued its program, targeting a series of university test sites growing new varieties of GMOs.

CRAIG ROSEBRAUGH: Companies a lot of times are not going to listen to ethics or ones saying that, "Please, please use your morals to stop the unjust acts," when they're making millions or billions of dollars a year off it. What they're going to listen to is their profit-and-loss margin. If you cause them enough economic damage or economic sabotage to their company, hopefully, they will see that it's in their best interest to stop their unjust acts.

NARRATOR: Meanwhile, back on Hawaii, there was cause for celebration. They'd negotiated the licenses they needed from Monsanto and the other patent holders. It had taken more than a decade, but Dennis Gonsalves and his colleagues believed they'd beaten the ring spot virus and saved a $45 million industry.

DENNIS GONSALVES, Cornell University: Once in a while, a technology comes along that is really good, that you can do something within your career span, and this is one technology. For me it's been very satisfying. It'd be even more satisfying to try to see where one day I visit Thailand, or visit Brazil or Jamaica, and can see the transgenic papaya just like how they grow in Hawaii.

RUSTY PERRY, Papaya Farmer: I can say I'm back in business, I guess, is what it really comes down to. I can say that we're going to be in business for a long time now.

What does the future hold?

NARRATOR: On Prince Edward Island in Canada, fishermen prepare their nets to go out and fish, the way they have for decades. But this kind of fishing is dying. Increasingly, fish is produced in farms where fish are raised and fed like cattle. This salmon could be the first genetically modified fish product in your stores. Elliot Entis, the CEO of AQUA Bounty Farms, the company that engineered it, believes we're on the verge of a revolution in fish farming.

ELLIOT ENTIS, CEO, AQUA Bounty Farms: In order to maintain the present world per capita consumption of fish, we will have to increase aquaculture seven-fold. Now, that's an enormous increase in the amount of food product that we have to produce.

NARRATOR: These salmon have been genetically engineered to grow four times faster than normal salmon. Awaiting U.S. regulatory approval, AQUA Bounty Farms grows them in tanks in a secure facility. Normal Atlantic salmon don't grow in the winter. The GM salmon, however, has been engineered with a gene from another fish, the ocean pout. This triggers a growth hormone gene, causing the salmon to keep growing even in winter. Transgenic salmon don't grow bigger, but they reach their full size in one quarter of the time.

AQUA Bounty Farms wants to become the Monsanto of the sea.

ELLIOT ENTIS: We'll be a little bit like seed suppliers in other industries. So it's our hope to run a hatchery or several hatcheries in which we will produce eggs, and those eggs will be sold to existing farmers, who will then use them to grow their own Aquaadvantage fish.

NARRATOR: But one scientist was worried what might happen if, by accident, these fast-growing salmon escaped into the wild. On the face of it, they would have a clear mating advantage.

WILLIAM MUIR, Purdue University: Size relay matters. Larger males are what females prefer. Fish just 25 percent larger will get 400 percent more matings than a fish of average size. And the theory behind that is called the "good genes" hypothesis, that if a male is large, this male must be good in securing resources, must be able to find its food, must be able to avoid predators. You know, so therefore it carries the good genes to make it a better parent.

NARRATOR: But would the fast-growing GM fish really be better parents? Escaping GM fish would also have to compete with wild fish at finding food, avoiding predators and producing viable offspring. Muir decided to investigate this ecological mystery by genetically engineering a laboratory fish called a medaka to grow fast. He then developed a computer model to mimic what would happen if these fast-growing transgenic fish escaped into the wild population.

WILLIAM MUIR: I was working on this at home late one night, trying to bring together all of these parameters into one mathematical model that would put all these things together. And when I put the mating success in there, my computer crashed. And I said, "Oh, my God. There's something wrong with my program." So I started looking through the code, looking everywhere. And what was happening was the population size was going to zero.

NARRATOR: The fast-growing GM fish got all the matings, but fewer of its genetically modified young survived. It was a recipe for an ecological disaster.

WILLIAM MUIR: You have a situation where the least fit individuals are getting all the matings but producing the fewest number of offspring. So gradually, over 20 or 30 generations, the population could go to extinction.

NARRATOR: If AQUA Bounty Farms salmon escaped and if they behaved like the medakas, it might lead to a catastrophe. At the moment, the genetically modified salmon are reared in fish tanks on land. But AQUA Bounty Farms wants permission to grow their transgenic fish in off-shore pens. And every year, millions of fish escape from these pens into the ocean beyond. AQUA Bounty Farms says they have anticipated this.

ELLIOT ENTIS: We can't ever guarantee that a fish won't escape from a pen. It's not possible. What we can guarantee with a high degree of certainty is that virtually all of our fish will be sterile. And we certainly can guarantee to 100 percent certainty that all of the fish will be female. Both of those factors really limit their general ability to interbreed.

NARRATOR: Despite these safeguards, Muir says we should be cautious.

WILLIAM MUIR, Purdue University: The worst-case scenario is that transgenic salmon get loose from net pens, and that one of them happens to be fertile. Theoretically, one fish can do it. It's not highly likely, but as we have more and more fish pens and more and more escapes, the probability increases.

NARRATOR: Unlike Bt pollen drifting a few feet into a neighboring field, an escaped transgenic salmon can spread its new genes throughout the ocean. The FDA is expected to rule on GM fish by the end of 2002. But even if the U.S.

doesn't allow it, other countries in the developing world will still go ahead. And their ecological problems could, in time, become ours, as well.

Whatever the fate of GM fish, many other GM products are in development. Scientists at Cornell are already working on the second generation of genetically modified organisms, and they're moving beyond simply producing food.

Some, like Charles Arntzen, want to make medicines. For 10 years, he's been trying to produce safer vaccines for Hepatitis B and Norwalk virus, diseases which kill millions in the developing world.

CHARLES ARNTZEN, Cornell University: How can we deliver a very effective vaccine but make developing countries less dependent on philanthropy and big industry? How can we provide the technology that a third-world country can make the vaccines themselves?

NARRATOR: Arntzen's radical proposal is to make a vaccine you can eat, a genetically modified banana.

CHARLES ARNTZEN: I don't see a village banana tree with vaccines in it, where everyone goes up and takes one when they want to. This is a medicine. I think something like a baby food puree, so you can make tens of thousands of little containers of a banana baby food, and you can sample each one and verify that the dosage is uniform, that they're free of any sort of bacterial toxins or anything else, the standard sort of stuff that has to be done with any pharmaceutical product. And we just- our switch on this is we can use food-processing technology, which is available in the developing world, and apply it to a medicine.

NARRATOR: Because bananas are hard to engineer, he started with potatoes, then moved on to tomatoes. Bananas are next. If everything goes well, Arntzen hopes to have an edible vaccine approved for use in six years.

In Switzerland, scientists have engineered a crop to prevent blindness in millions of children who lack vitamin A. It's rice.

INGO POTRYKUS, Swiss Federal Institute of Technology: My entire scientific career has been devoted to this dream to be able to help to solve burning problems of humanity.

NARRATOR: Ingo Potrykus spliced genes from a vitamin-rich flower - the daffodil - into the rice. Because that gave it a yellow tint, it became known as golden rice. Potrykus hopes eventually his rice will supply a quarter or more of a child's nutritional vitamin A needs. But as with the papaya, there were problems with patents. Before golden rice could ever be used, Potrykus would have to negotiate licenses with a dozen patent holders, including Monsanto.

HUGH GRANT, Chief Operating Officer, Monsanto: These are things that three years ago we, as a company, would never have considered. I think if you look at the model looking forward, this is going to be a prerequisite, how we will look at technologies and share them, share them around the world. And personally, that makes me feel good.

NARRATOR: And this time, facing a huge public relations problem, biotech companies were quick to give their agreement. The biotech industry launched a lavish advertising campaign, even though Potrykus's work is in a preliminary stage, years away from realization.

CHARLES MARGULIS, Greenpeace: Monsanto and the biotech industry has used this as a public relations tool. Biotech foods are being sold to the American public and to the European public on the backs of the developing world with this image campaign that we need this technology to feed the world.

HUGH GRANT: We are doing this not because of PR. And I think sometimes, when we make these gifts, that's the first question. I think what we're seeing today, after a few months with the rice genome work and after a few months between Monsanto and Zanetca with golden rice, there's a recognition that this is a genuine gift given in good faith.

NARRATOR: Whether you think GMOs are a force for humanity or a reckless experiment, some experts argue that we shouldn't judge it by what we've seen so far.

NICHOLAS KALAITZANDONAKES, University of Missouri-Columbia: If you think back to the first airplane that the Wright Brothers flew, the speed was seven miles an hour. So technology in the very early stages is crude.

NARRATOR: Biotechnology may be in its infancy, but according to Dr. Kalaitzandonakes, it's already clear that it will transform many industries, from drugs to synthetic materials. Like aviation and computers before it, biotechnology has the potential to change the world.

NICHOLAS KALAITZANDONAKES: Biotechnology is much like information technology. It's a very broad technology with very broad applications. Agriculture and food is just one application of it. Pharmaceuticals, waste management, forestry, cosmetics, energy and so on, the potential is so large that it's difficult to walk away. Nobody's walking away.

NARRATOR: This prospect of biotechnology dominating 21st century commerce has not gone unnoticed in Europe. In February, 2001, marking a radical turn-around, the EU voted to end the ban on GM crops. In its place, they are setting up a rigorous system to regulate, label and track GMOs.

European politicians like David Bowe are gambling Greenpeace won't have enough popular support to overturn it.

DAVID BOWE, European Parliament: Some of the campaigns that Greenpeace are running have run out of a bit of steam, I think. Everybody will tell you, you can only run one mark, one scare once. You know, after a while, if you cry wolf again, people ignore you. And I think that may be what's happening with some of the Greenpeace campaigns. And I think as long as we operate the rules rigidly and strictly and in the interests of the general public, we will succeed in getting acceptability of GM products in the marketplace, whether they're food or pharmaceuticals or many of the other applications that we're going to see.

JEREMY RIFKIN, The Foundation on Economic Trends: Europe will not accept genetically modified foods. And it will make no difference what the European Union says or Washington or the World Trade Organization. I think the introduction of genetically engineered foods in Europe and in parts of Asia and, hopefully, in America- I think it's going to be considered one of the great financial miscalculations in the history of introducing a new commercial line into the marketplace.

TELEPHONE POLLSTER: How do you rate the following statement:

"New technologies are generally worth the risk"? "Our technologies have now become so complicated that we can no longer"-

NARRATOR: Compared to the passion of the European debate, Americans have so far shown little interest in GMOs, even though they've been eating them for five years. But everyone believes there is one issue that has the potential to turn public opinion against GMOs: labeling

CHARLES MARGULIS, Greenpeace: The biotech industry is scared to death of labeling. In fact, biotech industry representatives have said putting a label on genetically engineered foods is like putting a skull and crossbones on it.

GENE GRABOWSKI, Grocery Manufacturers of America: To put a label on biotech foods, a mandatory label, would be an indication that something is wrong. That's the implication. And that would be absolutely false. That would be misleading to consumers.

HUGH GRANT, Chief Operating Officer, Monsanto: We believe very strongly, very strongly, that these products are safe. And in their safety, there is no need to label. And that's the position that has been held by the FDA.

JEREMY RIFKIN: You know we label everything in the United States. You can look on a label on processed food, and you can see the whole history of that food. Why would we make an exception when it came to genetically modified food ingredients?

[www.pbs.org: Read more of the interviews]

NARRATOR: If the FDA were to insist that all GM foods should carry labels, would that cause people to reject them?

HANK C. JENKINS-SMITH: Well, suppose we go, then, for a policy in which we add a requirement of labeling. How many of you could vote for that type of a policy? Virtually everyone.

PARTICIPANT: I think that you should label it and let people have a choice, just like we know about our calories.

PARTICIPANT: I want to be aware that it's in there. I want the choice to decide if I want my children and myself to ingest it or not.

HANK C. JENKINS-SMITH: If this stuff was all labeled, would your qualms about allowing companies to go ahead and try them be less? Does it affect- does it affect your willingness to tolerate, essentially, research and development, if you know that whatever is produced has to be labeled?

PARTICIPANT: It lets me make my own choices instead of having it hoisted upon me with no information.

PARTICIPANT: I think the labeling is just automatic.

NARRATOR: The full survey results are equally clear-cut. The effect of labels is the opposite of what most people expect.

HANK C. JENKINS-SMITH, University of New Mexico: The single strongest point that leads people to increase their level of support is the labeling

question. If people were- if labels were there and people could choose, you get a massive majority in favor of GMOs.

NARRATOR: Why should labels reduce Americans' fear of GM food? It's all about choice.

HANK C. JENKINS-SMITH: Many people accept risks. We ski. We ride mountain bikes. Extreme sports are a big deal in the United States, so people like taking risks, but they like to choose their risks. People don't like to have others imposing risk upon them, particularly if they are imposing the risk for purposes of generating a profit.

NARRATOR: Ironically, by the time U.S. consumers get a choice, it may be impossible to find much food without GMOs. In recent months, U.S. food companies like Gerber, who sought out non-GM grains so they could label their produce "GMO-free," have been shocked to discover that their products still contain genetically modified ingredients. Six years of growing, shipping and processing GMOs appear to have dispersed them throughout the U.S. food system.

Every country in the world is now trying to decide what to do about GMOs. Because the controversy has forced us to question the safety of the food we grow, in the long run we are all better off. But in the short run, there may be casualties in the GM food war.

Dennis Gonsalves has had a setback. The Japanese, who buy 35 percent of Hawaii's papayas, have refused to import them pending a full scientific review.

DENNIS GONSALVES, Cornell University: Japan has not allowed the papaya to come in yet, so some people are saying that it's not a success, that, "Look, we have a problem there."

NARRATOR: So desperate are some farmers to sell to Japan, they've gone back to growing non-GM papayas, and the ring spot virus is once again ravaging Hawaii. Gonsalves believes that the survival of the transgenic papaya, like any GM product, will ultimately depend on whether consumers need it more than they fear it.

DENNIS GONSALVES: With the papaya, you can see the situation. You can see that just having the technology is not enough.

Harvest of Fear

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Next time on FRONTLINE: It's all about buying and selling cool.

> **EXPERT:** The system closely studies kids to figure out what will push their buttons. Then it blares it back at them relentlessly.

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