INTERVIEWS
JEREMY RIFKIN

What first brought you to this issue?

Back in 1983, the United States government approved the release of the first genetically modified organism. In this case, it was a bacteria that prevents frost on food crops. My attorneys immediately went into the federal courts to seek an injunction to halt the experiment. The position I took at the time was that we hadn't really examined any of the potential environmental consequences of introducing genetically modified organisms.

We were making the first step out of the age of chemistry and physics, and into the age of biology. All of our regulations had been set up in an era in which physics and chemistry ruled. It seemed to me that we needed to have a thorough and thoughtful global discussion on the potential environmental implications of reseeding the earth with genetically modified organisms. At that time, the only discussion that had been held was a 20- to 25-minute meeting in a congressional committee that was overseeing this particularly genetically modified organism for release.

So my attorneys brought litigation in the U.S. federal courts. The judge ruled in our favor. We had an injunction that barred the government from conducting this first experiment. Then the government appealed, and we won in the appeals court. . . .

President of The Foundation on Economic Trends, he is a longtime opponent of biotechnology. **Rifkin** outlines why GM food is radically different from classical breeding and discusses how there are better ways to apply bioengineering to agricultural products. He also counters the argument that GM food is a solution in helping to feed a hungry world and talks about the threat of life science companies like Monsanto employing antitrust tactics in their patenting of gene technology. (Interview conducted August 2000.)

Before this, you had GMOs in labs, but this was the first time they would be released. Why was this a bigger deal?

They had taken a bacteria that's normally found in nature, Pseudomonas syringae, which plays a role, they believe, in the formation of rain. They took the actual gene out that allows ice crystals to form, and they created an ice-minus version of this bacteria. The idea was to seed our agricultural regions with the ice-minus bacteria, which would edge out the traditional bacteria that makes frost.

So you protect potatoes.

Absolutely. . . . What concerned us was the commercial introduction of this genetically modified organism. What if ice-minus were introduced, as they planned, across entire agricultural regions of the world, and it edged out the traditional ice-forming bacteria, which we think plays a role in rain patterns? There could be significant long-term ecological implications. . . .

When you introduce a genetically modified organism into the environment, it's not like introducing a chemical product, or even a nuclear product. Remember, genetically modified products are alive. So at the get-go, they're inherently more unpredictable in terms of what they'll do once they're out into the environment. Secondly, GMOs reproduce. Chemical products don't do that. Third, they can mutate. Fourth, they can migrate and proliferate over wide regions. And fifth, you cannot easily recall them to the laboratory or clean them up.

"THE INDUSTRY KNOWS THAT IF THOSE FOODS ARE LABELED 'GENETICALLY ENGINEERED,' THE PUBLIC WILL SHY AWAY, WON'T TAKE THEM. THE INDUSTRY'S HIDING FROM ITS OWN TECHNOLOGY."

So when we're dealing with genetically modified organisms, we're dealing with a whole new genre of environmental and health questions, totally different than when we introduce chemical or even nuclear products into the environment. . . .

Were GMOs properly regulated?

There was a regulatory vacuum, and there is a scientific vacuum. There has been ever since. Back in the mid-1980s, congressional hearings were held after we brought this litigation, and held up the first experiment. At that time, I went in front of Congress, along with the major agencies involved with this. And I asked Congress to make sure that, for every dollar spent in research and development to put these GMOs into the environment, we spend an equal dollar on the R&D to see if we can come up with a risk assessment methodology to judge the risk of introducing these into the environment. At the time, all the agencies--the Environmental Protection Agency, the U.S. Department of Agriculture, the National Science Foundation--pledged that they would devote whatever money was necessary to develop a methodology to judge risk. . . .

Here we are 17 years later. Those agencies never did come through. Even the USDA, the only agency that has a budget, spends maybe $1.5 million. You can't even do one risk assessment experiment with that amount of money. . . .

What about the issues of liability? . . .

The public should know that the liability issues here have yet to be resolved, or even raised. If you're a farmer and you're growing a genetically engineering food crop, those genes are going to flow to the other farm. You can't stop that from happening. So if a conventional farmer or an organic farmer goes to market and they find that their finished product has genes for herbicide tolerance or pest resistance, and they can't then sell their product, who's liable for those losses? The insurance companies aren't covering that. Should Monsanto be liable for these losses? Should the state government? Who's going to cover the losses? . . . The fact is, here's an industry with no long-term liability in place.

There is an analogy here with the nuclear industry. In the early days, the nuclear industry realized that the chances of an accident were small, but if an accident

did happen, the damages could be enormous and not coverable. So the nuclear industry went to the U.S. Congress to pass the Price-Anderson Act. This act legislates that the nuclear companies are only responsible for a certain amount of the damages, and then the government pays the rest. The American taxpayer pays the bill. There's no comparable legislation in place here. And believe me, the public would never accept comparable legislation in place here. . . .

Why did this take off in Europe recently?

To begin with, the media played a very important role. The electronic media introduced this idea to the larger audience very, very quickly. We spent years and years and years meeting with activists all over Europe to lay the groundwork for a political response, as we did here. So this did not come as a surprise to any of the nongovernmental organizations. . . .

I think it hit on such a large scale in Europe because it touched the nerve of two great political sensitivities: preserving biodiversity . . . and preserving cultural diversity and the cultural identity of European food and European agriculture. . . .

This was an attempt to keep US products out, like McDonald's . .

It's broader than that. Remember, half of these life science companies are U.S. and half are European. We do have Monsanto and DuPont in the U.S., but we also have Novartis and AstraZeneca and other companies in Europe. This was not a response to the U.S. This was a response to these new global companies who were beginning to embark on a radical new approach to agriculture that had tremendous significance--culturally, economically, and socially.

In an era where Europeans were feeling increasingly unable to control their individual destinies, and when there was more talk about globalization and a European Union, the last thing people felt they had some control over was their diet. So when Monsanto came in heavy and fast into the European market, the response was immediate, from the UK to France. The public said, "We don't want these foods. This isn't something that we have invited into Europe." . . .

In this country, the health concerns and the environmental concerns are as deep as in Europe. All the surveys show that. But here, we didn't have the cultural dimension. This is a fast-food culture. There is not a seamless web between culture and cuisine in the U.S. market. So we had half the response here. . . .

But even in Europe, you didn't have the support of the scientific community saying this was a safety issue.

Let me respectfully disagree with that. There were different opinions being expressed in Europe. For example, the environmental ministers and those they consulted with in the ecological sciences were very much critical and concerned about the introduction of GM foods in Europe. So there was a constant battle in various countries between the environmental ministers on one side, and the agricultural ministers and economic and trade ministers on the other. . . .

How far do you think it's going to go in Europe?

Europe will not accept genetically modified foods. It doesn't make any difference in the final analysis what Brussels does, what Washington does, or what the World Trade Organization does. In fact, this is going to be an interesting test on how ephemeral the power is of these new international and inter-regional bodies are. . . .

I think the introduction of genetically engineered foods in Europe and in parts of Asia, and hopefully in America, is going to be considered one of the great financial miscalculations in the history of introducing a new commercial line into the marketplace. They're swimming uphill at these life science companies. I ask the life science companies, "When you look down the line, and the public response to genetic foods, do you see light at the end of the tunnel?" They can't tell me they do.

The fact is, as the public in Europe and increasingly in the U.S. and Asia learns more about genetic foods, they become more concerned. Now, this is important, because Monsanto argued all along, from the time we began this discussion back in the 1980s, that people were just ignorant, and if you made them aware and knowledgeable about genetic foods, they would tend to be more supportive. The new surveys show us the exact opposite, which I've always believed. The more knowledgeable people are in genetic foods, the more likely they are to raise questions and be critical. . . .

So countries will violate the World Trade Organization if they have to?

Absolutely. President Clinton personally lobbied Prime Minister Blair in the UK to introduce genetic foods and Monsanto's products into the UK. Of course, Clinton and Blair are very much involved in third-way politics. They believe you have to move the marketplace and make sure there are no fetters to introducing new technologies. Both of these world leaders believe that the information sciences and the life sciences are the route into the 21st century. Blair went with Clinton, and championed introducing Monsanto's GMO seeds into the UK. The public reaction was instant and overwhelmingly in opposition, and Blair was caught by surprise. Here's a man who was wildly popular. His political cachet began to lose momentum the moment he sided with President Clinton and Monsanto. . . .

A few weeks later, the environmental ministers met in Europe to discuss a moratorium. . . . The result of that was a de facto moratorium on the introduction of any further GMO foods in Europe. This was a very, very important turning point in this debate. With Europe establishing a two-year moratorium, it meant U.S. farmers had to rethink their choices on whether they put genetic seeds into the ground. Since Europe would not accept those foods in export, American farmers didn't want to be caught holding the bag. As a result, in the year 2000 growing season, for the first time in the three or four years since introduction, the amount of seeds being bought leveled off and began to go down.

What makes you think the public debate over GM foods is going to travel to here?

"TAKE A HUMAN GROWTH HORMONE GENE AND PLACE IT INTO A SALMON. THAT'S JUST ONE GENE. BUT IF THE SALMON GETS OUT INTO THE MARINE ECOSYSTEM AND IT'S GROWING TWICE AS FAST AND TWICE AS BIG, IT CAN DESTABILIZE MILLIONS OF YEARS OF RELATIONSHIPS IN THE OCEANS. SO ONE GENE CAN BE VERY, VERY POWERFUL."

Every survey that I have looked at in the last few years, when the public is asked, "Do you want genetically engineered foods?" . . . a majority of the respondents say they're concerned and 90 percent of the respondents in the surveys say they want the mandatory labels so they can make a choice. The industry's not stupid. The industry knows that if those foods are labeled "genetically engineered," the public will shy away and won't take them. In a sense, the industry's hiding from its own technology. . . .

Obviously, voluntary labeling is one of things that will come.

. . . An example would be a company like Gerber, whose products would say "This does not contain GMOs." . . .

Gerber is owned by Novartis, which is one of the two major players in the GMO food industry. Just this week, Novartis' Food Division announced that they would not accept any genetically modified food in any of their foods; whereas Novartis' Agricultural Division is one of the two or three major players in the world producing genetically engineered seeds. This is a great commercial story, and I think the media missed this story. Here you have a company where the executive board of the company is at odds with itself. . . . When a company like Novartis--which is championing this technology--won't actually accept the final product, what does it say about the product?

Obviously, humans have been modifying nature genetically for 10,000 years with selection, breeding, mutagenesis. Why is this qualitatively different? . . .

In classical breeding, genes are turned on and off when you cross strains. I have no problem whatsoever with classical breeding, because it's worked itself over 10,000 years and it's also part of the evolutionary schema. . . .

What's different here is that we have now technologies that allow these life science companies to bypass classical breeding. That's what makes it both powerful and exciting. In classical breeding, you can cross close relatives. Taxonomy is an anthropocentric discipline anyway. You can, for example, cross various wheat strains and corn strains, etc. . . . 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 in recombinant DNA technology, allow scientists to bypass biological boundaries altogether. You can take a gene from any species--plant, animal, or human--and place it into the genetic code of your food crop or other genetically modified organism. Crossing genetic information from one species to another is something we've never seen in 10,000 years of classical breeding. . . .

But we're taking very small bits of it.

Those very small bits can change in qualitative ways when GMO is introduced. Let's say you take a human growth hormone gene and place it into a salmon. That's just one gene. But if the salmon gets out into the marine ecosystem, and it's growing twice as fast and twice as big, it can destabilize millions of years of relationships in the oceans. So one gene can be very, very powerful. . . .

Where you're placing a gene from an unrelated species into the blueprint of the second species, it's like introducing exotic organisms from native to non-native habitats. Here in North America, we brought a lot of organisms over to this ecosystem from all over the world. Some of those organisms fit in; some of them died out; some of them became pests. If you're from the South, you know about kudzu vine; or in the North, Dutch elm disease or gypsy moth or chestnut blight or starlings. These are all non-native organisms. When we put them into North America, they had no natural pest enemies. We can't deal with them, and they cause billions of dollars of damage. Ecologists tell us that when we introduce a genetically modified organism with genes from unrelated species, it's somewhat analogous to introducing exotics. . . .

There's a second generation of genetically modified organisms being readied in R&D. These organisms are plants that act as chemical factories to produce genes

that code for proteins to produce vaccines and chemicals and drugs and vitamins. . . . This all sounds very good, except no one has stopped for even a moment and paused and asked the following question.

When we seed millions of acres of land with these plants, what happens to foraging birds, to insects, to microbes, to the other animals, when they come in contact and digest plants that are producing materials ranging from plastics to vaccines to pharmaceutical products? There hasn't been as much as a single congressional hearing, and as far as I know, there hasn't been a single parliamentary debate anywhere in the world on introducing this second generation of pharmaceutical and chemical-producing plants.

They're introducing plants--corn, soy, cotton--that have herbicide-tolerant genes and pest-resistant genes. If your corn has a herbicide-tolerant gene, it means you can spray your herbicides and kill the weeds; you won't kill your corn because it's producing a gene that makes it tolerant of the herbicide. The problem here is that what makes it beneficial also makes it environmentally harmful. It means you're going to be able to kill a lot of weeds but not damage your corn. The problem is, you can't kill all the weeds. That means that the more virulent weed strains will become dominant and build up resistance quicker even than you had with petrochemical-based farming. . . .

I visited a farmer in the Midwest, and they just used two applications of Roundup Ready, one at the beginning of the season and one halfway through. It was much less than they've ever used before. . . .

I know quite a few farmers all over the United States who have tried this and have said the opposite, that they have to use more herbicides, not less. The same holds true with BT. Monsanto says, "Look. We're going to introduce a little gene into the plant that codes for a pesticide." Every cell of the plant is producing that pesticide, so the insect tries to eat the plant and dies when it tries to digest the material. Monsanto says, "This is a leap forward. We're ending pesticides, groundwater contamination."

Well, yes and no. Yes, they're ending the use of pesticides. But now they're introducing more toxin than they ever introduced with pesticides. When you spray a pesticide, it's infrequent, it's periodic. When you are putting the same toxin in the form of a gene into the plant, that plant is producing that toxin 24/7, perpetually over millions of acres. . . . A major study just came out in Science or Nature this year--a big study--showing that, when you introduce the gene for toxicity, it is going into the ground soil. . . .

Regarding the issue of resistance, Monsanto and the EPA requires that farmers plant a refuge. . . .

A refuge is supposed to prevent what? The genes from flowing out of sight? . . . This refuge idea won't stop insects from moving across boundaries. That's absurd. How many farmers are actually creating these refuges? . . . I've talked to enough farmers that say that it's too much time and trouble to do it. Even if they did do it, and followed it chapter and verse the way they're supposed to by the licensing arrangement, insects will pass through refuges at will. The idea that you can constrain them is absolutely absurd. Ask any good ecologist worth their salt, who's not on the corporate payroll of Monsanto, and they'll tell you what I've just told you.

The issue is not whether insects move across the refuge. The issue is the buildup of resistance, isn't it?

You're going to get insects all crossing the refuges. The insects that are vulnerable to BT will die. Those that aren't--the more virulent insects--will reproduce. That one gene resistance cannot deal with more virulent strains of the insects.

When you do classical breeding, you cluster for hundreds of genes in a plant that allow it to be resistant to a particular insect. Here, it's like one-gene resistance. It's like the French Maginot Line before World War II. The French thought they had a strong wall against potential German invasion, and the tanks went right over the wall. When you only have one-gene resistance, it will only take a few growing seasons--we're not talking about generations--for resistant strains of insects to build up and to overcome that one gene. Then the companies will have to come up with another gene, and another gene, and another gene. It's not defensible from a systems point of view.

But these are empirical questions. We don't know whether a refuge works or not. . . .

Monsanto says it does know the answer. The United States government that's OK'd all of this says it knows the answer. They're saying that refuges work. My question back to the U.S. regulatory agencies and to Monsanto is, "You're saying the refuges work. Show me the results. Where are the tests? Have you tested this across ecosystems around the world where this is going to be planted? Where is your risk assessment methodology that shows you that this is safe?"

There obviously have been tests, like in Arizona.

There's been virtually nothing. The amount of field testing to develop a methodology for risk assessment is almost nil. What we have here is a lot of rhetoric about protocols, but with very little science to back it up in the fields. . . .

The other major problem with introducing GMOs is gene flow. This is as significant as buildup of resistance, probably more significant. During pollenations, genes flow everywhere. Now, of course the company will say, "Well, the genes won't flow offsite. We have refuges, etc." Nonsense. There has now been a number of peer reviewed studies . . . that show that genes will jump way offsite during pollination, either by the wind or by transport by insects, etc. If you have a herbicide-tolerant gene, or a pest-resistant gene, and it flows off a site, what happens when wild relatives of those crops are invaded by that pollen? . . . How do you deal with a whole ecosystem where wild grasses and weeds have become herbicide-resistant, pest-resistant, and viral-resistant?

There are a couple of potential technical fixes. Take genetically modified salmon, for example. You make your salmon sterile. With plants, you make the so-called terminator gene. . . . If that was done, wouldn't this be reassuring to you?

The problem is that we know very little about how genes code for proteins and how they're turned on and off. So when you talk about all these fixes that they're going to come up with, you have to realize that whether a gene turns on and off and mutates depends, a great deal of the time, on the environmental factors and triggers. You can't get a guarantee that genes are going to turn on and off the way you want them to. You're dealing with life. It's too unpredictable.

If we had a risk assessment science in place, a really full-blown methodology, then maybe you could make some of these suppositions. But right now, these companies are running blind, saying, "We're going to make this fix and this fix and this fix." . . .

When I talk to environmental scientists, they're very, very uneasy about the idea that you can create a quick fix at each step of the way with this. It may be that everything the life science companies are telling us will turn out to be right, and there's no problem here whatsoever. That defies logic. When you introduce a powerful new technology that can radically change the environment, as they hope these technologies will, it's naive or disingenuous to think that that same introduction won't create equally troubling disharmonies and destabilization.

Remember, these are the same companies that brought us the petrochemical revolution. They used similar arguments to the ones they're using now, saying, "Look. We'll have a quick fix. We'll make sure that the chemicals don't ruin the environment. All of the alarm on the other side is unfounded and misguided." Now they're embarking on an adventure that's much more radical than chemical introduction, and that is actually changing the genetic instructions in microorganisms--plants and animals--and placing them into the environment, a lot of it through clonal propagation, on a very large scale. . . .

Is food safety an issue here, as you see it?

Yes, because what we're dealing with is the introduction of new genetic foods that have genes that code for proteins that we've never consumed. So when you place a Chinese hamster gene into your food crop, for example, and we consume it in raw or processed food, we just don't know what the reaction's likely to be. The fact is, we know that with traditional foods, 8 percent of children and 2 percent of adults have allergenic reaction to traditional foods. We 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. . . .

Many of the genetically modified foods will be safe, I'm sure. Will most of them be safe? Nobody knows. The fact is, even the Food and Drug Administration, in internal documents by their own scientists that were forced out in a lawsuit, suggested that these foods could pose some potentially serious allergenic and toxic reactions among consumers.

But everyone's aware of allergenicity as an issue, aren't they? This is not a secret. . . .

The American public is not aware that there might be potential allergenic and toxic reactions. . . . With regular food, at least people know which foods they have an allergy to. People know if they have an allergenic reaction to peanuts, for example. Here, you don't know, because the foods aren't labeled. Because these genes that they're placing in the foods have never been tested in the human diet, it's one big health roulette gamble. . . .

Of course, you can remove allergenicity genes, can't you? . . .

Only if you know they are allergenic. You can eliminate, for example, a Brazil nut gene if you know that it will create an allergenic effect. The problem here is, they're going to be introducing hundreds, then thousands and thousands of genes that code for proteins that we've never consumed. We simply don't know if they cause allergenic or toxic reactions. . . .

But you just said there was no way, in practice, that we <u>could</u> know.

This is the Catch-22. So do you want to take the risk when you don't need to? Maybe at some point down the line, the new genetics will tell us a lot more about the genomic makeup of all of our creatures. . . . We may be able to know which genes code for proteins against every single genetic profile on earth. We

don't have that now. I don't think the activists in the public are over-reacting. I don't think there's any hysteria in the streets here. What there is, is guarded and careful response. And I think the public is saying, "Why should we be put in jeopardy? Why should we be the guinea pigs in this experiment?" . . .

With food, we don't have an absolute standard of safety, obviously. The food supply that we have is not safe. So the question is about balancing risks and benefits. . . . One example is the papaya story, where a viral pathogen on the Hawaiian Islands was destroying all of the crops. The only solution anybody can think of is a transgenic crop. Is that a good risk-benefit calculation? . . . That's a risk-benefit where the benefits are immediate. . . .

This is the same thing we faced with the nuclear industry and the petrochemical industry. Obviously, there were short-term benefits in introducing nuclear power and petrochemical-based technologies and agriculture. The problem is, nobody at the get-go wanted to look at the long-term potential environmental and health risks down the line. In the long run, we saddled the environment and future generations with tremendous environmental and health costs. So when you talk about cost-benefit, the problem is, the benefits are always here and now. The costs always come later. . . .

This is why I've been involved in this discussion for more than 25 years now. I wanted to make sure that this be the first scientific and technology revolution in history in which the public thoroughly discussed all the potential benefits and all the potential harms, in advance of the technology coming online and running its course.

But your aim, then, isn't to stop it? . . .

The issue here is, how do we apply that science in the commercial arena, in our social life, and in the political life of the country and civilization? I believe there's a hard-path and a soft-path way to move into the age of biology. . . .

What's the hard path? Genetic foods. You turn that little piece of corn into a soldier in the fields, a little warrior. That little piece of corn is armed with all sorts of weapons--a gene for pest resistance and viral resistance and herbicide tolerance. This is hard path, old-fashioned nineteenth-century applied science. It's reductionist; it's not a systems approach; and it won't deliver ultimately in the field.

What's the soft path? We could use this same information we're learning on genomic nature of our plants and our ecosystems to create a sophisticated, market-driven, cheap, efficient organic-based approach to agricultural production in the 21st century. In the soft path, there's no gene splicing between species. Instead, we upgrade classical breeding with state-of-the-art genomic science. . . . You use the genomic information in your plants to find out which strains are best integrated into the environment. The environment's not the enemy. The environment's the partner. . . .

What I'm suggesting to you is that this could be a renaissance. We may be on the cusp of a future which could provide a tremendous leap forward for humanity. Instead of playing God and being an architect and creating a second genesis, and trying to rearrange millions of years of genetic blueprints, what we ought to be doing is understanding the genomic makeup of the world around us and how genes interact with environments and ecosystems. Then we can be a steward, so we can better integrate our social and productive activity into nature's activity. . . .

I haven't spoken to the chemical companies yet. I have spoken to scientists

at Cornell, UC-Davis, mainstream academic agricultural scientists. . . . Some of the mainstream agricultural scientists are not that concerned about the production of GMOs.

Many of the mainstream agricultural scientists, especially at the agricultural schools, but at all of our major universities, are tied into all sorts of contractual relationships and consulting relationships with the life science companies. There's been a growing debate in recent months about the close commercial ties between our academic institutions involved in this research, and the companies that are in the life science field. You really can't find a good molecular biologist or geneticist worth their salt who isn't involved in some equity relationship or consulting relationship or involved in some startup companies.

You think they're compromised, in other words?

. . . You may have seen in the New York Times, where there's been some big stories in the last few months . . . about the change in the relationship between the academy and the academic sector and the commercial sector. We have biologists across the United States and around the world whose research grants depend on corporate financing. We have major players in the agricultural field, as well as the other sciences, who are all involved in equity relations and have stock options and are part of these companies. You can find some independent scientists, but they are few and far between. We now have whole labs, especially in our ag schools, that are contracted out to Monsanto and Novartis. . . .

There's a lot of GM stuff out there--not just soybeans and corn-- but if you include genetically engineered enzymes, there's also cheese, beer, bread, sodas. This revolution has happened. What makes you think it's stoppable?

One thing I've learned over these last 30 or 40 years is that people make history. There's no fait accompli to any of this. We're on the cusp of a revolution in science. . . . The biotech century is going to be as complicated as the Industrial Revolution. Remember, in the Industrial Revolution there wasn't one agenda. For every capitalist, there was a socialist. For every entrepreneur, there was a trade unionist. For every Enlightenment philosopher, there was a Romantic poet. There were many agendas and issues. It was complex. There was great upheaval. . . .

We now have an opportunity, though, to do something we didn't do in the industrial age, and that is to get a leg up on this, to bring the public in quickly, to have an informed debate. If ever there was a scientific and technological revolution that cried out for everybody's involvement, this is it. This revolution affects the most intimate aspect of life on earth: our own biology, and the biology of our fellow creatures. . . .

But there is a huge constituency of agricultural scientists who see this as enormous potential for the developing world, for the hungry, for feeding the burgeoning population of the world. They fear that the reckless action of activist groups may kill this.

Let me take some responsibility, since I spawned much of this opposition. It's a little bit disingenuous for some of the life scientists to say they want to feed the world, when they create terminator genes designed to made a seed sterile so it can't be reused by farmers. We are already producing enough food to feed the world. We already have technology in place that allows us to produce more than we can find a market for. Here in the U.S. and in Europe, we pay farmers not to produce. The issue here isn't producing enough food. The issue really with feeding the world is, how do we create the effective mechanism, so the fruits of the technologies we already have in place can be shared equitably?

That argument's a little bogus, isn't it?

No. If we really want to talk about feeding the world, we have to talk about eating lower on the food chain. The fact is, we've had a great change in agriculture in the twentieth century. . . . Today, one-third of all the food grown in this world is feed grain, which is then consumed by animals, so that the wealthier people on the planet can eat high up on the food chain with grain-fed meats.

The interesting thing is, while we die of diseases of affluence from eating all these fatty meats, our poor brethren in the developing world die of diseases of poverty, because the land is not used now to grow food grain for their families. Rather, it's used to grow feed grain for the animal husbandry industry. If we would only find it in our hearts as a species to move down the food chain so that we could free up the land, so that instead of a third of it being grown for feed grain, it's grown for food grain, we could feed the world today and tomorrow and for many years in the future. . . .

Do you want to say anything last on patent issues? . . .

We have less than 10 life science companies in the world that have bought up all the independent seed companies in the last several years. They're now turning those seeds into intellectual property, so they 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?

When Monsanto provides a seed to a farmer, there's no traditional sale. There's no seller, there's no buyer, there's no exchange of the property. When Monsanto enters into a licensing agreement with a farmer, the farmer is being given access to the Monsanto network and being allowed to use the intellectual property in that seed for one growing season. That means the new seeds at harvest, which traditionally farmers have considered their own, now belong to Monsanto. If the farmer uses those new seeds, it's a violation of the intellectual property agreement.

Monsanto, if they had their way, would probably never want to sell another seed again. They'd much rather that every farm in the world enter into a licensing agreement and have to access the seeds, the intellectual property in those seeds, 24/7, every growing season. . . . That's chilling in its potential impact.

Does that raise antitrust issues?

There is now a precedent-setting antitrust lawsuit in the federal courts. The 10 largest antitrust law firms in the United States have gone into the federal courts charging Monsanto with creating a global conspiracy in violation of the antitrust laws, to control the global market in seeds. The plaintiffs are farmers in the U.S. and France. . . .

So it's a bit like Microsoft.

Yes. The antitrust litigation currently in the federal courts in the U.S. against Monsanto will be the test case in the life sciences, just as the Microsoft case was the test case in the information sciences. As we move to a network-based global economy, the real issue here is, can companies like Microsoft in the information sciences, and Monsanto in the life sciences, control these networks by controlling the intellectual property in the software or the wetware?

The difference is that the government was bringing the case against Microsoft.

Interesting enough, the chief litigator for the government was David Boies. His law firm is also involved in our litigation. The litigation's being spearheaded by Michael Hausfeld, one of the distinguished trial lawyers and litigators in the United States. So this is going to be a great test case. . . . I think it's going to set the framework, if you will, for the life science revolution, as Microsoft and that case has set the precedents for the future of the information science revolution.