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## Biotech's Sparse Harvest

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At the dawn of the era of genetically engineered crops, scientists were envisioning all sorts of healthier and tastier foods, including cancer-fighting tomatoes, rot-resistant fruits, potatoes that would produce healthier French fries and even beans that would not cause flatulence.

But so far, most of the genetically modified crops have provided benefits mainly to farmers, by making it easier for them to control weeds and insects.

Now, millions of dollars later, the next generation of biotech crops — the first with direct benefits for consumers — is finally on the horizon. But the list does not include many of the products once envisioned.

Developing such crops has proved to be far from easy. Resistance to genetically modified foods, technical difficulties, legal and business obstacles and the ability to develop improved foods without genetic engineering have winnowed the pipeline.

"A lot of companies went into shell shock, I would say, in the past three, four years," said C. S. Prakash, director of plant biotechnology research at Tuskegee University. "Because of so much opposition, they've had to put a lot of projects on the shelf."

Developing nonallergenic products and other healthful crops has also proved to be difficult technically. "Changing the food composition is going to be far trickier than just introducing one gene to provide insect resistance," said Mr. Prakash, who has promoted agricultural biotechnology on behalf of the industry and the United States government.

In 2002, Eliot Herman and his colleagues got some attention when they engineered a soybean to make it less likely to cause an allergic reaction. But the soybean project was put aside because baby food companies, which he thought would want the soybeans for infant formula, instead are avoiding biotech crops, said Mr. Herman, a scientist with the Department of Agriculture.

In addition, he said, food companies feared lawsuits if some consumers developed allergic reactions to a product labeled as nonallergenic.

The next generation of these crops — particularly those that provide healthier or tastier food — could be important for gaining consumer acceptance of genetic engineering. The industry won a victory last week when a panel of the World Trade Organization ruled that the European Union had violated trade rules by halting approvals of new biotech crops. But the ruling is not expected to overcome the wariness of European consumers over biotech foods.

New crops are also important for the industry, which has been peddling the same two advantages — herbicide tolerance and insect resistance — for 10 years. "We haven't seen any fundamentally new traits in a while," said Michael Fernandez, executive director of the Pew Initiative on Food and Biotechnology, a nonprofit group.

Now, some new types of crops are appearing. Monsanto just won federal approval for a type of genetically engineered corn promoted as having greater nutritional value — albeit only for pigs and poultry. The corn, possessing a bacterial gene, contains increased levels of lysine, an amino acid that is often provided to farm animals as a supplement.

Coming next, industry executives say, are soybean oils intended to yield healthier baked goods and fried foods. To keep soybean oil from turning rancid, the oil typically undergoes a process called hydrogenation. The process produces trans fatty acids, which are harmful and must be disclosed in food labels under new regulations.

Both Monsanto and [DuPont](#), which owns the Pioneer Hi-Bred seed company, have developed soybeans with altered oil composition that, in some cases, do not require hydrogenation. [Kellogg](#) said in December that it would use the products, particularly Monsanto's, to remove trans fats from some of its products.

Monsanto's product, Vistive, and DuPont's, which is called Nutrium, were developed by conventional breeding. They are genetically engineered only in the sense that they have the gene that allows them to grow even when sprayed with the widely used herbicide Roundup.

But Monsanto and DuPont say the next generation of soybean, which would be able to eliminate trans fats in more foods, would probably require genetic engineering. Those products are expected in three to six years.

Beyond that, both companies said, would be soybeans high in omega-3 fatty acids, which are good for the heart and the brain. These are now derived largely from eating fish, which in turn get them by eating algae. Putting algae genes into soybeans could allow for soy oil that is rich in the fatty acids.

"Our hope is it is easier to formulate into food without it smelling or tasting fishy," said David M. Stark, vice president for consumer traits at Monsanto.

Other second-generation crops are also on the way. DuPont is trying to develop better tasting soy for use in products like protein bars.

Some efforts are under way to develop more nutritious crops for the world's least developed countries, led by what is termed golden rice, which contains the precursor of vitamin A. Vitamin A deficiency is a leading cause of blindness in certain poor countries.

There has been progress in crops able to withstand drought. While those would mainly benefit farmers, it would also help consumers in regions like Africa, where droughts bring famine.

Mr. Stark said Monsanto had not anticipated that use of genetic engineering would discourage food companies from using the company's soybeans. "I don't get many requests for 'Is this a G.M.O. or not?' " he said, using the abbreviation for genetically modified organism. "It's more 'Does the oil work?' "

Still, opposition by consumers and food companies has clearly forced big companies like Monsanto and DuPont to choose their projects carefully. It has also made it difficult for academic scientists and small start-ups, which typically provide much of the innovation in other fields, to obtain financing.

Avtar K. Handa, a professor at Purdue, said he had stopped work on a tomato he helped develop a few years ago that was rich in lycopene, a cancer-fighting substance. Genetically modified crops are not being brought to market and research funds have diminished, he said.

Still, opposition is not the only problem. Alan McHughen, a professor at the University of California, Riverside, said that for small companies and university researchers, the main obstacles were patent rights held by the big companies and the cost of taking a biotech crop through regulatory review. That has made it particularly difficult to apply genetic engineering to crops like fruits and vegetables, which have smaller sales than the major grain and oil crops.

Technical issues are another obstacle. While a single bacterial gene can provide herbicide resistance or insect resistance, changing the nutritional composition of crops sometimes requires several genes to alter the metabolism within a cell. That raises a greater risk of unintended effects, some experts say.

Enhanced crops must also meet the demands of farmers for high yields and of food companies for good taste and handling properties.

DuPont won approval for a soybean high in oleic acid, which could produce healthier oils, back in 1997. But instead of becoming a showcase of the consumer health benefits of genetic engineering, the crop is now used only to make industrial lubricants.

Erik Fyrwald, group vice president of DuPont's agriculture and nutrition division, said one reason the crop was not sold for use in food was that demand for healthier oils was not as great then as it is now. But other experts say there was another problem — foods made with the oil did not taste good.

"The high-oleic oils are not very well received by the consumer," said Pamela White, a professor of food science and human nutrition at Iowa State University. Further, she predicted that soy oils containing the omega-3 fatty acids would be unstable, making them hard to use in fried foods.

William Freese, a research analyst at Friends of the Earth, which opposes genetically engineered crops, said genetic engineering had been oversold. "The facts show that conventional breeding is more successful at delivering crops with 'healthy traits' than genetic manipulation, despite all the hype from Monsanto and other biotech companies," he wrote in an e-mail message.

Scientists at the International Maize and Wheat Improvement Center in Mexico have already used conventional breeding to develop corn rich in lysine, similar to the new Monsanto product, he said.

The biotech companies concede that if improvements can be made conventionally, results would come quicker because such crops do not face regulatory scrutiny. Mr. Stark of Monsanto said that if his company could develop high-oleic soybeans using breeding, the product could reach the market in three years, rather than six for the genetically engineered version.

But in some cases, scientists and executives say, it is not possible to get a trait, like the omega-3 fatty acids, without using genes from another species. "With genetic engineering you can go further," said Mr. Fyrwald of DuPont.

Mr. Fernandez of the Pew Initiative said polls have shown that consumers seem to be receptive to genetically modified products that have direct benefits for them. But whether that would be enough to win wide acceptance of genetically engineered foods remains to be seen.

One issue is whether consumers would even know what they are eating. Right now, in the United States, genetically modified and conventional crops are typically mixed together, and food made from biotech crops is not labeled.

But it is likely that crops with consumer benefits would be segregated so farmers could charge more for them. And food companies are probably going to want to label them. But the labeling is likely to proclaim that the food has healthier oil or is better for the heart, rather than mention it was the product of genetic engineering.

In Europe, food containing genetically modified ingredients has to be labeled to that effect, but it is not clear whether the health aspects would be linked to genetic engineering on the label.

Chris Somerville, chief executive of Mendel Biotechnology, a small company developing drought-resistant crops, said acceptance would depend more on big food companies than

consumers. Companies, he said, would not want to risk their brands by using biotech crops if they thought there was even a slight chance of consumer rejection.

"Really, they're the gatekeepers," said Mr. Somerville, who is also head of the plant biology department at the Carnegie Institution. "The consumers aren't going to have any choice before the brand companies think it's safe to go out."