As controversy builds over the safety of genetically modified crops, the evidence so far hasn't pinpointed any specific problems—but also can't dispel the doubts

GM Crops in the Cross Hairs

An American entomologist publishes a study in *Nature* showing that pollen from genetically modified corn kills monarch butterfly larvae; two of his colleagues denounce him in a commentary for publishing "preliminary results" and imply that he is spreading rumors. A British food-safety expert writes in *Nature* that a concept that underlies regulation of genetically modified food in most of the developed world is "pseudoscientific"; an opponent fires back in a letter calling his commentary "a mishmash of old-hat sociology and poor science." A British scientist announces on television that genetically modified potatoes stunt the growth of rats and damage their immune system; his supervisors suspend him 2 days later. It would be hard to find a scientific debate more polarized than the one now being waged about the safety of genetically modified (GM) crops.

FOOD FIGHT

As the controversy continues over the safety of GM crops, *Science* takes a look at the evidence, and also at how the crops are regulated and industry's responses to its critics.

▶ RISKS AND BENEFITS
INDUSTRY RESPONSE

But while biotech opponents talk of Frankenfoods and terminator genes and industry groups minimize safety concerns, a small group of investigators has been taking a serious look at GM crops to see what health and environmental risks they might pose. What they are finding is in many cases reassuring—but not always. The plants, most of which have been modified to resist pests or weed-killing herbicides, seem to pose minimal risks to human health, say experts. But environmental concerns such as the possibility that the novel genes might spread to wild plants and produce new strains of weeds, although hard to substantiate, are also proving hard to dispel.

Complicating the weighing of risk is the question of how much any potential hazards are offset by the crops' potential benefits, such as reducing the use of chemical pesticides, lowering costs, and improving nutritional value. Part of the problem is that, unlike drugs or pesticides, plants have never been subjected to a risk analysis, says plant pathologist James Cook of Washington State University in Pullman, who chaired an international panel to devise risk assessment methods for GM crops. "We have to ask what are the safety issues raised by plants, then apply that to crop plants with transgenes," he says.

Food-safety concerns have stirred the most passionate debate among the public, prompting boycotts, bans, and protests. But few accept the conclusions of the report that sparked the furor over GM potatoes in Britain (*Science*, 22 October, p. 656). And there's little other research that might raise concerns that the transgenic crops now on the market threaten human health. "There's something wrong with the perception of risk here," says microbiologist Abigail Salyers of the University of Illinois, Urbana-Champaign.

In peril? Monarch caterpillars, like this one, live on milkweed, which may—or may not—put them at risk from Bt corn pollen.

For example, GM food critics worry about plant genetic engineers' practice of attaching the genes they are trying to introduce into plants to an antibiotic-resistance gene. They can then readily select those plants that have acquired the genes by treating them with the antibiotic, which kills any nonresistant plants. The critics charge that the antibiotic-resistance genes, which sometimes remain in the transgenic crops, could spread to pathogens in the body and make antibiotics less effective. But several panels of antibiotic-resistance experts have concluded otherwise. "Unanimously, the verdict has been that the chance of antibiotic-resistance genes getting into intestinal bacteria is minuscule," Salyers says. And if they did get in, "the virtually unanimous verdict is that it wouldn't matter" because the same resistance genes are already present in many of the bugs.

A more plausible—though still unlikely—threat to human health from transgenic foods comes from food allergies. An allergic reaction to food can be serious, even life-threatening, if it leads to anaphylactic shock. "That's one you certainly want to worry about," says food microbiologist Bruce Chassy of the University of Illinois, Urbana-Champaign, a former food-safety adviser to the U.S. Food and Drug Administration. Indeed, in a study reported in 1996 in *The New England Journal of Medicine*, Steve Taylor and his colleagues at the University of Nebraska, Lincoln, showed that people allergic to Brazil nuts are also allergic to soybeans that have been engineered to express a Brazil nut protein to make them more nourishing.

To Chassy, the outcome was reassuring: The results led the producer of the transgenic bean, Pioneer Hi-Bred International, to discontinue the soy line voluntarily before it was commercialized. What's more, the producers of GM foods screen their products for allergenicity, he says. Among other methods, they can check to see if the amino acid sequences of the proteins made by the genes they put into crop plants resemble those of known food allergens.

Critics say that because many proteins that trigger allergic reactions have not yet been sequenced, the sequence comparison test will fail to detect some allergens. "If you find a match, then you have a problem," says Rebecca Goldburg, senior scientist at the Environmental Defense Fund in New York City. "If you don't, it doesn't say anything." But Chassy notes that conventional foods already on the market, such as peanuts and Brazil nuts, pose much higher risks of allergies than GM foods, as do

CREDIT: LINDA RAYOR

Monarch Press Release Raises Eyebrows

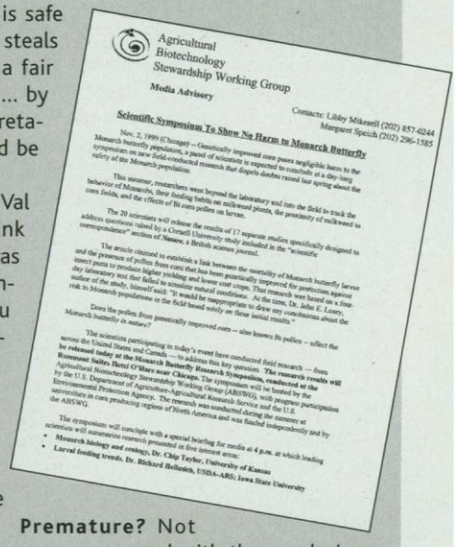
ROSEMONT, ILLINOIS—The 1-day conference, held here on 2 November, was not yet over, and researchers were still heatedly debating whether corn that had been genetically modified to make Bt, a protein toxic to insects, harms monarch butterflies. Yet a headline that day in the hometown newspaper, the *Chicago Tribune*, seemed to give the meeting's conclusion: "Monarch Butterfly So Far Not Imperiled." Similar stories appeared in the *Los Angeles Times* and the *St. Louis Post-Dispatch*. How could the newspapers have known the upshot of the conference before the researchers themselves did?

In fact, they didn't. The stories illustrate how eager interest groups are to spin even preliminary and debated results in the continuing war of words over the risks and benefits of genetically modified (GM) crops.

The conference, which was sponsored by an industry group called the Agricultural Biotechnology Stewardship Working Group (ABSWG) and the U.S. Department of Agriculture (USDA), was the outgrowth of research reported last May showing that monarchs fed Bt pollen in the lab often died. In the wake of the uproar the report caused, the ABSWG and the USDA funded new studies to see whether the butterflies are at risk in the field. The conference brought the researchers together so they could present their early results (see main text).

But the day before the conference began, the ABSWG had held a conference call between reporters and a small group of researchers whose results mostly seemed to show that the butterfly was safe. The ABSWG also issued a press release on the morning of the conference—before most of the researchers had presented their results—stating that the conference would "dispel doubts raised last spring about the safety of the monarch population."

The ABSWG's actions did not sit well with many meeting participants, including some whose results supported the industry claims. The press release "took me totally by surprise. I thought it was premature," says one such researcher, entomologist Galen Dively of the University of Maryland, College Park. And insect ecologist Orley Taylor of the University of Kansas, Lawrence, director of the conservation group Monarch Watch, describes what the ABSWG did as a "manipulation." Taylor, who remains to be convinced that Bt pollen is safe for monarchs, adds, "This steals the possibility of having a fair and deliberate discussion ... by dictating what the interpretation of the meeting should be before it was held."


Agricultural Biotechnology Stewardship Working Group

Media Advisory

Scientific Symposium To Show No Harm to Monarch Butterfly

Premature? Not everyone agreed with the conclusions of the ABSWG's press release.

ABSWG spokesperson Val Giddings responds: "I think that's nonsense. ... This was about as open and untrammeled a meeting as you could have hoped for." Entomologist Richard Hellmich of Iowa State University in Ames agrees: "The intention of the meeting was to talk about science, and that really didn't disrupt the discussion."

Giddings also defends the accuracy of the press release, saying that the majority of the researchers concluded that the potential harm to the monarch was minimal. "It was virtually, although not completely, a consensus view," Giddings says. But at the close of the conference, most researchers said more work was needed to show the true effect of Bt corn on the butterfly. "It was inappropriate to conclude there's no impact on the monarch butterfly," Taylor says. "That was not a fair conclusion of any of the commentary we heard." **–D.F.**

plants produced by classical breeding methods, which introduce many potential allergens into the product. "If a zero-risk standard prevails, we shouldn't put any new food on the market and we should get rid of a lot of old ones," he says.

Bt or not Bt?

It's the potential environmental effects of GM crops that stir deeper scientific debates, as was evident at a recent meeting, held near Chicago on 2 November, that examined whether pollen from so-called "Bt corn"—corn containing an insecticidal protein from the bacterium *Bacillus thuringiensis*—could harm monarch butterflies in the field. The colorful monarch became the poster child for the anti-GM movement last May, after entomologist John Losey and colleagues at Cornell University published a short laboratory study in *Nature* showing that Bt corn pollen could kill monarch butterfly caterpillars in the laboratory.

Out of a group of caterpillars that had munched on milkweed leaves—the larvae's only food source—dusted with Bt corn pollen, 44% died within 4 days, while larvae eating leaves dusted with ordinary pollen all survived. Although perhaps not surprising—researchers had known for years that Bt bacteria, which are themselves widely used as pesticidal sprays, could harm a variety of butterflies and moths—the Losey study was the first one published showing that a Bt plant could directly harm a nontarget butterfly.

The study attracted widespread media attention and alarmed biotech observers throughout the world. The resulting hubbub caused European regulators to place a moratorium on the approval of additional Bt crops and prompted jitters among biotech investors. Even so, it was not clear whether monarchs outside the lab, developing on milkweed plants growing near fields of Bt corn, are in fact in harm's way. To find out, major biotechnology companies, including Monsanto Co., Novartis Seeds Inc., and AgrEvo USA, formed an unusual consortium called the Agricultural Biotechnology Stewardship Working Group (ABSWG) that dispensed $100,000 to eight researchers at U.S. and Canadian universities to conduct

GM CROPS AROUND THE WORLD

Crop	Millions of hectares	
	1998	1999
Soybean	14.5	21.6
Corn	8.3	11.1
Cotton	2.5	3.7
Canola	2.4	3.4
Potato	<0.1	<0.1
Squash	0.0	<0.1
Papaya	0.0	<0.1
Trait		
Herbicide tolerance	19.8	28.1
Insect resistance (Bt)	7.7	8.9
Bt/Herbicide tolerance	0.3	2.9
Virus resist./Other	<0.1	<0.1

SOURCE: CLIVE JAMES

Biotech Critics Watch The Watchdogs

Although genetically modified (GM) foods have been in the spotlight in Europe for several years, the U.S. public is just now waking up to the fact that such foods—corn, canola oil, and soy, to name a few—are already widespread on supermarket shelves. With that awareness has come increased scrutiny of the government's system for regulating the safety of these crops—and charges that the system is lax.

The U.S. government divvies up oversight duties among three agencies: the Food and Drug Administration (FDA), the Department of Agriculture (USDA), and the Environmental Protection Agency (EPA). That situation, says Jean Halloran of the Consumer's Union, an advocacy group that is lobbying to require mandatory safety tests and labeling of GM foods, has produced a dizzying array of overlapping regulations that, despite their complexity, sometimes fail to offer sufficient safeguards. "Sometimes I think our regulatory process is designed to have a lot of smoke and mirrors. It's designed to look like it's a stringent process when it isn't," Halloran contends.

Regulators and industry representatives dispute that, maintaining that the U.S. system for regulating the foods is scientifically based and rigorous. "We are confident that the current policy does protect the public," says James Maryanski, biotechnology coordinator for the FDA's Center for Food Safety and Applied Nutrition. Indeed, although some studies have pointed to potential hazards of GM crops (see main text), so far there's no evidence that they cause any health or environmental problems.

In the current U.S. regulatory system, the USDA sets up the first hurdle. Companies often do field tests on promising transgenic crop lines to see whether they perform as expected. To ensure that the crops can't escape during the field tests, the companies are supposed to set up buffer zones around the test plots to keep the transgenic pollen from nearby fields, and to destroy transgenic seeds and plant tissue after the test. "It's like you grew it in a greenhouse," says Sally McCammon, science adviser for the agency.

Later, when a company wants to commercialize a crop, it's supposed to prove to the USDA that it won't have any significant effect on the environment, such as passing genes to nearby weeds and making them more aggressive. But critics charge that the USDA is more of a lapdog than a watchdog when it comes to protecting the environment. For example, in a 1995 study reported in *Trends in Ecology and Evolution*, ecological geneticist Joy Bergelson of the University of Chicago and Colin Purrington, now at Swarthmore College in Pennsylvania, showed that in approving new transgenic crops, the USDA often overlooks their own recommendations for performing field tests. "A lot of [their arguments] relied on no data whatsoever," Bergelson says.

Michael Schechtman, the agency's acting biotechnology coordinator, argues that field tests are unnecessary for crops that can't grow outside of cultivation and can't outcross with any weeds in the United States. He says the agency has required additional studies from companies whose GM crops can outcross with nearby weeds: "We think our review process has been thorough and has addressed all of the questions." Nevertheless, Dan Glickman, secretary of agriculture, asked the National Academy of Sciences in September to conduct an outside review of the agency's GM-crop review process.

The EPA, which comes into play only for those GM crops that produce insect-killing proteins, such as *Bacillus thuringiensis* (Bt) toxins, has also come under fire. In February, several environmental and organic farmers' groups filed a lawsuit, which is still unresolved, to force the agency to revoke the approval of all Bt plants on the U.S. market and run more extensive environmental tests on the plants. The groups' concerns include the possibility that pests would develop resistance to Bt toxins, making *Bt* bacterial sprays—a key pest-control tool of organic farmers—ineffective.

In addition, Joseph Mendelson, legal director for the International Center for Technology Assessment in Washington, D.C., which is representing the plaintiffs, maintains that in approving Bt crops, the EPA ignored evidence that the toxins could kill a broad range of moths and butterflies. "The agency basically threw up its hands instead of taking the proper precautionary approach," he says. But Steve Johnson, associate deputy assistant administrator for the agency's Office of Prevention, Pesticides, and Toxic Substances, says that Bt toxins did not harm several beneficial insects in toxicity tests, and *Bt* sprays have been used safely for decades. After assessing the risk, he says, "we felt that we were OK."

Some critics also doubt the aggressiveness of the FDA, which oversees the safety of most GM food in the United States. The agency does not mandate premarket safety tests, although before the food gets to market, companies voluntarily share with FDA officials the results of any toxicology, nutrition, or allergenicity tests they conduct. Rebecca Goldburg of the Environmental Defense Fund says that is not adequate, given that "the consultation process is voluntary and it's secretive." The FDA's Maryanski responds that although companies could lie about the safety data, "it's not in their interest." If the food that companies sell is not safe, he notes, they are legally liable under federal law, and the FDA has the authority to seize the product and order criminal prosecution.

The FDA has also resisted efforts by activists to require labeling of GM foods, as is now done in the European Union. Currently, Maryanski says, the agency doesn't have the legal authority to do that, although that could soon change. A bill was introduced in Congress earlier this month that would require labeling of all foods containing GM products. Moved by continuing protests against their products, ag biotech companies are coming around to the idea as well (see p. 1666). With advocacy groups cranking up the pressure to tighten regulation of GM foods, and Congress beginning to listen, the FDA and other regulators may be forced to change the way they regulate GM crops, whether they like it or not. **–D.F.**

further studies. The U.S. Department of Agriculture (USDA) and individual universities funded an additional 12.

The study participants presented their early results at the Illinois meeting, where they did agree on one point. "The worst case scenario of a toxic pollen cloud saturating the Corn Belt and wiping out all the Lepidoptera" is clearly not going to happen, says entomologist Stuart Weiss of Stanford University. But Bt pollen might still have less dramatic harmful effects—although a press release put out by the ABSWG early in the meeting suggested otherwise (see sidebar on p. 1663).

At issue in the new monarch studies is just how far pollen might drift from cornfields, and how toxic it might be to any monarch larvae that eat it. The potential for harm is certainly there, says entomologist John Obrycki of Iowa State University in Ames. Because corn pollen is relatively heavy, it is likely to settle near cornfields. What's more, Obrycki says, "we do find lots of milkweeds growing near cornfields, and they are being used by monarchs."

At a meeting of entomologists held last March, he and graduate student Laura Hanson reported results suggesting that enough pollen might collect on nearby milkweeds to harm the larvae. The work, which has not yet

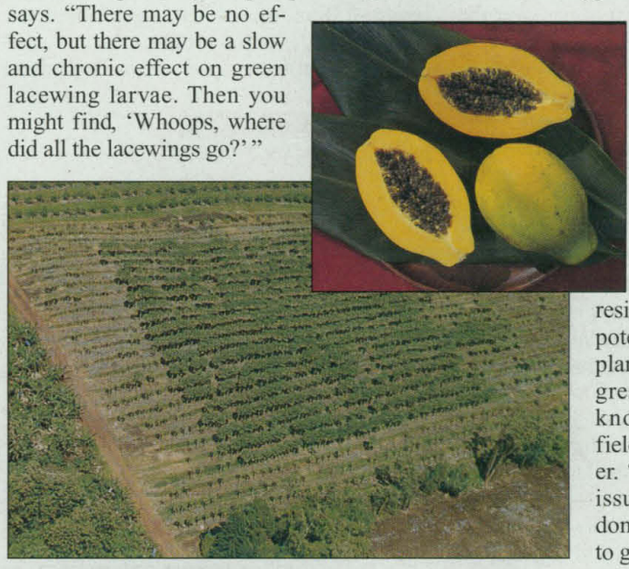
been published, showed that about 20% of monarchs that fed for 2 days on potted milkweed plants left at the edge of Bt cornfields died, compared to 3% of monarchs that fed on plants left near non-Bt cornfields. At the Illinois meeting, the industry- and USDA-funded researchers presented similar results, but their interpretation was more optimistic. In one study, for example, botanist John Pleasants of Iowa State and entomologist Richard Hellmich of the USDA's Agricultural Research Service and Iowa State first determined the levels of Bt pollen that are toxic to monarch larvae, then measured how much pollen they could trap on sticky slides left near cornfields.

The results showed that even milkweeds within 1 meter of the cornfield were unlikely to be dusted with toxic levels of Bt pollen from two of the most widely planted corn varieties, AgrEvo's CBH 351 and Monsanto's Mon810, Hellmich said at the meeting. The researchers did find that pollen from the same line that Obrycki tested, Novartis Seeds' 176, is sufficiently toxic to threaten monarchs feeding on milkweeds up to 2 meters away, thus confirming Obrycki's results. But the more toxic Bt line represents just 2.5% of the corn planted in the United States. Overall, Hellmich says, his team's results and similar data presented by others at the meeting revealed a minimal risk to the monarch. "A lot of the data presented were overwhelmingly positive," he concludes.

Still, monarch experts were not entirely reassured. One problem, says insect ecologist Orley Taylor of the University of Kansas, Lawrence, who directs the conservation group Monarch Watch, is that even if Bt exposure doesn't kill monarchs, it could make them less fit for their long migration to Mexico, where they overwinter en masse. At the meeting, Taylor presented a model, based on current Bt corn acreage and the butterfly's migration patterns and reproductive behavior, that predicted a worst case scenario in which 7% of the North American monarch population would die. Although the real effect would undoubtedly be less, he says, "there's plenty of indication that there's going to be an impact. It's a matter of degree."

Bt toxins might also threaten beneficial insects indirectly, by entering the food chain. For example, in work published in 1998 and 1999, Angelika Hilbeck and her team at the Swiss Federal Research Station for Agroecology and Agriculture in Zurich, Switzerland, showed that green lacewing caterpillars—a beneficial pest-eating predator—were more likely to die when they ate European corn borer caterpillars that had fed on Bt corn than when the borers had fed on non-Bt corn. "It's interesting science because of what it says about the toxicology of Bt," says entomologist Richard Roush of the University of Adelaide in Adelaide, Australia. But "a lot of us wonder whether it's really important in the field." He and others note that *Bt* bacteria have been sprayed on farm fields for 3 decades, and that earlier studies had shown that beneficial predator insects were unaffected.

Hilbeck argues, however, that because the toxin is expressed at high levels throughout GM crop plants, rather than just sprayed on their surfaces, plant-eating insects could receive a much bigger dose. She has begun field trials, and she says others should monitor the effects of Bt crops on lacewings and other insect-eating predators before a problem develops. "Anything is possible," she says. "There may be no effect, but there may be a slow and chronic effect on green lacewing larvae. Then you might find, 'Whoops, where did all the lacewings go?' "



The fruits of biotech. Healthy papaya trees that have been genetically modified to resist papaya ringspot virus are surrounded by infected trees. Inset shows GM papaya fruit.

CREDITS: DENNIS GONSALVES

Flowing genes and superweeds?

Ecologists also worry that genes such as those conferring resistance to herbicides or insect pests might pass from the crops into wild relatives and create so-called superweeds—invasive plants with the potential to lower crop yields and disrupt natural ecosystems. They note that a variety of crops, including canola, squash, sunflower, and sorghum, can outcross with weedy relatives growing nearby.

Plant geneticist Val Giddings, a spokesperson for the Biotechnology Industry Organization, downplays the risk, saying that even if such outcrossing allowed a weed to pick up a gene, it would not persist for long in the wild. A herbicide-resistance gene, for example, would disappear from weeds outside the confines of farm fields because there would be no herbicide to select for plants containing it. "There is abundant literature that demonstrates that in the absence of selection pressure, a neutral trait will be lost over time," Giddings says.

Sometimes, but not always, answers plant ecologist Allison Snow of Ohio State University, Columbus. In a study published in April in *Molecular Ecology*, Snow, with Rikke Jørgensen and Bente Andersen of the Risø National Laboratory in Roskilde, Denmark, crossed canola plants carrying the gene that encodes resistance to the herbicide glufosinate with a weedy relative called field mustard. They found that the gene persisted in the weed even when no herbicide was applied. What's more, the weed produced equally fit offspring whether or not it had the herbicide-resistance gene. That means that the gene will probably stick around, Snow says.

Another type of gene that might move to weeds are virus-resistance genes, such as those that have been engineered into yellow squash and zucchini, says Alison Power of Cornell University. If populations of the weedy relatives of these crops are kept in check by viruses, a virus-resistant weedy squash could potentially outgrow ordinary plants and become more aggressive. Researchers won't know until someone does field tests to find out, however. "It could be a significant issue," Power says, but "we don't have good information to go on."

Benefits of biotech

The backers of GM crops say that all this talk of their potential risks overlooks their benefits to consumers, farmers, and the environment. But although the risks remain hypothetical, it's also too early to tell whether GM crops are a proven boon, because only a few independent studies have been conducted, and those show clear benefits for some crops but not for others, agriculture experts say.

Cotton, for example, is notorious for needing heavy doses of pesticides, so Bt cotton should offer substantial savings and environmental benefits. Indeed, by planting modified rather than conventional cotton on 2.3 million U.S. acres (nearly 1 million hectares) in 1998, farmers reduced chemical pesticide use by over a million pounds (450,000 kilograms), according to a report released earlier this year by Leonard Gianessi and Janet Carpenter of the National Center for Food and Agriculture Policy, a think tank in Washington, D.C., that is funded by industry and the USDA. What's more, cotton farmers increased their yields by 85 million pounds (39 million kilograms) and made $92 million dollars more than farmers

who did not use the technology.

The report says, however, that not all Bt crops fared as well. Although 14 million acres (5.7 million hectares) of U.S. cornfields—about one-fifth of the total corn acreage in the United States—were planted with Bt corn in 1998, the increased profits from higher corn yields did not cover the extra cost of the Bt corn seed. In addition, the Bt crop saved only 2 million of those acres (800,000 hectares) from chemical insecticides because most farmers don't bother to spray for corn borers because spraying often doesn't protect the corn. Researchers also worry that pest insects could develop resistance to the Bt toxins over the next several years because the bacteria is now so widespread. That would make *Bt* sprays ineffective, eliminating one of the few effective pest-control strategies available to organic farmers, who forswear chemical pesticides.

Another recent report takes a look at the pros and cons of Roundup Ready soybeans—a herbicide-resistant line from Monsanto—and concludes that the results were mixed. On the plus side, says report author Charles Benbrook, an independent consultant to consumer and environmental groups in Sand Point, Idaho, and a former executive director of the National Research Council's Board on Agriculture, Roundup Ready soybeans allow farmers to substitute Roundup for more hazardous and long-lasting herbicides like acetochlor. And they reduce the need for farmers to till the soil to ward off weeds, which reduces soil erosion.

But Benbrook's findings did not support industry claims that the Roundup Ready beans reduce herbicide use by allowing farmers to kill weeds with one dose of Roundup after the soybean plants have sprouted instead of dosing the fields with a variety of herbicides before and during the growing season. Instead, the Benbrook reported concluded, farmers applied two to five times more herbicides of all kinds to their GM soybean fields than to fields growing conventional soybeans. And in contrast to industry claims, a recent study by agricultural economist Michael Duffy of Iowa State University showed that Roundup Ready beans made Iowa soybean farmers no more money than farmers growing ordinary beans. Despite the increased herbicide usage, applications costs were lower, but so were yields from the GM soybeans. "You had lower income and lower costs, so it was kind of a wash," Duffy says.

Even if the technology has yielded few clear-cut benefits in the developed world, agbiotech backers say that in the developing world, new crops in the pipeline could improve yields for farmers and make tremendous strides toward reducing malnutrition and environmental degradation. A genetically engineered line of rice reported earlier this year, for example, can make more vitamin A precursor and accumulate more iron, which could prevent infections, blindness, and anemia in people in the developing world (*Science*, 13 August, p. 994). Other researchers are developing plant-based vaccines to prevent diarrheal and other diseases in the developing world, says plant biochemist Charles Arntzen, president of the Boyce-Thompson Institute for Plant Research in Ithaca, New York.

And a Cornell group is engineering a virus-resistant papaya plant that could save crops in Brazil, Puerto Rico, and Jamaica. A version of the plant, which resists the papaya ringspot virus, has already revived Hawaii's papaya groves, devastated by the virus in the mid-1990s, says plant pathologist Dennis Gonsalves, who leads the effort. "You should go back and look now—it's beautiful," he says.

But before farmers sow GM crops around the world, researchers and regulators need to do a better job assessing the ecological risks, says Ohio State's Snow: "We shouldn't just be waving our hands. There really are not enough ecologists doing this research," in part because research funds are scarce. And even biotech backers acknowledge the need for better data. "I would say that the benefits totally outweigh the risks, but we can't ignore the risks," Washington State's Cook says. **–DAN FERBER**

Dan Ferber is a writer in Urbana, Illinois.

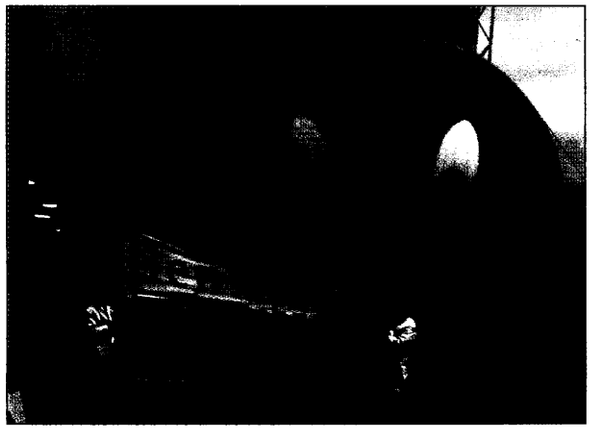
FOOD FIGHT

▶INDUSTRY RESPONSE

Ag Biotech Moves to Mollify Its Critics

As protests continue, the developers of genetically modified crops contemplate steps, such as labeling GM foods, once considered anathema

When two of Monsanto's top executives boarded a jet this summer to take them from St. Louis to London, it wasn't just a routine business trip. They were headed for a secret meeting with the leaders of the British environmental movement—the very people who had branded the company's genetically modified (GM) food products as potential health hazards and ecological time bombs, and whose actions had helped trigger tabloid headlines like *Frankenstein Foods* and *Farmageddon*. These, the executives knew, had led an entire nation to avoid their products like poison. In short, they were going to confront their worst nightmare.



Seeing red. Protesters demand the labeling of GM foods at a demonstration held in August in Cologne, Germany.

CREDIT: SPECHT/LAIF

Monsanto was in a predicament—which is far from over—that called for drastic action. Although some studies have raised concerns about GM foods (see p. 1662), so far, there is little evidence to suggest that those currently on the market are harmful, either to human health or ecosystems. Even so, the resistance to GM foods, which largely originated in Britain, is spilling into other European countries and the developing world. Companies such as Monsanto that have bet billions of dollars—and perhaps their futures—on GM crops are suddenly looking vulnerable, as are farmers who have staked their livelihoods on the new seeds. And development experts who are counting on the new technology to feed a growing world population are looking on nervously.

"The opposition is astonishing. There's no way you can sell products in Britain that contain genetically modified organisms anytime soon. Forget it," says Julian Kinderlerer, a researcher at the Institute of Biotechnological Law and Ethics at the University of Sheffield in the United Kingdom. Even in the United States,