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Risking Corn, Risking Culture

by Claire Hope Cummings

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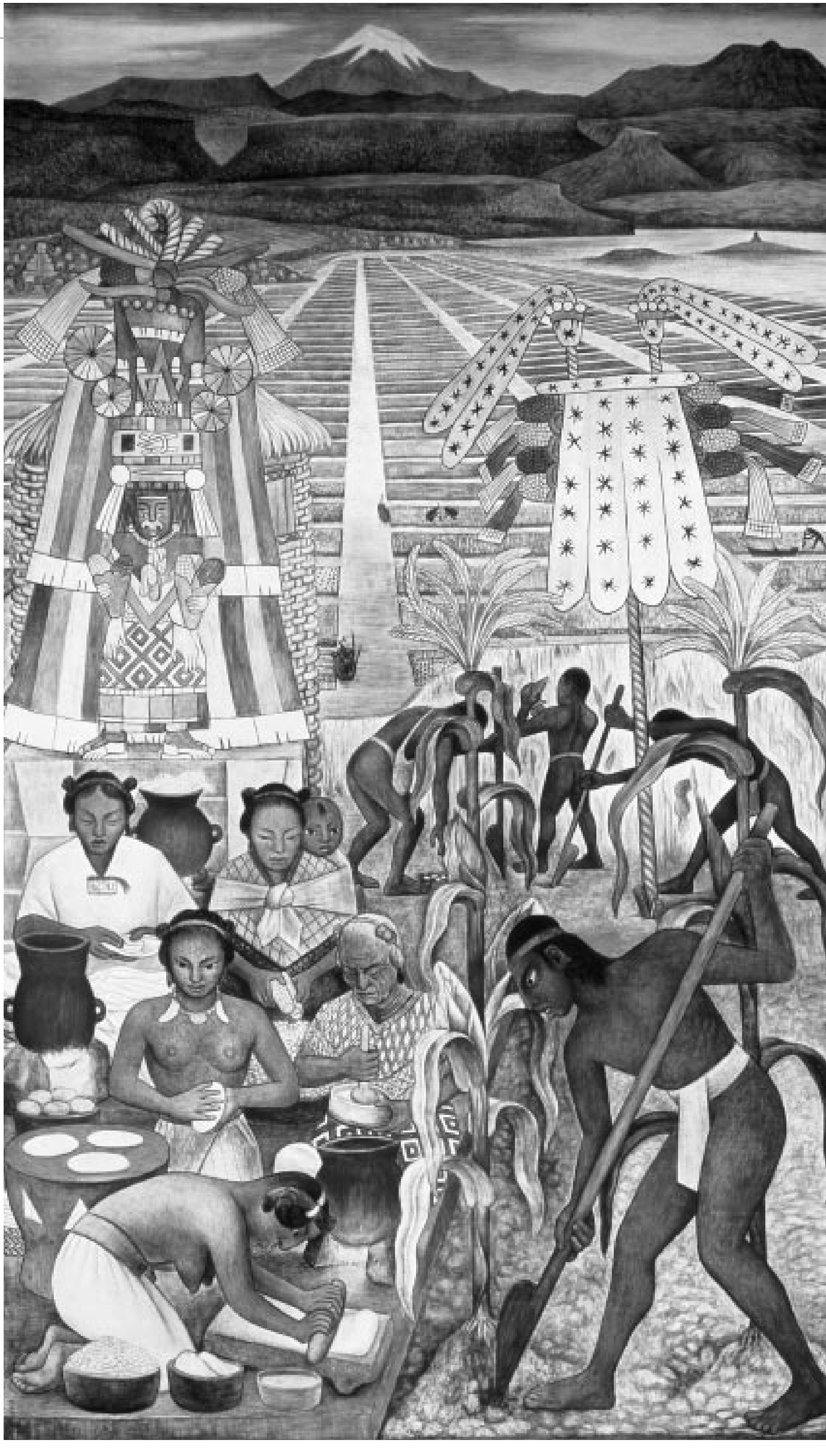

Risking Corn, Risking Culture

If genetically modified corn spreads around the planet, one of humanity's greatest creations—a highly diversified and reliable food source—could be severely weakened or even destroyed. So could many of the human communities that depend on it.

Capulalpam,
Sierra Madre de Oaxaca, Mexico

by Claire Hope Cummings

Here in the remote mountains of Oaxaca, one of the oldest stories on earth—the vital relationship between people and plants—is taking a dramatic turn. Corn was first domesticated here and in nearby areas of Mesoamerica, from wild grasses about 8,000 years ago. Native varieties of corn are still grown here by the descendants of those first farmers. Now, this place, the center of origin of corn, and the center of its genetic heritage and diversity, has also become the center of a welling controversy over the finding of genetically modified organisms (GMOs) in the native corn.

The land itself helps tell the story. The road from the valley city of Oaxaca to the small mountain village of Capulalpam weaves through a rich mosaic of ecosystems. It climbs through evergreen pine-oak forests, crosses the Continental Divide as it transects the *Sierra Juarez*, drops down through a semi-arid zone of manzanita and shrub, and overlooks the Mexican Rio Grande, which winds along a sandy riverbed studded with *agave* and *nopal*. The profuse flora, the abundant wildlife, and the clear water that flows through these mountains, known locally as the *Sierra Norte*, support some of the world's most treasured biodiversity.

As the road turns towards the mountain range, small towns carved out of the deep green forest glisten in the sun like jewels strung along the mountainsides. Most of the people who live here are Zapotec. They place a high value on cleanliness and beauty. Their villages fit harmoniously into the topography and feature colonial-style churches and scattered houses made of wood from their forests. Household gardens and *milpa* growing corn, beans, and squash are nearby. Each town is surrounded by communal fields, which are in turn surrounded by communal forests. These concentric circles of resource use and cultivation are collectively managed. The Zapotec call themselves the "people of the clouds," and for the entire day, even

Left: In the Patio Corridor of Mexico's National Palace in Mexico City, this 5-meter-high mural by Diego Rivera depicts the Huastec civilization, a Maya group in northern Veracruz, working on the various corn cultivating, harvesting, and culinary practices that have been at the center of their culture for centuries.

Above: Head of a Maize Goddess, carved of jade, from Palenque, Chiapas, Mexico. The bright green stone is the color of young corn, symbolic of youth. The cropped hair represents corn silk, crowned by corn foliage.

Above: Courtesy, National Museum of the American Indian, Smithsonian Institution (N21640). Photo by Carmelo Guadagno.

under a bright blue sky, a thick mantle of white fog clings to the wooded ridge tops.

Dr. Ignacio Chapela is one of two scientists from the University of California, Berkeley who documented the discovery of transgenes in the Mexican native, or *criollo*, corn grown here. Chapela and his colleague, David Quist, took their samples from Capulalpam, so this remote village is getting more than its fair share of visitors these days. Chapela has worked with the communities in the *Sierra Norte* for years, but he had not returned to Capulalpam since November 2001, when his report was published in the prestigious journal *Nature*. I went back to Capulalpam with Dr. Chapela, to talk with farmers and village officials about the impact that transgenic corn is having on their lives, and to explore what it might mean for the rich biodiversity and indigenous cultures of the region.

The Chapela/Quist discovery is the first report of GMO contamination of a major crop at its center of origin. A center of origin contains the early forms of a crop and its wild relatives. It is the gene bank the world depends on to improve and refresh a crop's genetics. Mexico's native corn varieties are a treasure chest of genes useful for breeding plants that can adjust to changing climate, agricultural, and nutritional needs. Scientists worry that if these plants become infected with GMOs, and if the artificial genes persist, they could dangerously contaminate, and possibly wipe out, the natural genetic basis of the world's most important crops. Although they are manufactured, GMOs are living organisms, capable of reproduction. Once released, they are beyond human control. They are a new form of pollution, one that is difficult to detect and completely invisible. Because so little is known, their release is an uncontrolled experiment, which the biochemist Erwin Chargaff, known as the father of molecular biology, has said would constitute "an irreversible attack on the biosphere."

For years, scientists and environmental activists have been warning the Mexican government that GMOs in imported corn could harm Mexico's exceptionally rich biological and cultural diversity. The known risks of GMOs include the creation of hard-to-control weedy relatives of crops through "crop-to-wild hybridization," the development of insect pests or weeds that are resistant to the chemicals used with GMO crops, and the unintentional poisoning of beneficial insects and non-target species (see 1).

No one knows how GMOs got to Capulalpam. It's suspected that they arrived, courtesy of the Mexican government and the North American Free Trade Agreement (NAFTA), in shipments of imported corn sold here for human consumption. Corn samples taken from the government-subsidized *Diconsa* store in Capulalpam tested positive for GMOs. A few local farmers, who were not aware that the imported corn contained GMOs, may have used the store-bought corn for seed.

Mexico, which banned the commercial planting of transgenic corn in 1998, imports about 6.2 million tons of corn a year, mostly from the United States. About a quarter of the U.S. commercial corn crop is GMO, and after harvest it is mixed with conventional corn. As a result, all conventional U.S. corn is now considered to contain at least a low level of "background" GMOs. And unlike Japan, Mexico does not require that GMO corn from the United States be segregated and labeled.

It was entirely predictable that GMOs in imported corn would find their way into Mexico's own cornfields. Corn is, after all, practically promiscuous in the way it spreads its pollen around, and corn farmers love to experiment with corn seed. What we call corn today owes its very existence to the intentional and accidental recombination of varieties by corn farmers. So it was only a matter of time before the foreign genes in the imported corn would get out and mix with the locals. If there was any surprise in this finding, it was how rapidly the GMOs had traveled to such a remote region. What is most alarming about this finding is that such rapid dissemination is occurring at a time when so little is known about how these transgenes will affect the ancestral ecosystems and the genetic heritage of the world's major crops.

Corn is the world's second most important food crop, after rice. It is practically miraculous in the way it converts sunlight into food. Corn plants can grow 11 centimeters or more a day, which may explain why Midwest farmers claim to be able to hear their corn growing (see 2). But corn's productive and adaptable nature also makes it particularly susceptible to GMO contamination. The corn plant reproduces through "open pollination" and it is in constant communica-

1 There are other, somewhat more speculative, environmental and health threats posed by GMOs, including the recombination of viruses and the creation of novel, perhaps uncontrollable, new pathogens as possible consequences of widespread genetic pollution. A recent report out of Iowa found that hog producers who were feeding their animals a diet of Bt corn were having "mysterious pseudopregnancies." The likely suspect is a mycotoxin, but when the hogs were taken off the Bt corn they returned to normal reproduction. The U.S. Environmental Protection Agency, which regulates Bt crops, does not require tests to determine how Bt crops affect animal reproduction.

2 The sound of corn growing is poetically described by Margaret Visser in *Much Depends on Dinner* as the "gentle stroke and rasp of leaves unfurling and sweeping along stalk and leaf edge: the hum of the driving wheel of North American civilization."

Diego Rivera's mural of the corn harvest (*La Cosecha del Maiz*) was commissioned for the Ministry of Education building (la Secretaría de Educación Pública) in Mexico City, where it can be seen at the Court of Fiestas, level 1, South Wall.

tion with its surroundings. As it grows, it evaluates its environment, senses the available light, moisture, nutrients, and competition, and then adjusts its height, length of cob, and time of ripening accordingly. Boone Hallberg, one of the world's experts on corn varieties, says that because of corn's adaptability, the Oaxaca region alone boasts up to 85,000 unique strains, or "sub-varieties" of *criollo* corn, that have conformed to specific local conditions.

Hallberg is a deeply tanned, and still spry, transplanted Californian, who has lived near Capulalpam for over 50 years. He teaches and conducts research on native corn varieties at the *Instituto Technologica* in Oaxaca. Sitting behind a desk piled deep with papers that are weighed down with colorful ears of corn, he talks at length about how these local "landraces" developed as corn fine-tuned itself to the diverse "agro-ecological niches" of the *Sierra Norte*. These landraces have developed dozens of useful characteristics. Some have improved nutritional qualities or agronomic values such as tolerance to acid, alkaline, or saline soils. Some are drought or frost resistant; others are able to withstand strong winds, or resist pests and plant diseases. One remarkable variety can even fix its own nitrogen.

How GMOs will affect these specialized landraces, and thereby impact the world's agricultural genetic diversity, can only be understood in the context of how perilous the state of the world's crop diversity currently is. As the late University of Illinois botanist and plant geneticist Jack Harlan (author of *Crops and Man*) famously said, the world's genetic diversity is all that "stands between us and catastrophic starvation on a scale we cannot imagine. In a very real sense, the future of the human race rides on these materials." Modern plant breeding programs focus on only a very few improved crops. The patenting of seeds and the privatization of agricultural research, which is part and parcel of the development of transgenic crops, further narrows the genetic basis of our food system. The UN Food and Agriculture Organization (FAO) estimates that 75 percent of the world's crop genetic diversity has already been lost just in the last century (see 3).

Chapela and Quist not only found GMOs in Capulalpam's *criollo* corn; they also asked how those genes would behave once they "introgressed" into the new plants. But just raising this question created an enormous controversy over their research (see 4). Their

This polychrome ceramic vessel, excavated from the ruins of an ancient temple and now in the Museo del Templo Mayor in Mexico City, is decorated with the likeness of Chicomecoatl, the corn goddess (or goddess of sustenance). Tlaloc, the god of rain, is on the far side. Chicomecoatl holds ears of corn in both hands. The vessel, which is about 18 inches high, contained more than 3,000 green stone beads when found.

3 How can we possibly know what germplasm or local knowledge systems we might need even 10, let alone 100, years from now? The lessons of the Irish potato famine, and other reminders of the dangers of mono-cropping, seem to be forgotten. In the late 1960s, a disease called the Southern Corn Leaf Blight got out of control. Crop losses were mounting, and by 1970 about 15 percent of the corn crop was lost. The Nixon administration, facing criticism over the war in Vietnam, couldn't afford a serious blow to the nation's economy, so efforts were made to hide the problem. A change in the weather helped curb its advance, but the blight made it clear that Mexico's genetic resources would be key to rehabilitating the U.S. corn industry if it were wiped out.

4 After Quist and Chapela published their paper in *Nature*, the biotechnology industry launched a concerted attack on them, causing *Nature* to all but retract the original publication. The resulting controversy has clouded the inquiry into the fundamental questions they raised. Their findings of GMOs in *criollo* corn have since been confirmed and amplified by the Mexican government. But the important scientific debate, which should have taken up the question of the stability of transgenes, has not begun, perhaps in part due to the media focus on the professional conflict instead of the scientific issues involved.

Above: Reproduced with permission of el Museo del Templo Mayor, Instituto Nacional de Antropología e Historia, Mexico

inquiry challenges one of the basic assumptions underlying biotechnology: that transgenes are stable. Although the industry immediately attacked their findings in letters to the journal *Nature*, Quist and Chapela stand by their conclusion that the transgenes they found did not behave predictably. The scientific jury is still out on this issue, but as a result of this and other controversies, researchers are increasingly reluctant to conduct studies that might shed light on how transgenes behave once they are released into the environment.

Norman Ellstrand, Professor of Genetics at the University of California, Riverside, says that we still do not know how GMOs will behave; they may be benign, but there is great risk in releasing GMOs prior to investigating their potential effects. Both Ellstrand and Chapela point out that the GMOs found in Capulalpam may not be the ones to worry about. While this discovery indicates that transgenes are not easily contained, both scientists say the GMOs to watch out for are the ones now being developed for what is called the "bio-pharming"of crops, such as the use of corn to grow industrial and medical materials like plastics and pharmaceuticals. There is a GMO corn, grown in the open, that contains a human contraceptive, (see ❺) and the U.S. government recently issued a permit to grow corn spliced with a human gene, used to fight herpes. No one knows the long-term environmental and health impacts of these GMOs, because the regulatory framework currently in place does not require industry to find out.

In 1995, Mexico's agricultural research centers convened a seminar to assess the environmental threats posed by transgenic corn. Participants included the International Maize and Wheat Improvement Center (CIMMYT), which is the world's most important repository of corn germplasm; the National Institute of Forestry, Agriculture, and Livestock Research, which is Mexico's national seed bank; and the National Agricultural Biosafety Committee. One of the questions discussed was how transgenic corn could cross with *teosinte*, the wild relative of corn that grows in Mexico. If GMO corn and *teosinte* crossed, it could create a new, transgenic wild-crop hybrid. And if that new plant had some biological advantage, such as insect resistance from Bt corn, it could wipe out the wild, natural form that was not resistant, and even lead to the extinction of natural *teosinte*. Known as the "lord of corn," *teosinte* is already in danger of extinction due to loss of habitat.

Bt corn is a patented hybrid corn variety that has been engineered to express a genetically modified form of a natural insecticide, *Bacillus thuringiensis*, or "Bt." The GMOs Chapela and Quist found in Capulalpam are known as "transgenic constructs"—easily identified synthetic vectors, such as a genetically modified form of the cauliflower mosaic virus, used in making almost all GMO plants. Most likely, these GMOs came from Bt corn, because most transgenic corn is Bt corn. And if that were the case, one likely environmental impact would be harm to Mexico's insect populations. Bt is commonly used as a conventional insecticidal spray. In its natural form, it stays inactive until it reaches the gut of a susceptible insect. But transgenic Bt has been genetically altered to be always active, constantly exuding its poison throughout the life cycle of the Bt plant. Transgenic Bt is known to injure susceptible beneficial insects and "non-target species" such as green lacewings, insects that are highly regarded as a natural pest control. And, when pollen from Bt corn, which contains active Bt, falls on nearby milkweed plants in the U.S. Midwest, it can kill or harm any insects or butterflies that feed on it—including the majestic Monarch butterfly that migrates between the Midwest and Mexico.

Corn reproduces in a marvelous, messy, affair that dusts everything around it with pollen (see ❻). The tassels at the top of the giant stalk, the male parts, can produce as many as 25 million grains of pollen. The ears, usually located midway on the stalk, are the female parts, and the silky hairs that protrude from the ears collect any pollen that lands on them. Fertilization takes place when a tiny speck of pollen falls on the silk and then flows along the strand to a single kernel, which is created from a tiny embryo at the end of the strand. An ordinary ear of field corn growing in the Midwest can contain 800 to 1,000 silks, and as many kernels.

Because Bt corn is constantly expressing an insecticide, everything around it is exposed to Bt. As a result of this overexposure, insects will eventually develop resistance to Bt. When that happens even the natural forms of Bt will lose their effectiveness, causing serious economic losses to organic and conventional farmers worldwide. And transgenic Bt, being always active, continually affects its surroundings, including the soil. The countless microorganisms living in the soil are affected both by the Bt in the plant's roots while it is alive and by any plant residues that remain in the soil after harvest. Characteristically, farmers in Capulalpam leave their dried corn stalks standing in their fields after harvest, so any transgenic Bt in their corn would

❺ A genetically engineered "contraceptive corn" has been developed by Epicyte, a company in San Diego, California. The Eypicyte corn kills human sperm by turning the plants into little horticultural factories that produce "secretory antibodies." The idea comes from a rare condition, immune infertility, in which sperm-attacking antibodies are produced in women. These antibodies can be mass-produced in large quantities in fermentation factories, but the GMO process is cheaper.

❻ It's almost impossible to contain corn pollen, GMO or conventional. Corn is often de-tasseled, the tassels are bagged before pollination, or corn is bred to be sterile. But without such extreme measures, corn pollen spreads by wind, insects, animal and human contact. Most of it falls in the immediate vicinity, but it can easily travel several hundred yards. It has been found up to several miles away, and it can stay viable for days, even weeks.

be available to their insect populations, and their soil environment, for most of the year.

Whether or not the GMOs found in Capulalpam will have these effects is still unknown. But the farmers I spoke to there said they'd heard that GMO corn could harm butterflies, and they worried about how it would affect their land, and their *criollo* corn. I met Señora Olga Toro Maldonado, one of the farmers in Capulalpam whose fields tested positive for GMOs. She stood in a field of dried corn stalks, dressed in a starched white shirt, blue denim pants, and straw fedora. Her skin matched the color of the golden leaves behind her. She gestured with her strong hands as she asked: how were they supposed to know, since the government said people could eat the corn sold in the *Diconsa* stores, that it should not be planted? She expressed dismay about the lack of information the village was getting. For now, she said, she was mostly concerned about feeding this transgenic corn to her six children.

Maldonado's neighbor, Señor Naum Sanchez Santiago, carefully saves his best corn from each harvest to use as seed. He farms without using chemicals and says he saves seed because that way he isn't dependent on outside sources. It's like "tucking away savings" every year, he said. He noted, proudly, that these practices keep his community independent. He pointed out that, so far, his cornfields were still free of GMOs. But he and his neighbors were worried. Señor Javier Cosmes Perez, the mayor of Capulalpam, and also a farmer, said that the situation here is very grave. "Our customs are being violated," he said. "It upsets us because it has to do with our traditions, the very essence of our people and our lives, our corn."

The farmers and village officials I talked to were especially anxious about the economic consequences of GMO corn. Santiago said corn in the village *Diconsa* store sold for four or five pesos a kilogram, while it cost him six to seven pesos a kilogram to grow his own varieties. These farmers are among Mexico's 3 million family farmers who feed 15 million of the country's rural poor. But they simply can't compete with the heavily subsidized price of U.S. corn. Under NAFTA, Mexico ended price supports and subsidies for its farmers. The United States, however, under the most recent farm bill, will be paying its commodity producers $180 billion over the next 6 years. GMOs are part of this subsidized commodity system. The resulting overproduction means that farmers in the United States get rock-bottom prices, while poor farmers in other countries get cut out of the market. Santiago and Maldonado pointed to some bare patches of ground on the hillsides behind them. They said those fields were abandoned because of the rising costs of growing their local *criollo* corn.

Still, millions of rural Mexican farmers continue to grow *criollo* corn varieties. While providing for themselves and their communities, these farmers also act as efficient custodians of corn's genetic diversity. But their contribution to the world's agricultural heritage is not being recognized, or rewarded. And no government action has been taken to protect them. Since NAFTA took effect, imports of corn from the United States have increased 18-fold. Mexico's agribusinesses, mostly transnational corporations, support these imports because they provide them with cheap corn for animal feed and food processing. They either turn a blind eye to the implications of the GMOs in their imports or they are outright supporters of biotechnology because it is part of the industrial agricultural system that keeps their prices low (see 7).

When NAFTA took effect, instead of helping traditional farmers convert to its terms, which provided for a 15-year transition, Mexico accelerated that into a 3-year period. The reaction of the rural Mexican farmers, according to NAFTA expert Alejandro Nadal, was not what the government had expected. In areas already deeply scarred by poverty, local farmers suddenly had to sell their crops at a buyer's market, flooded with cheap imports. If they stayed and tried to subsist, they were forced to grow more crops on increasingly marginal land, with fewer resources. Nadal says that without some effort to strengthen their social institutions, and outside assistance to maintain a more sustainable livelihood, these communities will only deteriorate and the harm to the environment from soil erosion and deforestation will only worsen.

When these poor rural farmers can no longer farm, they leave their communities to find work in overcrowded urban areas like Mexico City or at a *maquiladora* factory (see 8). Or they join the "migrant trail" to find work in the United States, sending money home to support their families. Many rural Mexican

7 Mexico is the second largest importer of U.S. corn, taking 12 percent of U.S. corn exports in 2001, notes Chela Vazquez, an analyst at the Institute for Agriculture and Trade Policy in Minnesota. Although the Mexican Senate passed a law requiring mandatory labeling of GMO foods, Vasquez says "a powerful consortium of biotechnology companies, AgroBIO Mexico A.C., opposed the legislation... and...20 U.S. agribusiness organizations requested that the U.S. trade representative ask Mexico not to implement mandatory labeling of GM foods."

8 Author John Ross writes about the ironies involved in replacing field work with factory work. He describes how, in the nearby Tehuacan Valley, the oldest corn ever discovered in Mexico was found. This ancestor corn, which fed the Olmecs and Aztecs, flourished in the valley's deep soils and abundant water. Now, there are few farmers left in Tehuacan. Instead, people work in the 300 *maquiladoras*, (foreign-owned assembly plants), that have taken over the valley, turning out millions of pairs of jeans a month for the U.S. market. They make about $36 a week, working six nine-hour days. The laundering of these jeans is drying up the ancient aquifers and polluting the surface water with acids, dyes, and other toxic waste. And while the Mexican government provides roads, water, and sewerage to the factories, it does nothing for the workers, many of whom live in cardboard crates with no utilities.

communities, including some in the *Sierra Norte*, are becoming dependent on this income. Remittances back to Mexico from migrant workers in the United States amounted to more than $9 billion last year, second only to oil, and surpassing tourism in earnings that support Mexico's economy. But as traditional farming collapses in rural Mexico, native corn varieties, and the world's corn diversity, also disappear.

Village officials in the *Sierra Norte* are concerned that, because of their precarious economic condition, imported GMO corn may well be what brings an end to their self-sustaining land-based traditions. Señor Miguel Ramirel Dominguez, the local agrarian authority, feels that outside interests want to control them, because if they lose their local *criollo* corn varieties, they lose their independence. These communities have withstood successive invasions over time as outsiders repeatedly exploited their hard working labor force and their rich natural resources. But after the extractive industries exhausted their mines, and their forests, at least the local people could return to farming. Now the question is, will they be able to continue to work the land in the face of the economic and environmental impacts of imported GMO corn?

Mexico's Ministry of Agriculture has responded to the crisis by continuing to encourage corn imports, without restrictions. Mexico's Assistant Secretary of Agriculture at the time of the *Nature* publication, Dr. Victor Manuel Villalobos, was quoted as saying that GMOs are not a threat to Mexico's corn because they are "just another hybrid." Mexico's Minister of Agriculture, Javier Usabiaga, has been even more cavalier, saying that 'a farmer who cannot survive in the 21st century is simply 'going to have to find another job."

The plight of the farmers in the *Sierra Norte* was discussed during a meeting held in February 2002 at Oaxaca's Ethnobotanical Garden. The Garden, located in a renovated convent behind Oaxaca's Santo Domingo Cultural Center, invited scientists, representatives of NGOs, government officials, and academics, including Dr. Chapela, to discuss the impacts of transgenic corn on Mexico's rich biological heritage and its genetic and cultural diversity. Representatives of Mexico's Secretariat of the Environment and Natural Resources (SEMARNAT) began the meeting with a report that confirmed and expanded on the Chapela/Quist study. Their results, from cornfields in the states of Oaxaca and nearby Puebla, indicated that GMO contamination of corn in Mexico was extensive and growing.

Raul Benet, Executive Director of Greenpeace Mexico, repeated his organization's demand for a ban on GMO imports, for completely eradicating the contamination from rural areas, for protecting the natural genetic diversity of corn, and for supporting the livelihood of the peasant farmers who grow it. One scientist said GMOs should be stopped at the border. Another proposed tracing GMOs by putting genetic identification tags on them. The National Commission on Biodiversity (CONABIO), whose mandate is to protect Mexico's biodiversity, proposed a system for monitoring and assessing the contamination.

Courtesy Boone Hallberg

How valuable is the heritage seed? Boone Hallberg (left) asked this *campesino*, who replied that a handful of the seed is worth more to him than his large old stone-walled family home in the town of Silacayoapan. An earthquake could destroy his home (a quake in 1985 had destroyed many in the area), whereas his corn seed inherited from his grandparents could be planted by a succession of his descendants a hundred generations into the future.

The international seed banks, which are responsible for preserving the world's endangered genetic resources, were not at the meeting. So far, CIMMYT has reacted somewhat defensively to the GMO contamination, issuing press releases assuring that its seed banks are not contaminated. However, CIMMYT conducts biotechnology research on corn and wheat, and an increasing amount of its funding comes from biotechnology related companies and their foundations. I visited their laboratories outside Mexico City and was able to see the biohazard bags that covered GMO corn tassels through the glass of their secure biotech greenhouses. The building that houses their invaluable seed collection is right next-door. I asked

CIMMYT about their bio-safety protocols and was assured that they were "state of the art," but I was unable to obtain a copy of them because, their spokesperson said, they were currently being revised.

While CIMMYT appears to be taking every known precaution at their Mexico facility, they have not addressed some basic questions, such as what will happen when they grow their seed collections out in the field. This is a necessary part of maintaining any seed collection that is held apart from the place where it was grown and collected. Such "ex-situ" collections are held by CIMMYT and its Mexican counterpart, INIFAP. Seed collections that are preserved in place, and cared for where they are traditionally grown, are called "in situ" collections. They have the added advantage of protecting local ecosystems, the traditional knowledge systems, and the cultural practices that maintain these local varieties.

The culture of corn is the key to its nature. During my trip, I came to understand that corn, more than any other crop, embodies the life-giving and ancient relationship between people, plants, and place. Certainly, corn has brought great wealth to both ancient and modern societies. At the same time, corn depends on people to care for it and release its densely packed kernels from the cob so it can reproduce. After the meeting at Oaxaca's Ethnobotanical Garden ended, I walked around the specimen collection with the Garden's Director, Alejandro de Avila, and asked him about the cultural meaning of corn. "Corn," he said, "is the living mediator between land and people."

Traditional native peoples of the Americas, past and present, view corn as a regenerative force that constantly reconnects them to the cycle of life and death, to their land, and to their communities. The ancient Maya considered themselves—as do their descendants today—to be a people who are made of corn. Corn is central to many contemporary native cultures in the Americas, and their corn creation myths offer some intriguing stories about its origins. Some of these stories are strikingly similar, with various versions telling how corn was given to humans as a gift from a divine source, usually in response to some need or severe hunger. But always, the gift of corn came with strict instructions about the human responsibilities and the reciprocal efforts that would be required to ensure its constant replenishment.

In the *Sierra Norte* the farmers take their reciprocal responsibility to corn seriously. Roberto Gonzalez, an anthropologist and author of *Zapotec Science: Farming and Food in the Northern Sierra of Oaxaca*, says it's common for people here to say, "Maize has a heart." (Maize is the word most of the world uses to refer to corn.) This saying has some biological accuracy. Corn kernels do have a nucleus, or heart, from which the seeds germinate. But, Gonzalez says, the villagers use the term "heart" in the moral sense, as they view corn as "a wonderful plant-person with a long memory, a strict moral code, and an unshakable will." He is emphatic that corn always "prescribes reciprocity." In areas where there are constant land conflicts, for instance, this reciprocity provides a means of binding communities together through market transactions, cultural traditions, and seed exchanges. "Thus maize is not only an economic good but a medium through which certain social and moral obligations and responsibilities, particularly reciprocity (toward kin, neighbors, poorer villagers, and people in neighboring villages) must be met."

The Zapotec communities in the *Sierra Norte* understand that if they maintain corn, it will maintain them. To the Zapotec, the concept of *mantenimiento,* or maintenance, which includes responsibility and reciprocity, is crucial. The Zapotec have a system of community work responsibility, or *tequio*, that keeps their roads free of trash and their communities immaculate. Reciprocity is also part of the practice of *gozona,* a mutual aid arrangement whereby favors and services are freely exchanged. This system underlies the practice of saving and exchanging corn seed, which is essential to preserving corn's genetic diversity. But that will end when biotechnology companies forbid these farmers from saving any seed contaminated with their patented GMOs. Mexican corn farmers will have to buy their seeds from agrochemical companies every year, just as corn farmers in the United States now do. The coming of GMO corn, then, brings with it the potential for a profound cultural transformation, as well as an end to the conservation of local varieties.

The more than 20,000 distinct varieties of corn still being grown in Mexico and Central America are the legacy of these ancient and sophisticated traditions. Gonzalez says that corn's remarkable diversity can be attributed to the intense emotional and cultural sig-

Serious McStakes

The clever newspaper headlines—"McTaco vs. Fried Crickets," "Mexico culturists want a break today from McDonald's"—belie the depth of feeling evoked by McDonald's Corporation's attempt to open a restaurant in the southern Mexican town of Oaxaca.

Hundreds of Oaxacans gathered on August 19th to protest the plan to site the eatery on the town plaza. The protestors didn't rant or wave signs. Fighting fast food with slow food, they instead made tamales and mole and the local delicacy, fried crickets (which reportedly taste like shrimp). They argued that McDonald's sells poor quality and unhealthful food, but were clearly more concerned about the affront to culture. The plaza is a UN World Heritage site and the town carefully preserves its colonial architecture. The cuisine dates back generations.

There are large themes embedded in this story. Alien food invasion, like the genetically modified corn also found in Oaxaca. Globalization versus the unique character of local places and communities. And politics; many Oaxacans welcome the Golden Arches: new jobs, new wealth, new variety. So is Oaxaca truly free to decide the issue itself? Or is it a done deal—and likewise inevitable everywhere else, too? To its credit, the town scheduled a debate for later in the year. Meanwhile McDonald's, which already has 250 restaurants in Mexico, opens a new one there every three or four days.

nificance that corn has for indigenous farmers. Because they love and respect this "plant-person," he says, they spend more time caring for it, helping it adapt to special ecological niches. Not surprisingly, corn has been called "the most remarkable plant breeding accomplishment of all time." When Columbus arrived in the Americas, says Walton Galinat in *Maize: Gift from America's First Peoples*, he failed to recognize that "this plant, developed by peoples he judged poor and uncivilized, far outstripped in productivity any of the cereals bred by Old World farmers—wheat, rice, sorghum, barley, and rye." And, he said, "Columbus did not realize that the gift of maize was far more valuable than the spices or gold he hoped to find."

In this current clash of cultures, what could industrialized agriculture learn from traditional corn cultures? The answer lies in the fact that corn reflects the values of the peoples who grow it. Because corn is so adaptable, it becomes what farmers want it to be. In the United States, commodity farmers want corn to be extremely productive and uniform, and so it is. In 1921 the average U.S. yield was about 28 bushels an acre. By 2001, the average yield was 138 bushels an acre. Some top producers could boast yields of over 300 bushels, although this kind of productivity is only achieved by adding enormous amounts of energy in the form of fertilizers and other chemicals. It could be said, then, that GMOs, with their commercial utility, uniformity, and privatized genes, are simply a product of an industrial culture that sees corn as little more than a biological machine, reflecting a culture that values efficient productivity and profitability while fostering farmer dependence on a handful of commercial hybrids.

The traditional farmers of the *Sierra Norte*, on the other hand, value genetic diversity and independence. They see corn in its ecological context, as a living thing, linked to the environment and to the health of all who depend on it for food. They need corn to grow productively under various stressful conditions. And so it does. These farmers may get lower yields than industrial farmers do, but they do not use vast amounts of chemical inputs, and they are free to save and freely exchange their seed. As a result, they have been able to maintain a high degree of autonomy while sustaining their land-based cultures. That, the village officials in Capulalpam said, is their highest value. And for them, that has been corn's greatest gift. And, Señora Maldonado said, that was why, despite all of her worries, she was going to keep on planting *criollo* corn.

Science supports both the industrial and the traditional views. Unfortunately, in the case of agricultural biotechnology, science has been hijacked by technology, a commercial technology that does not take into consideration the social, environmental or cultural impacts of its products. The biotechnology industry says the GMOs found in the *Sierra Norte* pose no threat. This opinion is based on their belief, codified into the regulations governing GMOs by industry lobbyists, that transgenes are "substantially equivalent" to conventional genes. This highly reductionist—and widely questioned—view of molecular biology holds

Courtesy Claire Cummings

A farmer of Calpulalpam. He stands in somewhat modest contrast to his U.S. counterpart, who might be riding in a high-tech tractor cab equipped with satellite communications, air conditioning, and e-mail. But the Mexican's knowledge of corn—of the differences among the many varieties developed to thrive under a wide range of growing conditions—is probably far greater.

The native corn, hoe, and bare feet belong to one of just three old Maya farmers in San Antionio Aguas Calientes who still wear the traditional black tunics of the region.

that a transgene is just like any other gene.

This uncritical acceptance of GMOs has now opened the door for the transgenic contamination of all the world's major crops at their centers of origin. Next it may be rice or soybeans in Asia, cotton or potatoes in South America, or other cereals, like wheat, in Europe. Then there may be genetically engineered fish, trees, insects, and other organisms now being developed. All of this is supposedly the best of what American industrial agriculture has to offer the world, but many countries outside the United States are beginning to oppose the onslaught of GMOs. As we drove through the *Sierra Norte*, I asked Dr. Chapela what he thought about the proliferation of GMOs. He said part of the answer

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could be found in the place where transgenes were first found—here, in the nearby village of Trinidad.

We arrived in Trinidad late in the day, just as the last rays of light were slipping off the treetops. The sound of church bells and a choir singing drifted out over the tiny valley. Twinkling lights appeared, giving Trinidad a magical feeling. This little slice of heaven is the last place on Earth you'd expect to find a genetics laboratory. But upstairs in Trinidad's small municipal building, which is painted a persimmon color, is a small, tidy laboratory run by an indigenous organization, called the Union of Zapatecos and Chiantecos (UZACHI.)

Trinidad, a former mining town, has been struggling to find sustainable ways to live, while preserving local forests. Chapela, who is Mexican, started the lab in the mid-1990s when he was working for the Swiss pharmaceutical company, Sandoz, now Syngenta. At the time, Sandoz was prospecting for medicinal plants, a practice Chapela now rejects as "biopiracy." Chapela later helped convert the lab into a locally managed operation that produced mushrooms as a community development project. It was here that the first evidence of the GMO contamination of *criollo* corn was discovered when Chapela's colleague, David Quist, used a local corn variety for testing some DNA equipment and got a positive result. They thought it was a mistake, and the lab asked Quist and Chapela to take some samples back to Berkeley with them for further testing. Confirmation of the results led to the study published later in *Nature*.

Lilia Perez, a Zapotec who is now in charge of the UZACHI lab, showed me around. She described what it was like when she first found out that transgenic corn had arrived in her tiny town. As she told a friend, John Ross, author of *The War Against Oblivion – eight years with the Zapatista rebellion in Chiapas,* "it felt like an attack on my communities, my people. Transnationals are selling hunger in the *Sierra*." What is being imported, she said, along with their transgenics, is "cultural genocide."

Indigenous resistance movements like UZACHI and the Union of Organizations of the *Sierra de Juarez* of Oaxaca (UNOSJO) are still a powerful force in Mexico. They are extremely worried about the arrival of transgenics in their communities. In Chiapas, Ross says, the reaction to the news of GMO corn has been "tantamount to panic." The indigenous communities in Mexico are doing what they can, given their limited resources. They are establishing seed banks, holding conferences, and working with international NGOs that support their cause. They want a moratorium on the release of GMOs for any purpose, rigorous studies of their impacts, and support for safeguarding their traditional varieties and the farmers who grow them. These ancient corn cultures see GMOs as nothing less than a threat to their cultural survival.

Before leaving Trinidad I walked down a steep cobblestone street toward a tiny plaza out in front of the only commercial presence in town, a sparsely stocked *Diconsa* store. I was following the smell of something delicious cooking. Under a single light bulb dangling from a wire temporarily strung through the store window, members of the commune were cooking *tacos al pastor* for a small clutch of families out in the cool evening air.

As I waited behind them, I watched a thin crescent moon and a few stars appear in the deepening sky. I was thinking about how some of the best food I ever had, smoky salsas and sweet grilled peppers, had been served by the gracious Zapotec hosts here in the *Sierra Norte.* I was hungry. When my turn came, I handed over a few pesos. A smiling woman then handed me a soft taco on a small paper napkin.

I could feel the weight of it, warm and oily on my hand. I took a bite. The first flavor was the sharp green of the chopped cilantro on top, then the fresh sweet onions, and under that, the salty hot meat. And finally, I tasted the tortilla. It was a deep earthy color, grainy with nubs of hand-ground corn. It was the taste of life itself in the *Sierra Norte*—the soil where the corn had grown, the work of the hands that did the grinding, and the faith of the countless farmers who have cared for that corn for so many generations.

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