AGBIOTECH

Seeds of Discontent

Plant breeders, developing nations, and agricultural firms battle for control of the world's stock of crop diversity

For the past 10 years, at a research compound outside Harare, Zimbabwe, Marianne Bänziger has been painstakingly constructing corn plants that will thrive in drought-prone areas of southern Africa. Bänziger, a breeder for the International Center for the Improvement of Maize and Wheat (CIMMYT), collects pollen from the tassels of one plant, sprinkles it over the silk of another, and waits for another growing season to examine the results.

Earlier this year, CIMMYT announced that Bänziger's decade of labor had paid off: She had created several new lines of corn, or maize, dubbed "Grace" and "Zm521," that exhibit remarkable vigor even when afflicted by drought. In field trials conducted in South Africa, these varieties produced 30% to 50% more corn than traditional varieties grown by small farmers in the area. In the depleted soils of Zimbabwe's communal lands, the new varieties performed as well as the best commercial hybrids. CIMMYT, a publicly funded research institute with headquarters outside Mexico City, will now make Grace and Zm521 seeds available free of charge to seed distributors around the world—one more tool in the giant task of growing crops to feed the world.

But Grace and Zm521 are products of a system under threat. To create the new strains, Bänziger drew on thousands of native varieties of corn from CIMMYT's extensive seed banks, which were built up through decades of free exchange with other seed banks around the globe. In recent years, however, many nations have invoked a 1993 international treaty on biodiversity to block access to their seed collections and prohibit export of "genetic resources," fearing that they might be giving away valuable property. As a result, CIMMYT and other international seed banks have found it increasingly difficult to add to their collections.

This breakdown of seed exchanges threatens the lifeblood of plant breeding, according to some observers—including some of the prime movers behind the 1993 biodiversity treaty. They fear that if breeders don't have free access to the planet's genetic diversity, they will be increasingly hampered in their efforts to develop crops that resist disease and pests, or that thrive under shifting climate. This is particularly worrisome for breeders in the developing world, such as Bänziger, who rely on seed collections that are most directly threatened by moves to nationalize genetic resources.

To head off that threat, a new international treaty, drafted but not yet signed, attempts to revive international seed exchanges with financial incentives. Under the draft agreement, commercial seed companies that use samples from public seed banks to breed new privately owned varieties will have to pay royalties to a fund to be established under the auspices of the United Nations' Food and Agriculture Organization (FAO). The proceeds would then go into a common fund to be distributed among member countries, probably to support seed banks and conservation projects. Nonprofit outfits like CIMMYT, which distribute varieties free of charge, would be exempt from paying royalties.

African corn. Marianne Bänziger with her hardy corn plants in Zimbabwe.

CREDIT: CIMMYT

Some important disputes remain to be resolved, but the treaty—formally known as the revised International Undertaking on Plant Genetic Resources—is scheduled for signing at a high-level meeting at the FAO set for 2 to 13 November in Rome.

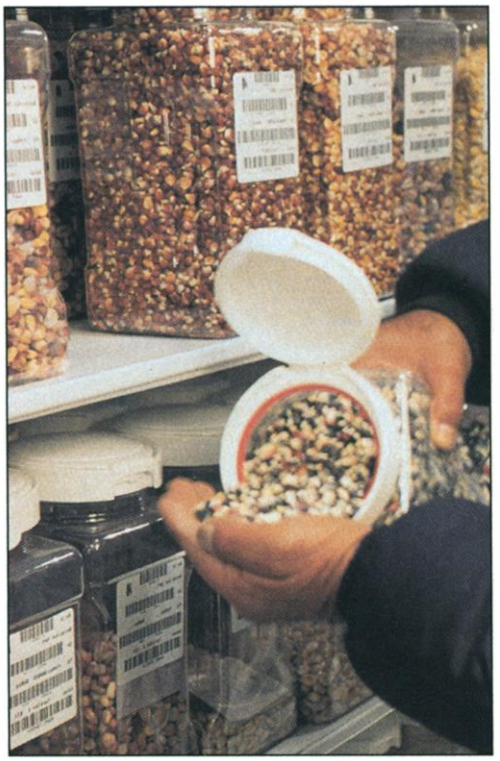
Surprisingly, seed companies and the biotechnology industry appear to be taking the proposed treaty in stride, while scientists in charge of gene banks are distinctly unenthused. Seed companies are accustomed to paying for the use of genes or plant varieties, notes Stephen Smith, a research fellow at Pioneer Hi-Bred International in Des Moines, Iowa. Perhaps, he says, the prospect of future profits may even induce gene banks to uncover hidden treasures within their own collections. For the seed banks, however, the system could be a logistical headache. "We're having trouble imagining, from a practical point of view, how this [tracking seed use] would work," says Peter Bretting, a manager of gene banks operated by the U.S. Department of Agriculture (USDA). And there is also "a sense of sadness" among gene bank administrators, says one government official. "For 4 decades now, the U.S. has stood by a philosophy of open access. And they are seeing that system [being] shut down or changed."

Smashing rocks together

The genealogy of Bänziger's maize varieties shows how free exchanges work. The ancestors of Grace and Zm521 were "landraces," or traditional varieties of corn grown by farmers in the Latin American countryside. Some landraces had originally been collected by CIMMYT, some by Latin American research institutes, and some by U.S. researchers who deposited their collections in U.S. seed banks. Some seeds then found their way from the United States to Kenya and Egypt before they arrived at CIMMYT. Before Bänziger ever started her work, CIMMYT's breeders had subjected the landraces to repeated cycles of inbreeding and selection. By thus concentrating particular genes within a population, breeders uncovered previously hidden genetic traits, in this case an ability to withstand drought. "The original landraces do not show the trait," Bänziger says.

Bänziger selected 50 breeding lines from among several thousand in CIMMYT's collection and set to work crossing the various lines in her test plots, shuffling and reshuffling the genetic combinations represented by each line of corn. The process, she says, "is like collecting big stones from all over the world. You smash them together to make small stones, and with that you make a mosaic." Ten years later, she had Grace and Zm521.

Similar stories can be told about the origins of any new variety of a major crop, whether created by research stations in Asia or profit-driven seed companies in Des Moines or St. Louis, and whether created solely by traditional breeding or in part by molecular genetic engineering. Every variant form of wheat, maize, or potato traces its lineage back to the genetic diversity found in an ancestral homeland. Soybeans came from China, potatoes from Latin America, sorghum from Africa, and so on.



Golden kernels. Corn seeds like these in CIMMYT's seed bank are valuable to plant breeders.

North vs. South

In the 1990s, the system of free exchange began to unravel. Ironically, the roots of its downfall lie in a campaign begun by people who wanted to preserve it. Agricultural activists saw a threat to free exchange from private control over seeds and, specifically, from laws that allow companies to claim intellectual property rights over new plant varieties or the genes that they contain. These activists fought what they saw as exploitation of cash-poor but gene-rich developing nations by gene-hungry multinational corporations. Among the most prominent of the campaigners were Cary Fowler, Pat Mooney, and Hope Shand, co-founders of the Rural Advancement Foundation International (RAFI), a nonprofit based in Canada. "We were talking about these resources being the common heritage of humankind, our common responsibility," says Fowler.

Over the years, many Third World governments became persuaded that their fields and forests harbor genetic treasures, and many decided to claim those treasures for themselves. The international Convention on Biological Diversity, which entered into force in 1993, provided the legal framework: It declared that genetic resources—every rock and pebble in Bänziger's mosaic—were subject to the control of the nations on whose territory these resources were found. More than 50 nations have since enacted laws restricting the export of plants, seeds, and other biological materials from their forests or gene banks. First World seed banks have found it nearly impossible to collect additional plants or seeds from many foreign fields (see graph), according to USDA officials. Although some companies may be able to buy access to valuable collections, such restrictions could place useful seeds beyond the reach of nonprofit breeders such as Bänziger.

This turn of events has placed the original critics of "biopiracy" in an awkward position. After spending most of his life railing against the evils of multinational corporations, Mooney of RAFI (which recently changed its name to the ETC Group) now finds himself condemning the legal walls that Third World governments are building around seed banks. "Forcing farmers and other researchers to reduce their options and [restrict] their access to diversity is irresponsible. It is the flip side of intellectual property monopoly and equally immoral," he wrote earlier this year.

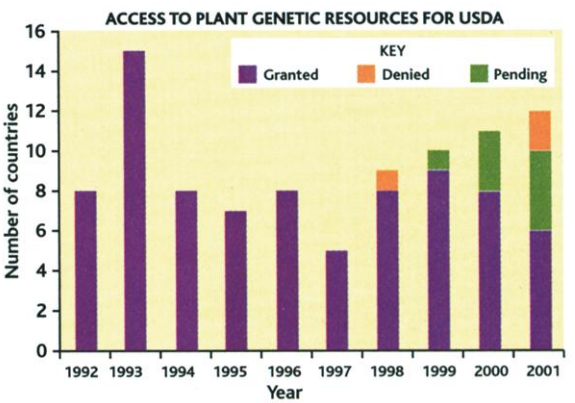
Furthermore, those restrictions on seed transfers are likely to hurt developing countries most, notes Fowler, who left RAFI nearly a decade ago and now works as an adviser to the International Plant Genetic Resources Institute (IPGRI) in Fiumicino, Italy. In collaboration with two other researchers at IPGRI, Fowler recently published data showing that agriculture in nearly all developing nations relies on crops that originated somewhere else. Africans, for instance, depend heavily on maize and cassava, both imported from abroad. New varieties of these crops will depend on genetic resources found originally in Latin America and Asia.

Moreover, says Fowler, genetic resources now flow mainly from "North" to "South" rather than the other way around. In one recent typical year, for every single seed sample that developing nations sent to international gene banks, those gene banks sent about 60 samples back. Farmers in poor nations now depend on seeds held by gene banks located in or funded by rich nations. For Fowler, the conclusion is obvious: If poor nations create a world in which they have to bargain for access to the genetic resources in these banks, they lose.

Out of the pot

In effect, such bargaining began during negotiations leading to the proposed treaty. The treaty attempts to break the logjam over seeds by creating a way for Third World nations to profit from the riches stored in the world's public seed banks, including the national seed banks of the United States and various European nations. It establishes a common pot of seeds that will be freely available to plant breeders, in exchange for royalties if the seeds are used to develop commercial varieties. For example, if a commercial seed company used seeds from Grace and Zm521 to breed new proprietary varieties, it then would have to pay royalties into the common fund. (Pharmaceutical and other nonfood uses are excluded.) This common pot, called the "multilateral system," currently contains seeds from about 30 of the world's major crops, including corn, wheat, rice, potatoes, bananas, and beans. All seeds from these crops in all the public databases of signatory countries would be included.

Soybeans, however, are not in that common pot, because China, the homeland of soybeans, objected to its inclusion. Latin American nations, meanwhile, refused to include tomatoes or groundnuts such as peanuts, and African nations kept a variety of tropical grasses off the list. In order to obtain samples of these crops from national gene banks, researchers will have to obtain special permission and perhaps buy access. Some predict that this will severely hamper efforts to develop better varieties of such



Free trade? USDA officials seeking seed samples from other nations have begun to get rebuffed.

CREDITS: (TOP TO BOTTOM) A. M. SANCHEZ/CIMMYT; SOURCE: USDA

crops, many of which get little attention from breeders anyway. "The implication is, they really think that they can make money by selling these genetic resources," says one European observer in apparent disbelief.

In reality, however, a Third World gene cartel isn't likely to squeeze much money from the agricultural seed industry. Unlike the pharmaceutical industry, seed companies generate relatively meager profits—less than half a billion dollars each year worldwide. In the case of some plants for which Third World nations might control unique genetic resources, such as tropical grasses, a commercial seed industry doesn't even exist.

During plenary sessions of the negotiations, excerpts of which were published on the Internet,* delegates spoke in high-minded tones about the need to include as many crops as possible in the multilateral system, in order to assure food security for the world's poor. In private, many delegates refused to give up control over genetic resources that they considered valuable. Two participants in one small negotiating session on the final day describe the following episode: Latin American delegates turned to their Asian colleagues and offered to include tomatoes, peanuts, and a few other crops in the common pot if Asia agreed to include soybeans, sugarcane, and oil palm. Asia's representatives refused. The Latin Americans then turned to Africa's representatives and offered to include their tropical legumes in exchange for the Africans' tropical grasses. The Africans declined.

Progress on the list of crops, suggested Tewolde Berhan Gebre Egziabher of Ethiopia, one of the leading spokespersons for the developing nations, may depend on resolution of another sticky issue: the patenting of plant genes. African nations, in particular, have demanded a ban on the patenting of anything discovered within public seed banks. The United States, supported by Australia and Canada, agreed that patents shouldn't be allowed on plant varieties obtained from public gene banks; such varieties, they argued, wouldn't be patentable anyway under U.S. law. The United States and its allies adamantly refused, however, to ban patents on "genetic parts and components," referring to individual genes that might be isolated from the seeds and transferred to other species via genetic engineering.

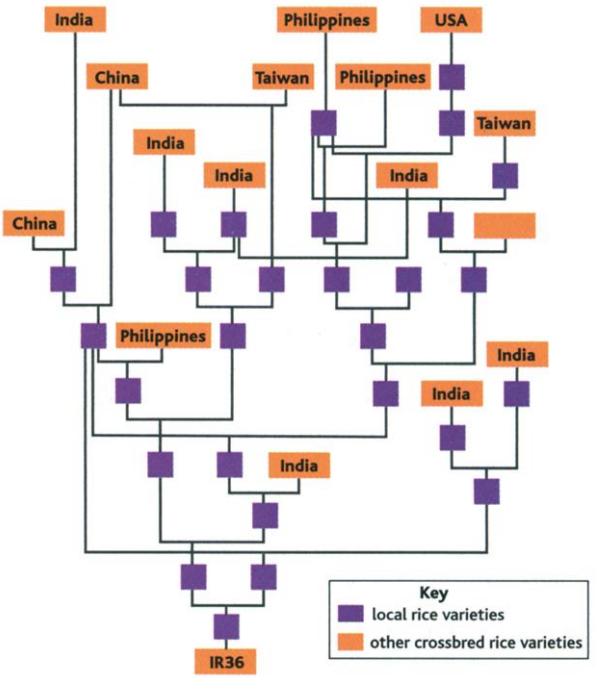
This dispute will be taken up again in November, at the meeting where the treaty is supposed to be signed. "If they can fix 15 words, it'll happen," says one industry observer. It's also possible that most nations will go forward with the treaty, even without agreement from the United States.

If the treaty is signed, USDA's Bretting foresees big problems in implementing it. He says he has no idea how USDA's gene banks could track the use of their seeds in commercial products in order to collect royalties. When a particular sample of seeds leaves a public gene bank, it "goes into the gene pool and is crossed with a gazillion different things." Twenty years later, it could become one distant ancestor of a commercial product. "Who's going to track this?" Bretting asks.

Meanwhile, the thorny questions of how much the commercial seed companies will pay—and exactly how the common monies will be administered and distributed to member countries—have been left to the treaty's "governing body," which is yet to be created. During the negotiations, a group of African nations suggested that public gene banks might generate annual royalties of half a billion dollars or more. Industry representatives roll their eyes at such numbers and point out that this sum would exceed the current global profits of the commercial seed industry. A more realistic estimate of potential revenues, they say, might be a few million dollars, beginning a decade or more down the road. "The belief that there's gold in those hills just waiting to be extracted is really unfortunate," says Jeffrey Kushan, a lawyer with the Washington, D.C., office of Powell, Goldstein, Frazer & Murphy, which represents the U.S. Biotechnology Industry Organization. Because the governing body is supposed to operate by consensus, such differences could lead to paralysis, leaving all seed exchanges in legal limbo.

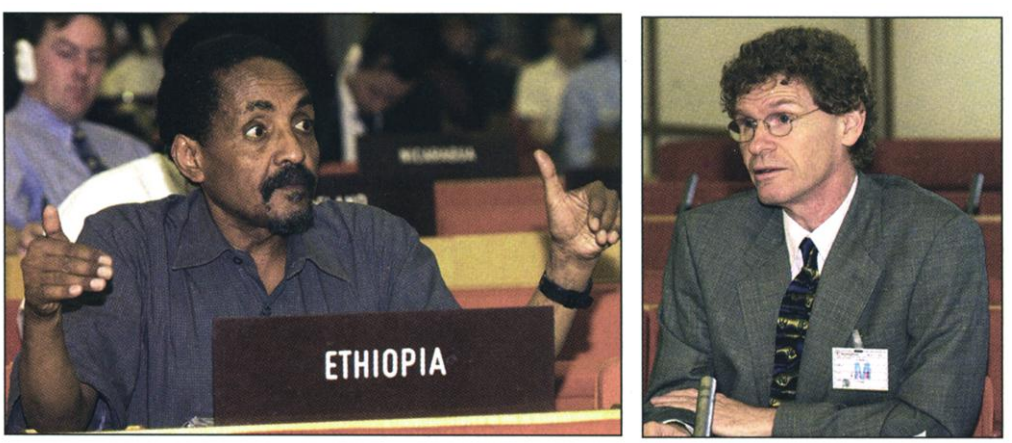
On one point, however, there seems to be unanimity: There's no going back to the informal practices of an earlier era. Whether justified by the Convention on Biological Diversity, national laws, or the new treaty, government controls over seed exchanges are now a fact of life. "The era of free exchange," says Stephen Smith of Pioneer Hi-Bred, "is gone."

–DANIEL CHARLES



Tangled tree. To create a single rice variety, breeders drew on many strains from around the world.

CREDITS (TOP TO BOTTOM): PLUCKNETT *ET AL., GENE BANKS AND THE WORLD'S FOOD PRODUCTION* (PRINCETON UNIV. PRESS, PRINCETON, N.J., 1987); A. HENRY/IISD



Seeking agreement. Ethiopia's Egziabher and Fowler, representing international researchers, testified in Rome.

Daniel Charles is the author of *Lords of the Harvest: Biotech, Big Money, and the Future of Food*, published this month.

* See the International Institute for Sustainable Development's coverage of the negotiations at www.iisd.ca/biodiv/ExCGRFA-6