CIMMYT in Latin America

Colombians Take Maize with Their Coffee

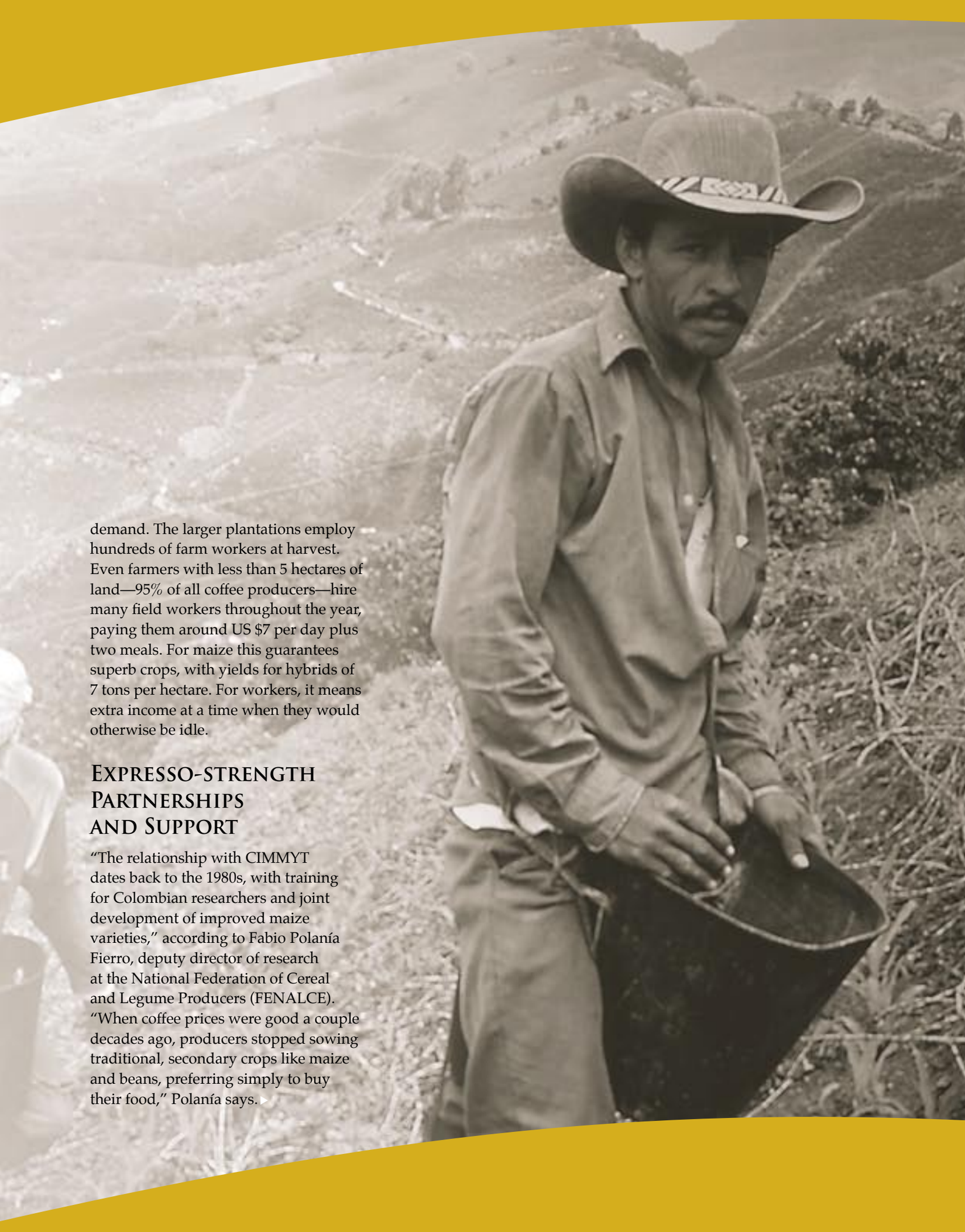
Disease resistant maize varieties and agronomic training from CIMMYT allow Colombian coffee farmers to diversify and profit.

With help from CIMMYT and partners, many Colombian coffee growers have lately become convinced that sowing maize is more profitable than fighting weeds. In 2004 they raised 38,000 hectares of high-yielding maize between coffee rows in fields where coffee plants had been pruned. In the bargain, they pocketed good profits and added to the incomes and food security of hundreds of thousands of farm laborers. "A maize crop provides about 50 additional worker-days each growing season," says Gustavo Rincón, administrator of "La Holanda," a 160-hectare coffee plantation in Alegrías Valley, Risaralda Department, Colombia.

Rincón figures he gets a profit of US $700 above cost on every hectare of maize he sows. Following recommended practices, he prunes coffee bushes to short stems after several harvests. He also replaces old plants with new ones every five years. During the 18 months or so the new or pruned coffee plants take to yield beans, the land they occupy is was normally unproductive and hosts vigorous stands of weeds. "Growing maize puts this land to profitable use, controls the weeds, protects plots from erosion, and, if proper care is taken of the soil, does not affect the coffee," Rincón explains. He sells much of his maize as whole ears for street-corner vendors in cities. The rest goes into feed for his farm animals, or is given away as a bonus to live-in plantation workers or coffee buyers. His peers generally market their output to intermediaries for use in poultry feeds.

Hands-on Approach a Boon to Workers

Growing coffee is an exacting, labor-intensive business. Producers draw on excellent soils and rainfall, good infrastructure and processing equipment, and long experience in agriculture. But no machinery is used for field operations: Andean hillslopes are too steep, and hands-on management is still the best way to get the quality consumers



demand. The larger plantations employ hundreds of farm workers at harvest. Even farmers with less than 5 hectares of land—95% of all coffee producers—hire many field workers throughout the year, paying them around US $7 per day plus two meals. For maize this guarantees superb crops, with yields for hybrids of 7 tons per hectare. For workers, it means extra income at a time when they would otherwise be idle.

Expresso-strength Partnerships and Support

"The relationship with CIMMYT dates back to the 1980s, with training for Colombian researchers and joint development of improved maize varieties," according to Fabio Polanía Fierro, deputy director of research at the National Federation of Cereal and Legume Producers (FENALCE). "When coffee prices were good a couple decades ago, producers stopped sowing traditional, secondary crops like maize and beans, preferring simply to buy their food," Polanía says.

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- **Fabio Polanía Fierro**
  Deputy Director for Research, FENALCE

This changed with free markets and falling global coffee prices throughout the 1990s, according to Luis Narro, CIMMYT maize specialist in South America. "In 2002, maize was identified as an attractive option to boost coffee producers' incomes," Narro explains, "but only if we could come up with new varieties resistant to two locally harmful maize diseases—tar spot and gray leaf spot." CIMMYT provided hundreds of experimental varieties for testing on experiment stations of the National Federation of Colombian Coffee Growers (FEDERECAFE) in 2002. "We identified two white-grained, disease resistant hybrids that yielded more than 10 tons of grain per hectare," says Narro. Later that year, FEDERECAFE, FENALCE, and CIMMYT signed an agreement to develop systems for producing maize on coffee plantations.

Meanwhile, with strong support from FEDERECAFE and the government, Colombian coffee growers have been sowing maize for several years, using commercial hybrids and applying

fungicides for disease control. "The Minister of Agriculture has given both political and financial support; this has been crucial," says Polanía, "and President Álvaro Uribe got interested and suggested the idea of a contest for the best maize crop."

Encompassing more than half a million coffee-growing households and 800,000 hectares of coffee lands, FEDERECAFE has also thrown its considerable weight behind the coffee-maize marriage and provided diverse logistical and material support, says Edgar Echeverri Gómez, Technical Manager of the organization. Among other things, its legions of yellow-shirted, blue-capped extension agents are now knowledgeable in maize agronomy.

Demand Driven?

A major concern is ensuring markets for locally-grown maize. Colombians consume just over 3 million tons of maize each year as food, feed for poultry and pigs, and industry products. They produce slightly more than a third of this and import the rest from places like Argentina or the USA. Foreign maize is cheaper than home-grown grain, although its quality is often lower.

"There's a market for Colombian maize—people prefer it for food products—but the demand is much less than for animal feed," says Alejandro Ochoa Norena, who received the first-prize trophy for maize productivity in 2004 from the hands of President Uribe. Ochoa and his sister Johana manage their father's coffee plantation near the town of Santuario, Risaralda Department. He says that marketing maize is an increasing challenge, and growers frequently go through middlemen. "This arrangement is often unfavorable for farmers," says Ochoa. Still, Ochoa and his peers are guardedly optimistic about the prospects for maize in the near term, and feel it offers a solid alternative for diversification.◂

▲ To process maize harvests, Colombian coffee growers like Alejandro Ochoa Norena take advantage of much of the same equipment they use for sorting, washing, drying, and bagging coffee beans, but occasionally invest in specialized machinery, like the maize sheller shown here.

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Making the Plow Passé in Mexico

What started as a money-saving technique at a wheat station is now turning heads for its advances in conserving resources and boosting maize yields.

CIMMYT's Toluca station is a centerpiece in wheat improvement, but is located in a mostly maize-growing part of Mexico. Station superintendent Fernando Delgado Ramos has become a pillar of knowledge on conservation agriculture and is changing the way some farmers think about the plow.

Julián Martínez, one of many farmers who have followed Delgado's recommendations to reduce tillage, keep residues on the soil, and sow on permanent, raised beds, says his maize yields have nearly doubled, since adopting the practices three years ago on his small farm in the Toluca Valley, southwest of Mexico City.

Drought or Downpours: Zero-Tillage Still Works

Delgado's initiatives started out small in Central Mexico, but the conservation agriculture practices he promotes have piqued the interest of maize farmers nation-wide, as they face water shortages, rising production costs, and low prices for their produce. From the community of San Andrés, Jalisco State, farmer Sergio Vázquez made the trip over 300 kilometers southeast to Toluca in 2004 for a demonstration by Delgado. He was immediately impressed by the savings from eliminating extensive tillage operations. Back home he tried to convince his cousin and partner, José Antonio Aranda, to apply the new methods. Aranda first refused but later relented. "That season it rained a lot and we saw we couldn't sow or, in some cases, even disk the plowed fields, so we tried zero-tillage and were able to plant 90 hectares," Vázquez explains.

In the last few years Fernando Delgado, head of a wheat research station, has helped maize farmers, who flock to him for advice. He does this as a sideline, after a full day of office and field work.

Seeding directly into brush and residues was difficult, according to Vázquez, but not as hard as putting up with the laughter and sarcasm of local acquaintances. "Their comments changed when they saw our crop emerge and the weeds wilt away from the herbicide we'd used, and this led a few friends to try zero-tillage on some of their plots."

Suffering one of farming's cruel ironies, in spring 2005 the partners faced exactly the opposite from the previous year's dilemma: two dry spells of several weeks each, the first coming right at planting time. Vázquez had his soils tested and found enough moisture to germinate maize seeds, so he and Aranda sowed 210 hectares directly into the unplowed fields. Despite the droughts, their maize crop grew strong on the residual moisture. Neighbors using conventional tillage either had severely stressed plants or had to wait for rain and plant late, thereby risking yield losses from frost in the fall. "There are still many aspects we need to improve," says Vázquez, "but we're convinced that zero-tillage is better than traditional tillage for profitable farming."

The Tide is Turning

In the nearby state of San Luis Potosí, farm-group leader Carlos Rocha Cabrera has been in frequent contact with Delgado in search of ways to lower productions costs for farmers he serves. "Using zero-tillage practices with irrigated maize, we've had savings of 40% in water, 80% in herbicide, and 80 and 40% in soil- and leaf-applied insecticides," says Rocha, who presides over the administrative council of "Agropecuaria y Forestal El Mezquite." Members of this farmer association are sowing some 350 hectares with no plowing and keeping residues on the soil, and have done experiments comparing the effects on soil moisture of varied amounts of residue. "Change [toward conservation agriculture] is coming from all agriculture sectors, including smallholders, those working former communal lands, and large-scale farmers," Rocha says, "and government support is growing."

Economics: The Mother of Invention?

Delgado's movement toward conservation agriculture started as a way to save money in operations at the Toluca station by reducing machinery passes and use of water and fuel. Fifty percent of the station's land is used for wheat experiments, and the other half is devoted to crop rotations to sustain the land. It was there that Delgado started direct seeding on permanent beds to save money for use on other projects. Conservation agriculture caught his eye after a couple harvests, when yields went from 5-8 tons per hectare to 10.

CIMMYT agronomist Ken Sayre has traveled throughout the developing world, championing cropping diversification and use of permanent, raised beds. He heartily applauds Delgado's efforts. "People like Fernando still believe that improving crop production directly in farmers' fields is the most valuable way to achieve impact," he says. Delgado's practical initiatives are certainly finding an echo with Mexican farmers and helping many to increase their productivity and profitability in challenging times.

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Clarion Call to Conservation in El Bajío

Joining the growing number of farmers worldwide squeezed by rising input costs, low grain prices, and degrading resources, farmers in Michoacán State, south-central Mexico, are moving toward conservation agriculture, assisted by researchers like Rebeca González Íñiguez. The northern section of the state is part of Mexico's El Bajío—a large region with rich soils, good rains, and extensive irrigation, but mounting problems relating, among other things, to improper use of agro-chemicals and water. Michoacán farmers enjoy relatively large holdings—as big as 200 hectares—and practice an intensive rotation centered on irrigated wheat or barley in dry winter months and rainfed, summer maize or sorghum.

A cereal scientist at the Mexican National Institute of Forestry, Agriculture, and Livestock Research, González helped introduce the farmers to cropping on raised beds, a practice many are using to improve irrigation efficiency. "In 1994, we organized a visit by farmers to the CIMMYT research station at Ciudad Obregón, in northern Mexico, to learn about bed planting and better ways of managing irrigation," she says. "The furrows on either side of the beds speed up irrigation and channel the water so there are no flooded or dry spots in the field." González also brought them a bed shaping implement provided originally by CIMMYT wheat agronomist Ken Sayre, who encourages and supports González and the Michoacán farmers.

Soon after, to gain time and thus be able to sow more productive, longer-season maize hybrids, most of the farmers began seeding maize directly into residues with no tillage after wheat or barley harvest. "They picked this up from peers in another area of El Bajío, and besides allowing earlier sowing it has saved them the cost of plowing," says González. From there, it was a short leap to experimenting with year-round zero-tillage on permanent raised beds. Local farmer Moisés Orozco Velázquez began testing the approach with his brothers on part of their 100-hectare holdings in 2004, mainly to lower expenses. At first he didn't like some of the new ideas—like slashing fertilizer use—suggested by a brother studying agronomy. But he acceded

and was happily surprised at the results. "We cut our costs in half with savings in fertilizer, tillage operations, and field-hands, and our crop looks as good as or better than that of our neighbors, who used traditional tillage and lots more fertilizer," says Orozco. "We also had some heavy rains this year, and in lower-lying spots where we'd normally lose part of the crop to waterlogging, the infiltration was excellent." Now he and the family plan to apply a suite of resource-conserving practices, including year-round zero-tillage, on all their land.

Like other farmers adopting the new practices, Orozco is still struggling with diverse issues, including optimal seeding and fertilizer rates and, above all, managing residues as plentiful as 15 tons per hectare each year. "We've found that if we spray urea on it, by sowing time the straw has begun to decompose," Orozco says. They also bundle and sell some straw for forage, but still have problems getting seeders to chop through residue and put seed in contact with the soil. González says this points up a major issue to solve: "The future of conservation agriculture in the region depends on farmers' access to effective, affordable machinery." Sayre and his associates are working on relevant designs that Mexican machine manufacturers can eventually build and market. ◂

▲ A small-grain cereals specialist, Rebeca González Íñiguez says a key part of her work involves listening to and learning from the accumulated wisdom of Mexican farmers like Agustín Orozco Velázquez, pictured here: "They know what they're doing and what they need; I simply try to provide support and guidance. If I don't know the answer to one of their questions, I call in an expert who can help them."

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Reflected Rays Tell When to Feed Crops and Starve Sea Algae

A new technology from CIMMYT and Oklahoma State and Stanford Universities will help developing country maize and wheat farmers to better target and regulate fertilizer applications. Farmer incomes and the quality of soils and fisheries stand to benefit.

"I wish I had known about it this season—this will save me money," says Rubén Luders, a farmer who grows 400 hectares of irrigated wheat in the Yaqui Valley of Mexico's Sonora State. What Luders and more than 25 other farmers saw in a demonstration was an effective and accurate way to determine both the right amount of nitrogen fertilizer for a wheat crop and the best time to apply it. Traditionally farmers in the region fertilize before they sow and then again at first irrigation. The new approach, developed in conjunction with Oklahoma State University (OSU), USA, uses an infrared sensor to measure the performance of wheat plants as they grow.

Conducted in the fields of four different farmer-volunteers, the demonstrations showed that farmers could maintain high yields using far less fertilizer. "We used to feed the soil first, before growing the wheat," says Luders. "Now we know we should feed the wheat." He and his peers calculated that the nitrogen sensor, which costs about US$ 400, would pay for itself in a single season from savings in fertilizer use on just 80 hectares of wheat.

"I'd long been looking for something to determine nitrogen requirements," says CIMMYT wheat agronomist, Iván Ortiz-Monasterio. "It has taken time to calibrate it, but now we have a useful tool to determine the nitrogen a wheat plant needs."

The sensor is held above the growing plants and measures light reflected at two different wavelengths—red and invisible infrared. In technical terms this is called the normalized differential vegetative index (NVDI). After much testing, Ortiz-Monasterio and his colleagues from Oklahoma State found they could get a handheld computer to calculate plant nitrogen requirements from the readings.

Reflected Light Illuminates Soil Status and Nitrate Runoffs

CIMMYT research associate and wheat agronomist Bram Govaerts has used the sensor to measure plant performance in a long-term experiment on maize and wheat conservation agriculture at CIMMYT's El Batán experiment station in south-central Mexico. "Variation of spectral reflectance within plots is a sound indicator

of agronomic mismanagement or soil quality problems," says Govaerts. "Uniform readings suggest that farming practices are sustainable."

Govaerts and CIMMYT post-doctoral fellow Mirjam Pulleman helped conduct a training course in September 2005 on the use of the sensor. Organized by CIMMYT wheat agronomist Ken Sayre and OSU researcher and former CIMMYT wheat agronomist William Raun and financed by the United States Agency for International Development, the workshop drew 27 participants, including 10 Mexican researchers and extension workers. Rebeca González Íñiguez, of Mexico's National Institute of Forestry, Agriculture, and Livestock Research, plans to use what she learned to help farmers adopting conservation agriculture in an intensively cropped area where fertilizer overuse threatens soil quality and incomes (see "Clarion Call to Conservation in El Bajío," p. 30). In this case, she will calibrate the sensor to fine-tune fertilization of farmers' rainfed, summer maize crop.

But there is more to this technology than just efficient farming. A recent Stanford University study published by the prestigious science journal *Nature* showed that excess fertilizer from northern Mexican farms washes into the nearby Sea of Cortez. The extra nitrogen feeds blooms of algae that deplete sea-water oxygen—an effect that has spoiled fisheries in several parts of the world. Fertilizer-optimizing practices like the sensor help head-off the problem. "As farming systems intensify to feed more people, we need to minimize the environmental impacts," says Ortiz-Monasterio.

Just five days before the demonstration with Yaqui Valley farmers, researchers in Pakistan received their first infrared sensor, the result of a USAID linkage grant with CIMMYT and Oklahoma State. In this way, a technology proven in Mexican fields is going to benefit farmers worldwide and help maintain the health of coastal waters. ◂

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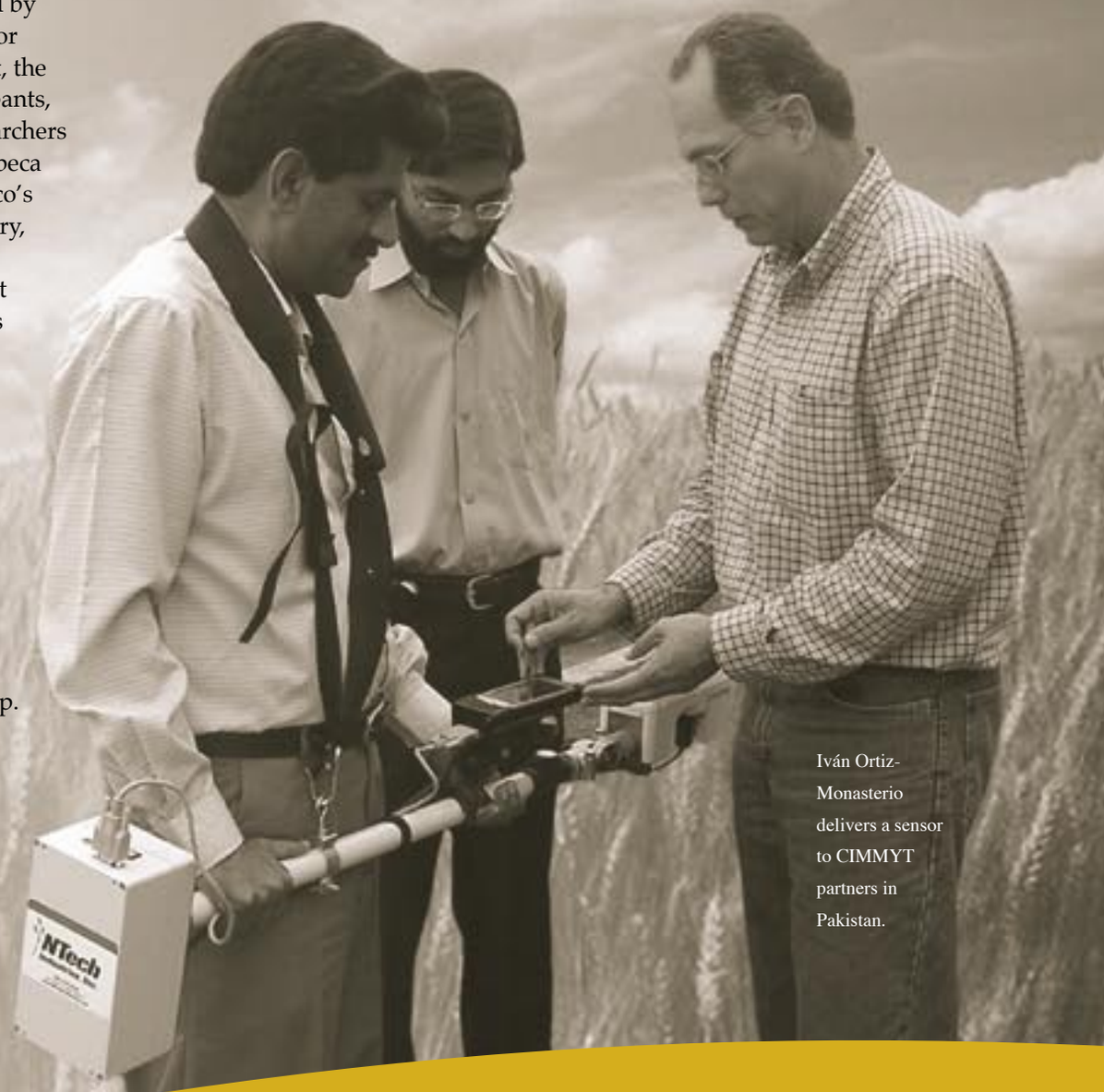

Iván Ortiz-Monasterio delivers a sensor to CIMMYT partners in Pakistan.

A Maize Variety for Farmers on the Edge

Peruvian farmer Virgilio Medina Bautista and his wife pay for boarding school for their two children by growing maize and coffee on sections of their 12-hectare homestead. After testing other varieties and hybrids, he grows Marginal 28 because "…it's a good maize and yields well."

On a hillside that abuts more than 3,000 kilometers of Amazonian expanse beginning in Peru and reaching clear across Brazil to the Atlantic, farmer Virgilio Medina Bautista weeds his maize field under the stifling equatorial sun. He and his wife Sabina Bardales typically arise before dawn to cook a meal for their field workers and work all day until bedtime, around 9 p.m. "We come to the field with the food for brunch and ready to work," Medina says. "It's a hard life, but there's no other way, for someone without an education."

Like 90% of the farmers in this region of Peru—the lowland zones east of the Andes known as the "jungle"—as well as many on the coastal plains or in inter-Andean valleys, Medina sows Marginal 28. This open-pollinated maize variety, developed in the 1980s by Peru and CIMMYT, is popular for its high yields and broad adaptation. It provides two or three times the average yield of the local variety it replaced, and grows well in diverse environments. "Private companies have been trying to introduce maize hybrids here, but they yield only six tons per hectare," says Edison Hidalgo, maize researcher from the National Institute of Agricultural Research (INIA) "El Porvenir" experiment station, whose staff help spread productive farming practices throughout the region. "Marginal 28 gives that or more, under similar management, and because it's an open-pollinated variety, farmers don't have to purchase new seed every season."

Luis Narro, CIMMYT maize researcher in South America and a native of Peru who helped develop Marginal 28, says the cultivar's adaptation and uses have far outstripped expectations. "This variety is sown most widely in jungle zones—truly marginal, lowland areas characterized by poor soils, heavy weeds, and frequent drought, to name a few constraints," Narro says. "But I was just at a station in Ayacucho, ▸

"This suggests part of the value of a global organization like CIMMYT, which can combine contributions from around the world to develop a useful product for small-scale farmers."

- Luis Narro, maize breeder, CIMMYT, South America

at over 2,700 meters in the Andes, and saw seed production fields of Marginal 28 where yields were probably going to hit seven tons per hectare." Farmers in jungle areas use it chiefly for animal feed or for export to the coast. Coastal farmers grow Marginal 28 because the seed is relatively cheap and yields high-quality forage for their dairy cattle. In the Andes, the grain goes for food and snacks.

Its adaptability may be explained in part by its genetically diverse pedigree, which even includes as a parent an internationally recognized variety from Thailand. "This suggests part of the value of a global organization like CIMMYT, which can combine contributions from around the world to develop a useful product for small-scale farmers," Narro says.

Can Poor Farmers Stop Chopping Down Jungles?

Despite the clear benefits of Marginal 28, Peruvian farmers are still struggling as markets shift, production costs rise, and maize prices remain low. Farmer Jorge Dávila Dávila, of Fundo San Carlos, Picota Province, in the Amazon region of Peru, grows maize, cotton, banana, and beans on his 10-hectare homestead. Because he is

▲ Farmer Jorge Dávila Dávila believes more outside assistance will be needed, if farmers in the region are to switch to environmentally friendly farming: "To stop cutting down jungle land, we need a proposal that lets us live off our farms."

relatively far from the trans-Andean highways leading to the coast, where maize is in heavy demand for use in poultry feed, middlemen pay him only US $70 per ton of maize grain—well below world market prices. "Maize is a losing proposition; that's why so many farmers here are in debt," he says. "They can't take their maize to local companies for a better price, because they already owe it to the middlemen who provide inputs."

Unlike most farmers, Dávila makes ends meet through hard work and what he calls "an orderly approach" to farming. Many in the region slash and burn new brushland, cropping it for two or three seasons until fertility falls off, and then they move to new land. Dávila has stayed put for eight years on the same fields. "I tell my neighbors not to cut down their jungle," he says. "I've seen that leaving (the brushland) brings me rain." With support from INIA researchers like Hidalgo, Dávila is testing conservation agriculture practices. For example, on one plot he plans to keep maize residues on the soil surface and seed the next crop directly into the soil without plowing. Research by CIMMYT and others has shown that this practice can cut production costs, trap and conserve moisture, and improve soil quality. ◄

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