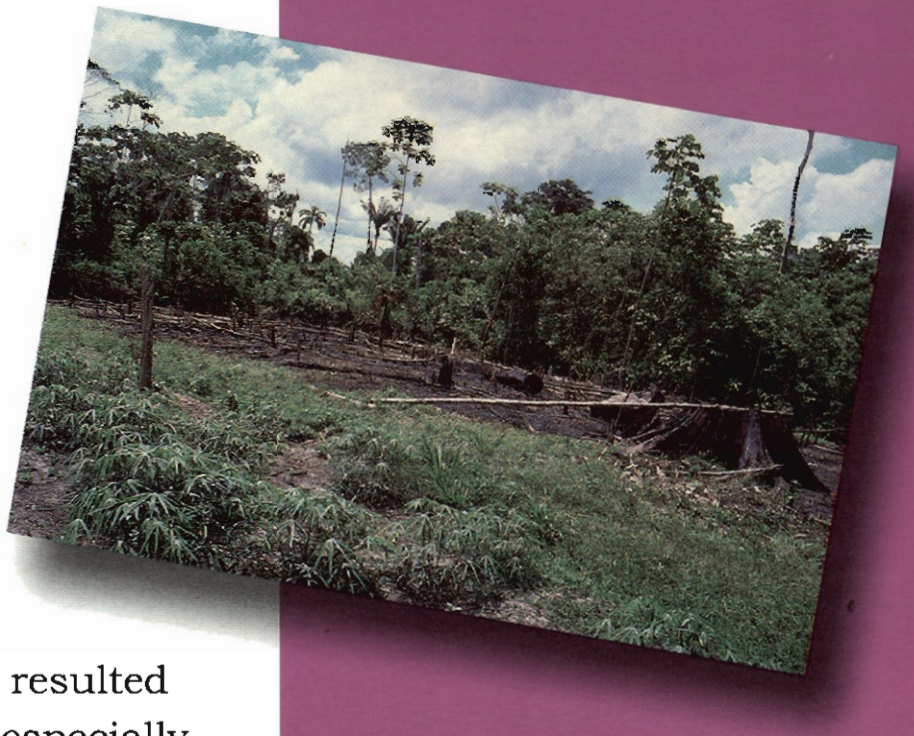
CIAT in Perspective 1996-97

Contents

Perspective in Practice

In 1997 the International Center for Tropical Agriculture (CIAT) turned 30. That is a good age for taking stock of an institution's experience—for asking what it has accomplished and what it must do next.



The Center's principal achievements have resulted from sustained research on crops that are especially vital for the poor in developing countries. Now, we are pursuing an integrated approach that combines crop improvement with strategic research on natural resource management to raise agricultural productivity and alleviate poverty, while reducing environmental degradation. This new approach, reflecting CIAT's perspective in practice, is the focus of our annual report for 1996-97.

"Failure to solve the agriculturally based problems of rural areas will only exacerbate the urban deprivation so manifest in Latin American cities."

Richard Smith, Senior Lecturer in Geography, University of Leeds, UK

A Decision Revisited

Grant M. Scobie
Director General

At CIAT we faced a momentous decision in 1996, very much like one that Center management confronted 25 years ago—a decision that shaped the course of the Center's work, as well as my own career as an agricultural economist, for more than 2 decades.

After all these years, I still remember the exact spot where I sat in the office of then director general John Nickel, when he informed me and other members of the Small-Farm Systems Program that our group was to be disbanded. It had been created to help knit together the work of CIAT's commodity programs. The central focus of our work was to be the small-farm family in Latin America—its social and economic realities, its natural resource base, and the impact of technical change on its well-being.

The program was eliminated for several reasons but mainly because the Center needed to achieve impact as quickly as possible by focusing on a few key crops. In retrospect, Center management clearly made the right decision. CIAT researchers did achieve impressive results, and these have benefited millions of small-scale farmers and urban consumers in the last 25 years. The scientific literature contains many studies documenting the gains from improved crop technology in Latin America and beyond.

Some of these studies resulted from my subsequent work as a rice economist. Shortly after my meeting with the director general, the leader of CIAT's rice research, Peter Jennings, offered me an opportunity to study the impact of the new varieties his team was developing.

In management's shoes

Almost a quarter of a century later, I assumed the directorship of CIAT. A few years earlier, my predecessor, the late Gustavo Nores, had taken the bold step of launching a major initiative for research on natural resource management at the Center. He led the preparation of a strategic plan that called for the integration of research on crops and natural resources to promote growth in agricultural productivity, more equitable sharing of its benefits, and preservation of the natural resource base.

In 1996 we began preparing the Center's medium-term plan for executing this strategy in the period 1998-2000. To accommodate a budget shortfall, it was tempting to eliminate whole areas of CIAT's integrated program. Many people urged me to do just that and return to the four-commodity focus that had served the Center so well in the 1980s. Instead, we found ways to preserve the main elements of our strategy and the key capacities needed to carry it out.

Why was this decision—which seemed diametrically opposed to the one that changed my career in 1973—the right way to go in 1996? Three reasons stand out among the rest.

First, we address complex problems today that were not on the agenda two decades ago. The spread of new technology that enabled farmers to intensify crop production has also strained the natural resources on which they and others depend. To find ways of simultaneously increasing productivity and preserving the environment requires an integrated research portfolio that ranges from the genetic improvement of staple crops to the management of whole landscapes.

The second reason is that we now have extraordinarily powerful tools—molecular techniques and geographic information systems, to name but two—that better enable us to deal with complex new challenges.

And third, the decision CIAT took 25 years ago has resulted in a solid record of achievement that helps us face those challenges.

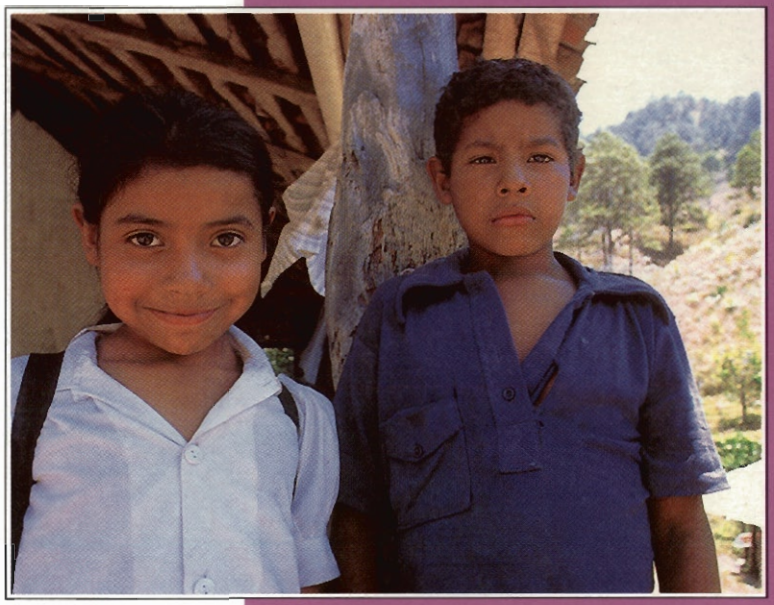
Conditions for success

In moving forward with our integrated approach, we are aware of two major conditions for its success.

First, we must develop new approaches for exerting and measuring impact. A big part of the challenge is extrapolating the results of natural resource management from "benchmark" sites to other places with similar characteristics. As explained in the following essay on our work in hillside environments of Honduras, we think the answer lies in developing widely applicable tools that better enable others to analyze options, solve problems, and assess progress.

Second, as stated in *Doing Research Together: CIAT's Medium-Term Plan 1998-2000*, we must continue to broaden our array of partners. Strategic alliances are vital for bringing the necessary research capacities to bear on the complex problems of people living in less favorable environments of the tropics. One place where we work toward this end is Pucallpa, Peru, which represents tropical America's extensive forest margin agroecosystem. Our cooperative work around Pucallpa is described in a subsequent section of this report.

Much of our work in Pucallpa and Honduras takes place under the umbrella of the Ecoregional Program for Tropical Latin America. This is one of the systemwide programs created by the Consultative Group on International Agricultural Research (CGIAR). It provides a platform for CIAT's collaboration with national programs and international centers in our home region.

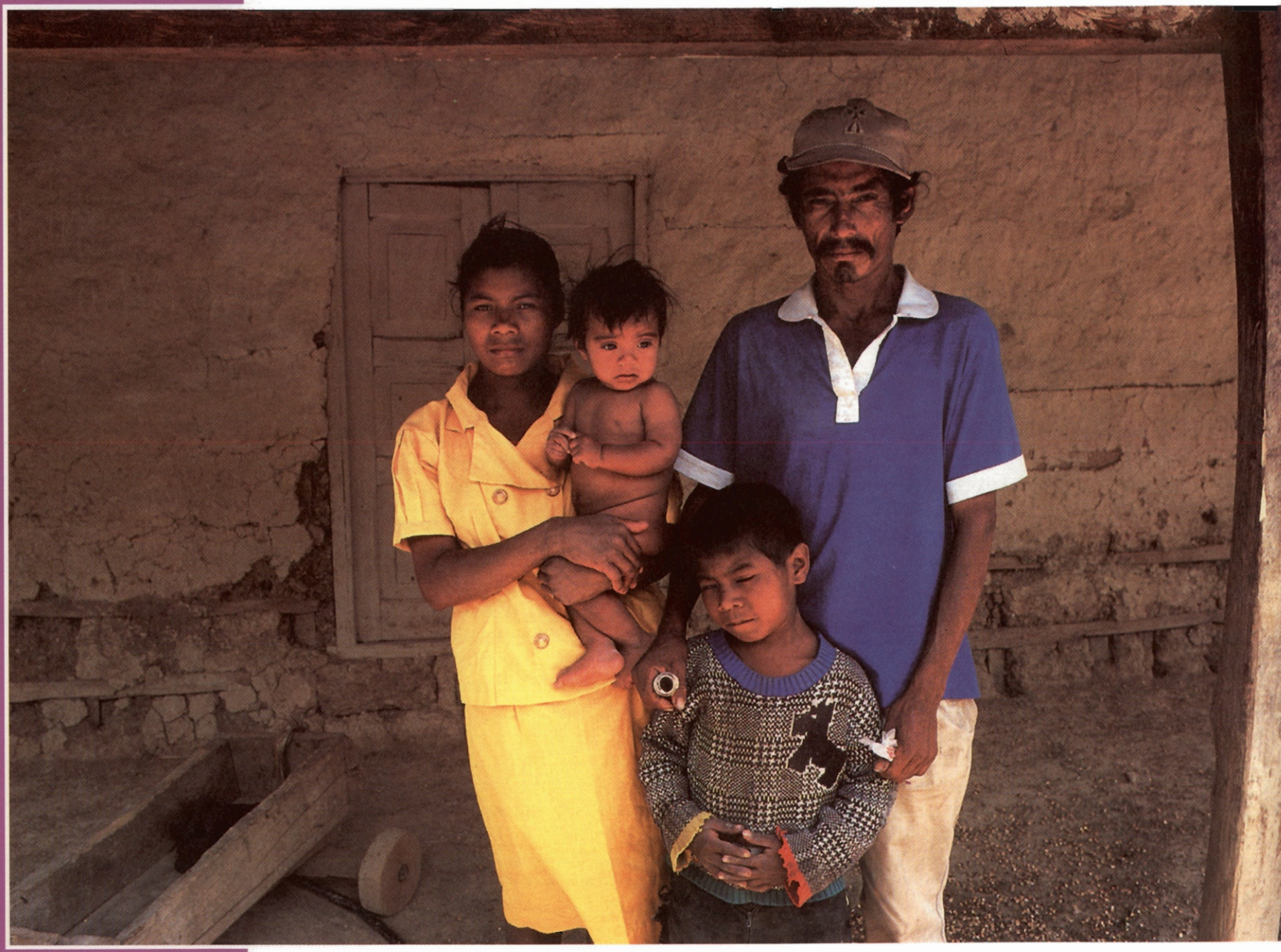


Two other systemwide programs that we coordinate—Soil, Water, and Nutrient Management (SWNM) and Participatory Research and Gender Analysis—are strengthening the Center's global projection, which originated in our crop improvement research. Nearly a third of CIAT's resources are now devoted to sub-Saharan Africa and Southeast Asia. As shown later in this report, our work for those regions is producing exciting results and impact.

Though much remains to be done in the endeavors we describe here, we know you will find solid evidence that we took the right decision in 1996, that our integrated approach is effective, and that we are truly "doing research together."

"Activities are a means to an end, not an end in themselves. That is why we seek to measure impact in terms of changes in the lives of people—changes that are associated with what CIAT does."

Lowell Hardin, Former CIAT Board Member



Tools for Development in the Honduran Hillsides

In Honduras the dry season's last rainless days are a signal for farmers to burn their fields in preparation for planting. The result is a nationwide smoky pall that reaches indiscriminately into city apartment and adobe farmhouse.

This is a place where the synergies of poverty and environmental degradation are vividly apparent. Honduras is one of the poorest countries in Central America; almost half of its people live on less than US$1 per day. Acute poverty pushes a rapidly growing rural population deeper into the hillsides, where farming on steep slopes results in soil erosion and deforestation, threatening the productive capacity and ecological integrity of fragile environments.

"The World Bank identifies an important concentration of the absolutely poor rural people of tropical America on the hillsides."

Janet Townsend,
Lecturer in Geography,
University of Durham, UK

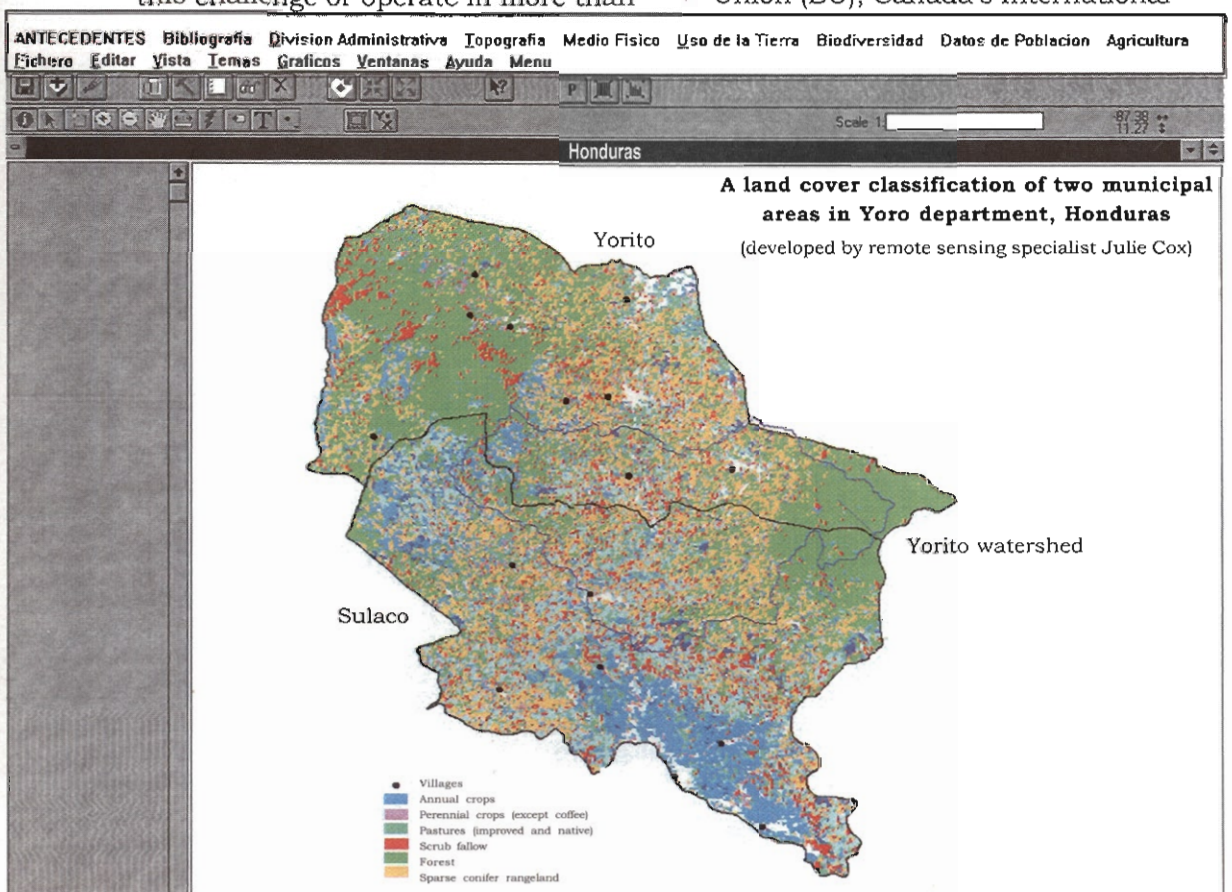
What We Can Do

A strategy for integrated agricultural research

What can we do about the dilemmas faced by rural communities throughout Honduras and the rest of Central America? How can agricultural science help these people find new paths of development that will lead them out of poverty and reverse the degradation of their natural resources?

Obviously, no single institution, especially an international center like CIAT, can grapple with all aspects of this challenge or operate in more than a few places at a time. What we can do, however, is work in an integrated fashion with a wide range of research partners at carefully selected sites. The products of this work are decision-support tools, analytical methods, farmer participatory approaches, and prototype technologies that can be extrapolated to other, similar places, providing local organizations with new ways to solve problems.

That is the strategy CIAT is pursuing with financial support from the Swiss Agency for Development and Cooperation (SDC), the European Union (EU), Canada's International Development Research Centre (IDRC), the Inter-American Development Bank (IDB), and the Ecoregional Fund to Support Methodological Initiatives, which was set up by the government of the Netherlands. In concert with the Inter-American Institute for Cooperation in Agriculture (IICA), the International Maize and Wheat Improvement Center (CIMMYT), several national institutions, and numerous community organizations, we are developing an array of widely applicable research and development tools. The work centers on several watersheds that form a continuum from northern Honduras into Nicaragua, but it makes connections between those sites and other, similar places in both countries.



Adding Value to Information

Decision-support tools for improved land management

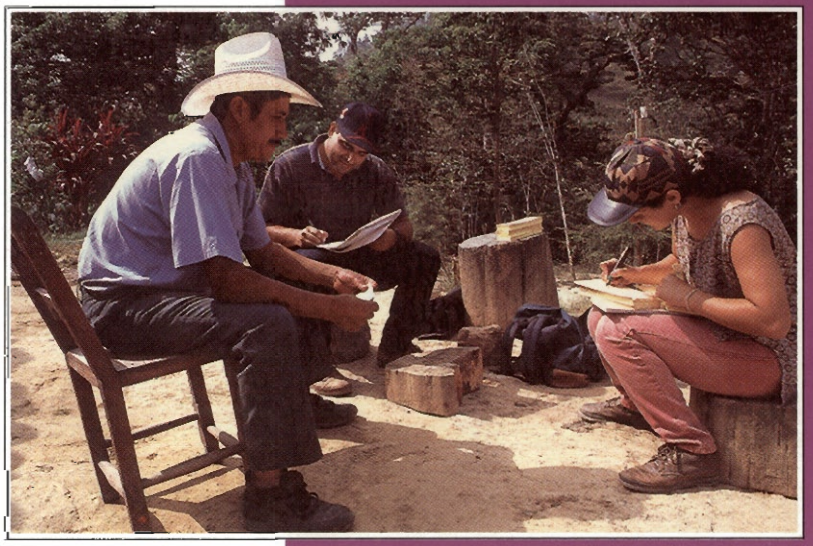
One set of tools that is proving extremely valuable for advancing agricultural research and development is GIS, or geographic information systems. With these, specialists in various disciplines can now bring

GIS enables people at the local and national levels to examine land use issues in watersheds. These are a logical focus for collective efforts to improve natural resource management.

together and analyze information from a wide range of sources to deal more effectively with a myriad of issues in developing-country agriculture.

GIS has a bright future—both for community decision making and for designing development policies and strategies at the national level. These tools present many types of information, often in map form, with diverse layers of data represented by different colors and patterns. One practical application of GIS is for targeting areas where people and their natural resources are at risk. Another is to aid the extrapolation of technologies from areas where they have already succeeded to other locations having similar needs and characteristics. When integrated with modeling programs, GIS allows users to examine multiple "what-if" scenarios and choose among likely outcomes.

Soil scientist Héctor Barreto, who has a joint CIAT-CIMMYT appointment and is based at Tegucigalpa, works in collaboration with the GIS team at CIAT headquarters in Colombia. Under the direction of agricultural geographer Peter Jones and GIS specialist William Bell, the team is entering a cornucopia of knowledge, much of it supplied by collaborating national programs, into various databases. The data include facts about climate, topography, drainage, soils, land use, socioeconomic data on the people who live in hillsides, and information on economics, from input costs to market accessibility.



Much of the information is already available on laptop computer programs that Barreto can show to fellow agricultural researchers, officials of nongovernment organizations, and community leaders. For example, in a database on the department of Yoro in Honduras, Barreto moves through overlays that depict various aspects of land management. "GIS allows us to discriminate among hillside environments that used to be considered essentially homogeneous," he says. "Now, we have the means of targeting areas for specific agricultural enterprises and technologies."

Carlos Machado, an IICA scientist, is a strong believer in the GIS effort. He recently saw one of Barreto's demonstrations at a meeting of research institutions convened to draw up a new Honduran plan for science and technology. The attending scientists, he says, "saw that land use bears little relationship to political

"The project does not compete with other actors on the scene but rather offers them valuable inputs into their own work."

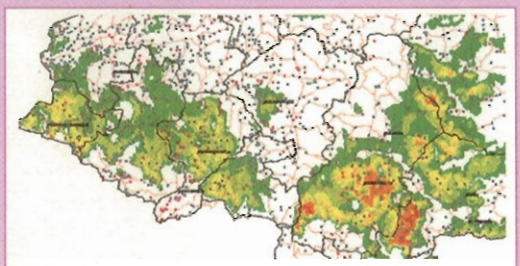
From the report of an external review commissioned by the SDC

boundaries." Rather, the maps were focused on watersheds. "The power to manage a country's natural resources, to shape its future, now depends very much on having this kind of information," he says.

By enabling scientists to examine land use issues at the watershed level, GIS helps them overcome major limitations of previous agricultural research, according to CIAT soil scientist Ron Knapp. "We've always done a lot of work at the level of individual farmers' fields," he says, "but we lacked a way of relating this work to what was happening at higher levels in the surrounding landscape." Having that ability is vital for reconciling increased agricultural productivity with improved resource management in hillside environments.

GIS provides the foundation for a number of tools that will help the Center and its partners accomplish precisely that. One tool relates to CIAT's mandate to conserve and use the genetic resources of domesticated and wild beans (see box). Our germplasm specialists are using GIS to locate areas where there is a high probability that samples of particular plant species may be found. Another example is the digital atlas Barreto has assembled, a tool with an impressive ability to facilitate a wide range of decisions about land management.

The beans that were not there



In red areas it is highly probable that wild *Phaseolus* occurs. Blue dots are for towns with high population growth, which may threaten biodiversity.

When germplasm specialist Stephen Beebe went on a recent trip to Honduras, he packed a map that would help him predict the whereabouts of wild beans in the field.

If seed of a particular species have previously been found in a place with a certain combination of climate, soil quality, elevation, and other conditions, one might assume that additional samples could be found in similar, unexplored areas. That is the basic assumption underlying a powerful new GIS tool that better enables researchers and policy makers to pinpoint areas of biological diversity—an important first step in identifying threats to this resource and in planning programs to better protect and use it.

But this time the model seemed to have failed. After days of finding wild germplasm just where the map predicted, Beebe headed for another area of "high probability." The map said there would be wild beans on hand, but the scientist's eyes and experience told him otherwise. "This is not right!" he told himself. "There's something wrong."

Passing farmers confirmed that there were no wild beans where the map said they should be. But he could find them over there—the farmers indicated an area a few kilometers away.

When Beebe returned to CIAT headquarters, he reported the incident to Peter Jones. The agricultural geographer laughed and told his colleague that during Beebe's absence he had learned that the temperature data on which the map was based were off by a significant factor. The data had been corrected, and a new map had been generated. It indicated a high probability of finding wild beans precisely where the farmers had said they could be found.

Barreto agrees with Jones and Bell that GIS cannot become a decision-making tool on its own but that it has a marvellous ability to provide high-quality information for those who do make the decisions. "By producing a general GIS description of an area—say, a watershed—we can empower groups representing farmers to make their own decisions on a more informed basis," says Jones. "We intend to format these GIS products into simple software that's cheap and easy to run on a PC, so farmers cooperatives or NGOs working in a particular valley can have all that information at their fingertips, and people can actually interact with it."

Targeting Rural Poverty

A new method for focusing agricultural projects

Rural poverty is one of the forces associated with land degradation. To deal effectively with both problems, we must therefore know, not just where natural resources are at risk, but where the people who manage those resources are at risk. Without such information researchers and development specialists, as well as international aid agencies, lack a firm basis for deciding where and how to focus their limited resources.

Helle Munk Ravnborg, a Danish rural sociologist at CIAT, thinks there is more to the poverty equation than the usual statistics on income and expenditures. Poverty is not a static condition, one that kicks in when income falls below a certain point, but rather "a multifaceted predicament," she says.

Ravnborg has developed a practical method for assessing rural poverty in regions where small-scale agriculture predominates. She has tested the method in Colombia and is now applying it in three study areas in Honduras, thanks to support from IDB and the Danish International Development Agency (Danida). The method uses a "well-being ranking" technique to gain a fuller understanding of poverty as rural people themselves perceive it. The method translates this understanding into a series of indicators that can be measured quickly and cheaply over large areas to give a comprehensive poverty profile.

A crucial step in the method is the selection of communities. For this purpose Ravnborg chose six factors that might give rise to different perceptions of well-being across communities. These were elevation, population density, ethnicity, gender composition, public services, and

"Before, this was all Chinese to me, but now I can actually use geographic information to aid strategic decisions about the coffee sector."

Franklin Osorio, Technical Adviser, Honduran Coffee Institute

"Institutional strengthening through working alliances is a central theme of CIAT's collaboration with IICA."

Carlos Machado, Science and Technology Specialist, IICA, Honduras

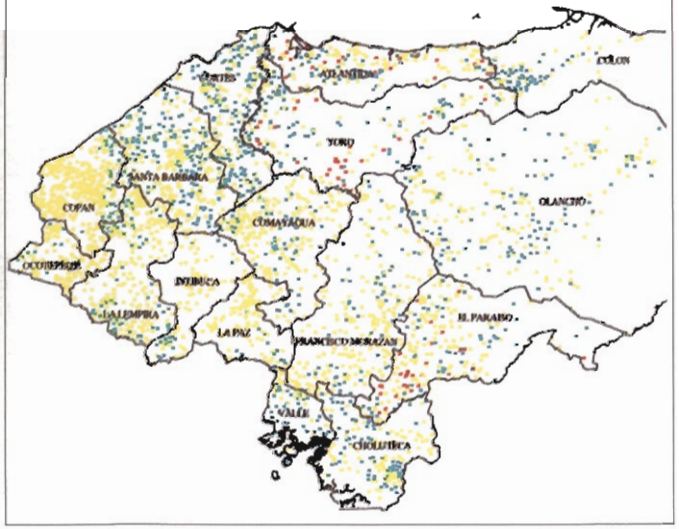
accessibility by road. Then, surveys were conducted in 90 contrasting communities. "If we find significant overlap in the core indicators of poverty that the different communities identified, then we have a basis for extrapolating the indicators to other places in Honduras that are similar to our sample communities," explains Ravnborg. The statistical analysis done so far shows that the overlap does exist.

Field researchers Rosa Mercedes Escolán and Carlos Fernando Mendoza have been carrying out the well-being ranking in Honduras. First, they approach community leaders to get a complete set of residents' names. In one such visit, a leading farmer gives them 72 names, which they write on yellow index cards. From the list, they select a number of informants to visit, based on age, occupation, and ethnicity. They ask informants to sort the cards into piles and then to describe the households in each pile.

It is apparent that the respondents are sorting their neighbors (without using their individual names) into three or more categories, from the highest to the lowest level of well-being. In listing the characteristics of those in each category, the respondents present their own perceptions of poverty. Back at the CIAT office in Tegucigalpa, Escolán and Mendoza enter their findings in a database; a definition of poverty gradually emerges that is translated into quantifiable indicators, based on rural people's perceptions.

In addition to mapping poverty, our scientists are assessing people's natural resource endowments and their resource management in Honduras. The result will be a comprehensive geographic information system that helps CIAT and other organizations target people and resources at risk.

Extrapolation of poverty indicators in Honduras



The red dots in this map indicate 90 Honduran communities for which poverty indicators were derived. The blue dots are for communities to which the indicators could be extrapolated, and the yellow dots indicate those for which extrapolation is not possible.

Although much technology has been developed to reduce poverty and halt land degradation, it often does not reach the farmers who need it most. With new methods for targeting the most vulnerable rural people and environments, organizations in Honduras will be better able to ensure that suitable agricultural technologies are directed to them. Among other benefits, the poorest farmers should gain improved access to new maize germplasm developed by CIMMYT and its collaborators and bean germplasm from the longstanding Regional Bean Program for Central America, Mexico, and the Caribbean (PROFRIJOL), which is coordinated by CIAT and financed by SDC.

Seeing the Bigger Picture

Strategic research on leguminous cover crops

For another type of technology —leguminous cover crops that help intensify agriculture—Center scientists are developing tools that will facilitate their integration into different production systems. The advantages of these species—particularly their ability to provide more nutritious food for livestock, create new sources of green manure, recycle nutrients, and retard soil erosion—are especially important in less favorable agricultural environments, such as the steep Central American hillsides.

"The law of erosion control," according to Ron Knapp, "says to keep vegetation covering the ground." One legume that has proved useful for this purpose is *Mucuna* sp., which under some conditions has worked well in rotation with maize. Héctor Barreto and research assistant Luis Brizuela are testing different ecotypes of *Mucuna* at varying altitudes in northern Honduras and measuring different indicators of their performance, such as the accumulation of biomass, or dry organic matter. Their research shows that when biomass falls beneath a certain level, *Mucuna* cannot do a good job of protecting the soil.

To determine which ecotypes perform best and under what conditions, Barreto is working closely with rural communities. Some time ago he distributed 32 collections of *Mucuna* among cooperating farmers. "Doing research with farmers is extremely important," says Knapp, "because they are experts in adapting new technology to specific situations."

But international agencies such as CIAT are able to see (literally, in the case of satellite-generated images) the bigger picture—one that extends beyond an individual's property boundaries to entire watersheds and regions. Using GIS, Barreto and his colleagues are analyzing agroclimatic and agronomic data on the performance of *Mucuna* and other cover crops. In combination with insights from farmers' experience, this information will better enable local groups to determine how and where they can introduce these species into current cropping systems.

To provide local institutions and community groups with a wider range of new options, CIAT scientists are also evaluating various forage grasses and legumes with farmers at four sites in the department of Yoro. "Because livestock are one of the few ways these farmers can earn and save cash," says research assistant Edy López, "they are eager to obtain new species that will make their animal production more efficient." New forages offer other advantages as well, serving as barriers against soil erosion, as soil covers, and as green manures.

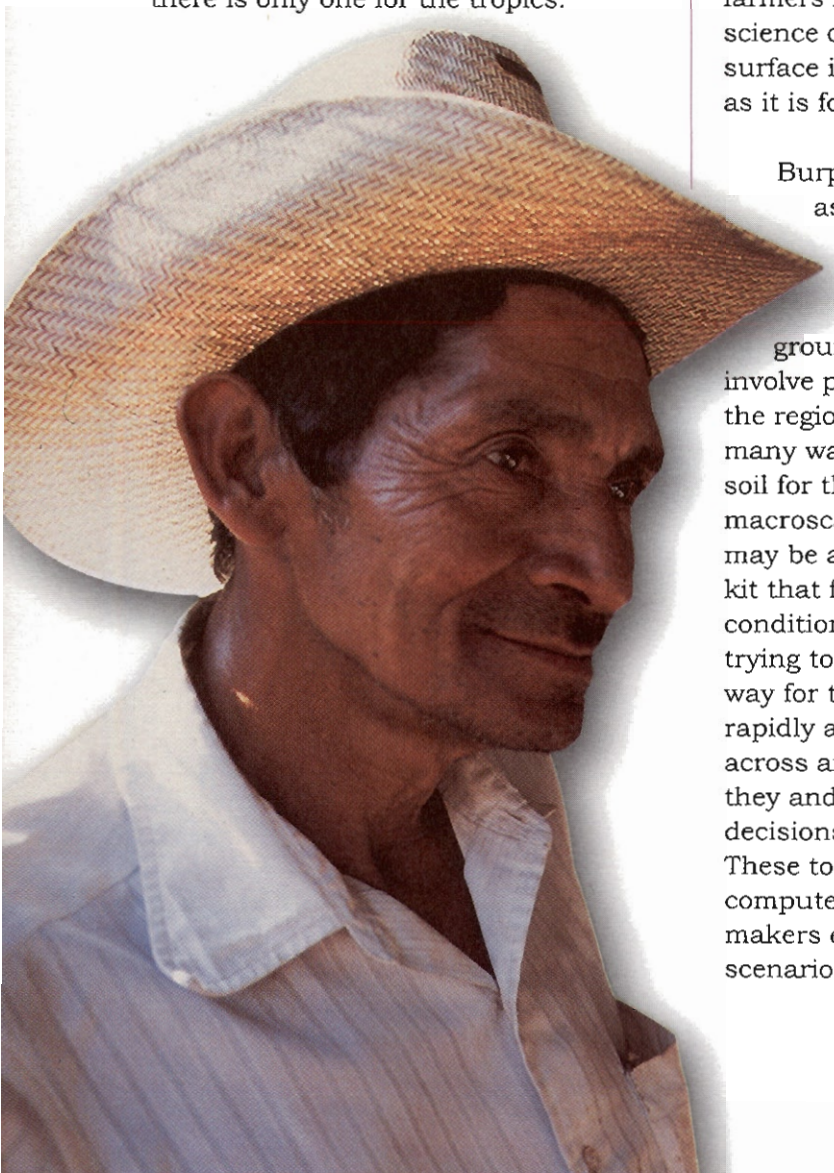
"The project is highly relevant to our efforts to improve livestock production through improved pastures. For that reason we wish to initiate technical cooperation with you this year."

José Montenegro, Executive Director, Directorate of Agricultural Science and Technology (DICTA), Honduras

Artisans of the Soil

Soil-quality field kits for small farmers

There is a statistic that CIAT soil scientist Gaye Burpee cites often: for every one thousand soil scientists in the temperate regions of the world, there is only one for the tropics.



Gaye Burpee is one of the one. She is committed to improving soil quality in the tropics but faces two big obstacles. First, soil management is a site-specific issue, so the work of the lone scientist must be spread across many communities, valleys, and hillsides. And, second, although farmers make their living from soil, the science of what goes on beneath the surface is a mystery to many of them, as it is for most people.

Burpee is using information assembled in the form of databases, aerial photos, and satellite imagery to work more effectively on, or in, the ground below. That work does not involve prescribing solutions in each of the region's watersheds; there are too many watersheds, too many types of soil for that. Rather, Burpee is using macroscale maps to identify soils that may be at risk and is constructing a kit that farmers can use to assess the condition of their soils. "What I'm trying to do," she explains, "is find a way for the farmers themselves to rapidly and easily characterize soils across an entire watershed, so that they and others can make better decisions about land management. These tools can also provide data for computer models that help policy makers examine different land use scenarios."

The soil-quality field kit has two elements. One is a self-scoring questionnaire farmers can use to rate their soil's quality. The other, which Burpee is now assembling and testing, includes two sets of simple tests that community organizations and farmers can use to learn more about their soil: its density, pH, water infiltration, compaction, aggregate stability, microbial activity, earthworm population, and susceptibility to erosion.

One of the tests for erosion is the very essence of "low-tech." It requires a long nail and a washer. The farmer slips the washer on the nail and pushes the nail partway into the surface of a slope. The washer rests on the ground. The farmer measures the distance between nail head and washer at the outset and then at weekly intervals. If the distance increases, erosion is taking place. A somewhat more complex technique enables local technicians to estimate soil loss.

The aim, as in CIAT's other undertakings in Central America and beyond, is to show how farmers and local organizations can be equipped with tools to make their own informed decisions about the often explosive interface of agriculture and natural resources. "Ultimately," Burpee says, "we hope that farmers themselves can test their soils, compare notes, and

form a clear picture of resources throughout the whole watershed." Then, the farmers will be armed with enough information to carry the process a step further: to experiment with cover crops or other innovations and find out how best to halt erosion, improve soil quality, and make cropping more sustainable.

Scientific Communities

An experiment with farmer participatory methods

To find lasting arrangements for involving farmers in this and other research, CIAT is experimenting with participatory methods for Honduras and other countries of Latin America. Our scientists have understood the value of such methods for a long time. Jacqueline Ashby, the Center's director for natural resources and a pioneer in the field of farmer participation, sees this collaboration as an essential part of CIAT's integrated approach to solving problems in agricultural production and natural resource management.

"In the real world, decisions are made using an integrated approach," she says. "Farmers have to decide, for example, what variety to grow and whether to plant it in the same plot or open up the forest to create a new and more fertile field. Scientists may develop a better crop variety, but they alone can't decide where and under what conditions the variety should be grown. Making these choices involves a partnership," says Ashby. "It can't be just the scientist who makes the choices, and it can't be just the policy maker. Somebody else has to be integrated into the making of choices, and that's the end user—the person who, in addition to growing crops, sometimes cuts down trees and erodes the soil."

In work supported initially by the Ford Foundation and then by the Kellogg Foundation, CIAT has been assessing factors in the successes and failures of an approach that organizes farmers into CIALs, or Committees for Local Agricultural Research. From five pilot committees in Colombia, the CIALs have spread to more than 200 committees throughout Latin America as if, in Ashby's words, "by spontaneous combustion."

"Unless you participate, you can't obtain new knowledge."

Mauro Rivera, Farmer, Honduras

Women in action

Four of the 28 Committees for Local Agricultural Research (CIALs) established so far in Honduras are active in the watershed of the Tascalapa River. One of these four is run entirely by women in the town of Sulaco.

To form a CIAL, the community selects four farmers known for their interest in innovation to lead the group. With help from an extensionist or facilitator, a community brainstorming session produces a diagnosis of the area's needs. Next, the extensionist helps the CIAL identify a menu of possible actions, their benefits, and the trade-offs. The community evaluates the options and sets the committee's research agenda. The CIAL carries out the resulting experiments, using petty cash from a rotating fund, and then reports back to the community. The extensionist, who may have been invaluable in the beginning, withdraws gradually from the process as the community starts conducting research on its own.

The Sulaco CIAL, which its members have named "Women in Action," decided to conduct research aimed at identifying the best cassava varieties for local conditions, explains the group's president, Ana Rosa Estrada. These women depend on cassava to extend their supplies of maize flour in times of shortage. They established a test plot near one of their homes and planted six varieties of the starchy root crop. One was the local favorite. Midway through the experiment, the local variety seemed to be doing best, but the women were not jumping to conclusions. In the manner of true researchers, they planned to record the yields at harvest and compare them with other factors, such as taste and texture. When they have found the best varieties, they will make recommendations for the rest of the community.

But they definitely will not go out of business when that task has been completed. Already, says Estrada, members have suggested further experiments with carrots and other vegetables. "We want to expand," she says.

Many groups are now promoting farmer participation in research in Central America. It helps when a regional organization serves as a liaison with local groups. Such is the case with the Project for Participatory Research in Central America (IPCA). IPCA receives funds from the University of Guelph in Canada and support from CIAT. In the project's first year, Center staff provided training in the CIAL methodology for 18 people from a dozen different Honduran institutions.

IPCA's Juan Ramón Gonzáles explains that the newly formed community organizations have different research agendas and goals (see box). But all have two things in common: they promote sustainable agriculture, and they represent small farmers in hillsides. "They're thrilled when something comes along that offers a break with the traditional pattern of no change," says Gonzáles.

The Community in Charge

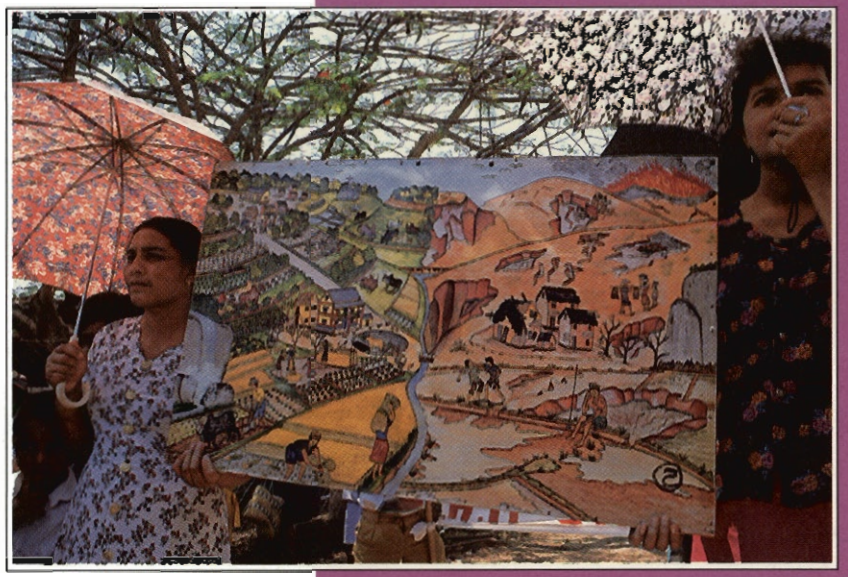
An association for resource management in a hillside watershed

Sometimes this break takes the form of a public demonstration, like the recent march to protest environmental degradation in the town of Yorito in Yoro department.

Hundreds of people, many of them school children, turned out for the march on a hot Friday toward the end of the dry season. The children wore homemade animal masks and carried signs that demanded the protection of animals and nature, especially against fire. "Protect the forests!" said several. Homemade floats on truck beds depicted a watershed in miniature. Half of one float was green and full of lush foliage, and figures of wild animals ranged through the "woods." The other half had been ravaged by a simulated fire. The float passed through a nonsimulated blue haze in the air around Yorito, caused by the widespread burning of cropland in preparation for the new growing season.

The march in Yorito was coordinated by a recently formed group called CLODEST, or the Local Committee for Sustainable Development in the Watershed of the Tascalapa River. It is made up of organizations from scientific, educational, religious, and other fields, and it receives technical assistance from CIAT and IICA. The consortium coordinates the efforts of 19 local organizations to find new ways for local communities to increase agricultural productivity and incomes, while preserving natural resources.

Here and elsewhere in Central and South America, the experiences of the CIALs and organizations like CLODEST are proving that participatory methods do work. Hector Barreto says he is optimistic about their contribution to technology development and watershed management.



At first, he says, local meetings were organized, so that farmers could talk about their problems and propose solutions. "We led some of the meetings early on," he notes, "but then we withdrew a bit to see if they would meet on their own. We didn't want to become indispensable to the group. And they actually organized themselves better and with greater participation. With the community itself in charge, the leaders of today and tomorrow started playing bigger roles." The lesson is clear, says Barreto: "the community must do the work. The decision-support systems and other tools that CIAT is developing for organizations like CLODEST are drops of oil in a big machine."

"The dignity, determination, and remarkable humor of the Central American people must be taken as a cause for hope."

John Booth, University of North Texas, and Thomas Walker, Ohio University, USA

A Menu of Options for the Peruvian Amazon

The Ucayali River would seem to be the undisputed boss of much of the Peruvian Amazon. But the region of the Ucayali has other masters, too. Originally, they were the region's indigenous peoples, who still derive their livelihood from the river and surrounding forest. But the new masters are colonists who came from the Andes and the Pacific coastal region and settled near the frontier town of Pucallpa.

Thanks to policies that encouraged settlement and clearing of land for agriculture and to a highway that opened the region to commercial exploitation, the frontier has become a battleground of people against their natural surroundings.

"Colonization tends rather to extend the rural slum than create the stable farm family beloved of many government agencies. The exciting resource frontier becomes a mere misused periphery."

Janet Townsend,
Lecturer in Geography,
University of Durham, UK

Why Pucallpa?

A good candidate for integrated agricultural research

The Pucallpa region is typical of a frontier area in the Amazonian rain forest that is threatened by deforestation, biodiversity loss, and land degradation. The damage is nondiscriminatory: it threatens the livelihoods of indigenous people, as well as the colonists who came for a better life; it harms Peru's economic and environmental interests; and through the consequences of huge carbon emissions, it even jeopardizes the environmental health of faraway nations.

CIAT is one actor in a long-term, interdisciplinary, multiagency effort in the Pucallpa region. Its purposes are to gauge the damage that has been done, establish why it is happening, identify ways to turn land degradation into sustainable land management, and then extrapolate the technologies and tools that make this possible to other forest margin areas.

Why should this effort be focused on the river community of Pucallpa? One obvious answer is the highway that links Pucallpa, a city of 332,000 and the oldest human settlement in the Peruvian Amazon, across the Andes to Lima (see box). Another is CIAT's long history of conducting research around Pucallpa; the Center has been testing tropical forage germplasm in the acid soils of the forest margins and evaluating alternative fallow systems since the early 1980s.

There is quite a difference between the commodity-based research of that period and the work now under way. The current effort is an example of CIAT's integrated approach to research on crop

The importance of a road

When the bumpy road connecting Pucallpa to Lima was improved in the 1960s and 1970s, the result was more than just a highway project. An environmentally vulnerable section of rain forest was opened for settlement by colonists, most of whom had no experience in the humid tropics and many of whom knew little about farming. An 813-kilometer pathway from Peru's largest city was opened right to the muddy banks of one of the Amazon River's main tributaries. Suddenly, there was better access to 56 million hectares of Peruvian Amazon forests, about 43 percent of the nation's land surface.

Several waves of people descended on Pucallpa and its environs, fleeing the cities and high Andes and encouraged by government policies that promoted settlement and deforestation. The traditional method of turning forest into farmland—slashing the vegetation and burning it—continued, but with an important difference: fallow periods were truncated, hastening environmental degradation.

With what seemed to be an endless supply of land available, colonizers moved through a series of promised "booms," most sweetened by subsidies. There were promises of quick wealth from rubber extraction, timbering, citrus fruits, and finally cattle production. Where settlement before had followed the rivers, the new people built their modest homes along the Lima road. When they required more land because they had obtained more cattle or their existing cultivated land had grown infertile, they pushed back the forest some more.

In the 1980s and 1990s, terrorism throughout Peru slowed the pattern of growth, as did trafficking in illegal drugs. But with the virtual elimination of the Shining Path guerrilla movement, settlement is rebounding, even though subsidies were withdrawn.

The settlement and its intensity can be clearly seen in a GIS-produced map

improvement and natural resource management, which blends the expertise of soil scientists, ecologists, an anthropologist, geographers, and experts in forages and livestock.

These CIAT scientists are part of a wider effort that includes other international centers—notably the International Centre for Research in Agroforestry (ICRAF)—national research organizations, and other groups. The Consortium for the Sustainable Development of Ucayali (CODESU), whose members include government and nongovernment organizations, provides an institutional umbrella for this effort. The Consortium is supported by Canada's International Development Research Centre (IDRC).

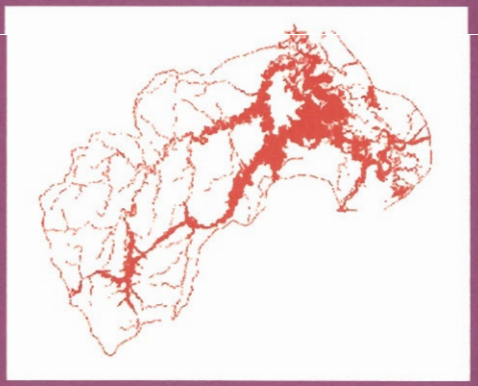
One aim of the work around Pucallpa is to understand the dynamics of deforestation—to determine how badly the forest margins have been damaged and why. As in Honduras, a prime tool for this purpose is geographic information systems (GIS), which are used in conjunction with diagnostic surveys.

that CIAT and other agencies use in Pucallpa. Published by the Institute for Research in the Peruvian Amazon, the map employs aerial photograph data collected as early as 1955 and again in 1974, 1981, 1989, and 1995 to depict the advance of deforestation. At first human settlement ran in a thin corridor along the sides of the Lima road. Deforestation proceeded slowly, at a rate estimated to be less than 5,000 hectares a year between 1940 and 1974. Successive map overlays show dramatically how the forest margin has been pushed farther and farther back from the main road for many kilometers west of Pucallpa. After 1974 deforestation rates increased rapidly, to 20,000 hectares a year during the 1980s.

Deforestation in the Ucayali region of Peru, 1955-95

(Source: Institute for Research in the Peruvian Amazon)

1955



1981

1995

Sam Fujisaka, a CIAT agricultural anthropologist, says that images collected by remote sensing can give researchers in Pucallpa insights they could never get from interviews with farmers. One is the "analysis of deforestation as a function of distance from the roads." When maps showing such information are overlaid with maps showing property boundaries, GIS can reveal deforestation per parcel for the entire area, a feat never before feasible. But since remote images are not very good at distinguishing among various sorts of agricultural uses, they must be checked on the ground in a process called "ground truthing," which is employed also in the Center's work on hillsides in Honduras.

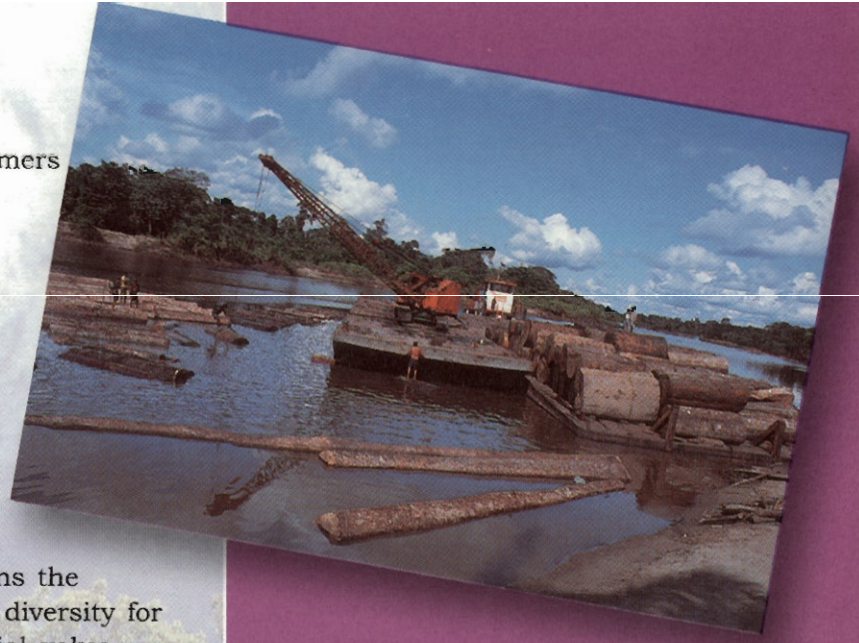
Putting a Value on Biodiversity

A study on farmers' views about forest preservation

Research conducted by CIAT indicates that settler-farmers look more kindly on the forest than is commonly thought. Agricultural economist Joyotee Smith surveyed farmers in the region to determine what compensation they would require as an incentive to adopt more sustainable

land use practices. The study concluded, writes Smith, that "contrary to the conventional wisdom, slash-and-burn farmers appear to place a high value on forest preservation." Among other findings were these:

- Almost all the farmers surveyed said it was important to preserve forests. The environmental services performed by forests are "a common element of local culture and a part of farmers' shared knowledge."
- Three-quarters of the farmers demonstrated some knowledge of other environmental services provided by forests, such as purification of the air (mentioned by most), shade, soil improvement, and stabilizing influence on climate.
- At first few farmers listed among their considerations the preservation of biological diversity for possible future commercial value. But when they received information on the subject, their interest increased notably.



"Between 60 and 80 percent of all the species on earth are found in 8 or 10 countries with megadiversity, of which four countries of the Amazon are privileged to be included."

From **The Cultivation of Native Amazonian Fruits: A Manual for Extensionists**

- Farmers said they were willing to forgo US$40 to $70 in potential income per hectare to sustain the environmental benefits of the forest.

Smith notes that CIAT's survey provided "an optimistic note within the generally pessimistic scenarios on tropical deforestation." She suggests that farmers in the Ucayali region might be candidates for participation in a global environmental market in carbon emissions. In such markets a developed country that has promised to reduce carbon emissions purchases "carbon offsets"—in effect, pollution rights—from a developing country. The polluters can do this by funding reforestation projects. The deal can take place between governments or between a polluting industry, such as a utility company, and farmer associations.

Buying Time

The search for alternatives to slash and burn

Research conducted in the Pucallpa region suggests that, with the right incentives, settlers who ordinarily practice slash-and-burn agriculture will be disposed to change their ways. But, as shown by other studies, clearing and pasture establishment increase land values, giving these farmers a powerful financial incentive to clear more forest. So, what can be done for the farmer who may value biodiversity, but who is too poor to afford the luxury of conserving it and has compelling motives to do just the opposite?

The answer lies, not in a single dramatic prescription, but rather in a menu of technologies and policy options. Sam Fujisaka points out that Peru's years of political and economic instability left a lot of land around Pucallpa that is degraded and underused. The Center and its collaborators now have an opportunity to "buy time," he says, by demonstrating better ways to use the already deforested land.

To identify appropriate technologies and policies, we need to understand the dynamics of current land use. Toward this end Fujisaka has surveyed settler-farmers in cooperation with Peru's National Institute of Agricultural Research (INIA) to determine their own assessments of land use. He is analyzing the results in conjunction with satellite and radar images of land use from 1972 to the present. At the same time, he and ICRAF scientists are studying indigenous people's knowledge of forest biodiversity to gather new information about the value of this resource that could encourage farmers to protect it (see box). Fujisaka is also quantifying the effect of forest clearing on carbon emissions and biodiversity.

Carbon dioxide, explains Fujisaka, is a major product of forest burning. It is also a major constituent of greenhouse gases, which trap heat and warm the earth's surface, leading to what a majority of scientists believe is increasing global warming.

Fujisaka is estimating the amount of carbon emitted by deforestation, as well as the effect of different agricultural land uses on biodiversity in the Ucayali area. In previous work in Rondônia, Brazil, he concluded that more than 93,000 hectares of forest had been converted to agricultural land over 20 years, with a loss of

A river of knowledge

The Ucayali River is another, older highway, one that attracted settlers of a different sort than the road to Lima. Today it attracts CIAT researchers, too. In addition to travelling the road west of Pucallpa, they head down the river and its tributaries to visit indigenous communities. There, they are learning more about the value of plant species that are not as well known to agricultural science as cassava, beans, rice, and maize.

One of the communities, Calleria, is situated on the river of the same name, about 3 hours from Pucallpa by fast motorboat. There, scientists have begun assembling an inventory of the plants that Calleria's 513 residents find useful for many purposes. To start, CIAT and ICRAF scientists are asking the residents what they call the plants and how they classify them.

Why are these researchers asking indigenous people about plants that are little known to the rest of the world? Sam Fujisaka explains: "local organizations are looking for ways to decrease deforestation for the social benefits of preserving biodiversity, maintaining forest functions, and reducing carbon emissions. One possible way is simply to learn more about the value of the standing forest. And that can be done only with these indigenous groups." The more recent settlers, he says, are much less knowledgeable about the plant species around them.

CIAT and its research partners feel that once market opportunities have been identified for locally important species, both indigenous peoples and colonists will recognize their value and seek to generate income from them. Thus, they will be less likely to slash and burn the species to make way for crops and animals, as they do now.

"Our focus is on people, but we also seek rational long-term management of the primary forest."

Alfredo Riesco, Executive Director, CODESU, Peru

14 million tons of carbon to the atmosphere. This, he says, is the equivalent of emissions from 325,000 automobiles in normal use. Such information provides governments with a better quantitative basis for deciding policies, which are a decisive factor in governing rates of deforestation and patterns of land use.

Winning Grass-Legume Mixtures

Improved technology for dual-purpose cattle production

Key actors in the future of the forest margin may be unimposing-looking grasses and legumes, which CIAT has been studying and improving for decades with support from the Japanese and Colombian governments, among other donors.

The margin is receding because farmers have slashed and burned their way back into the primary forest as grazing degrades their initial plots. By investigating ways to improve the productivity of dual-purpose cattle (which serve as both meat sources and producers of milk), the Center and its collaborators are developing systems that could stabilize agriculture if accompanied by appropriate policies. The work done so far shows that degraded pasture can be made more permanent and productive. The key question is whether this technology can be supported by policy incentives that will discourage farmers from expanding their pastures.

With the new technology, degraded pastures are planted to mixtures of improved grasses and legumes that intensify milk production and, through the contribution of legumes, improve the health of the soil. The Tropileche project is conducting adaptive testing of this technology, drawing on many years of strategic research carried out by CIAT. The project also seeks new strategic insights into the performance of grass-legume mixtures in the Amazonian region. The work is funded by IDB and through the CGIAR Systemwide Livestock Program, which is coordinated by the International Livestock Research Institute (ILRI). The project also involves Cornell University in the USA and nine research and educational institutions in Colombia, Costa Rica, and Peru. The principal collaborators in Peru are the Veterinary Institute for Research in the Tropics and Highlands (IVITA), INIA, and the National University of Ucayali.

Research has shown, since some time, that the mixtures are a winner. Improved forages mean longer lasting pastures. They also improve the nutrition of cows and calves, thus giving the dairy farmer more milk per cow. Legumes enrich the soil and serve as cover crops to prevent weeds from invading perennial crops, such as oil palm and fruit.

Carlos Lascano, ruminant nutritionist at CIAT, explains that the grass-legume mixture is a subtle

combination, which must be created for the specific jobs it does and the places it does them. One legume, *Stylosanthes*, for example, promotes better nutrition for calves and, at the same time, adds nitrogen to the soil. A shrub legume, *Cratylia argenta*, is useful in places with extended dry seasons. The legume is drought tolerant and adapted to acid soils. Another legume, the forage peanut *Arachis pintoi*, serves especially well as a cover plant while providing a nutritious fodder for cattle.

A visit to a cattle farmer in Pucallpa confirms the value of the new technology. Initially, he followed the typical pattern of clearing and burning the forest, growing maize, and gradually shifting over to pasture. When he indicated his willingness to experiment, Tropileche introduced a cocktail of grass and legume species on his land and conducted ongoing tests on milk production and soil health. When the tests ended, the farmer continued the process on his own.

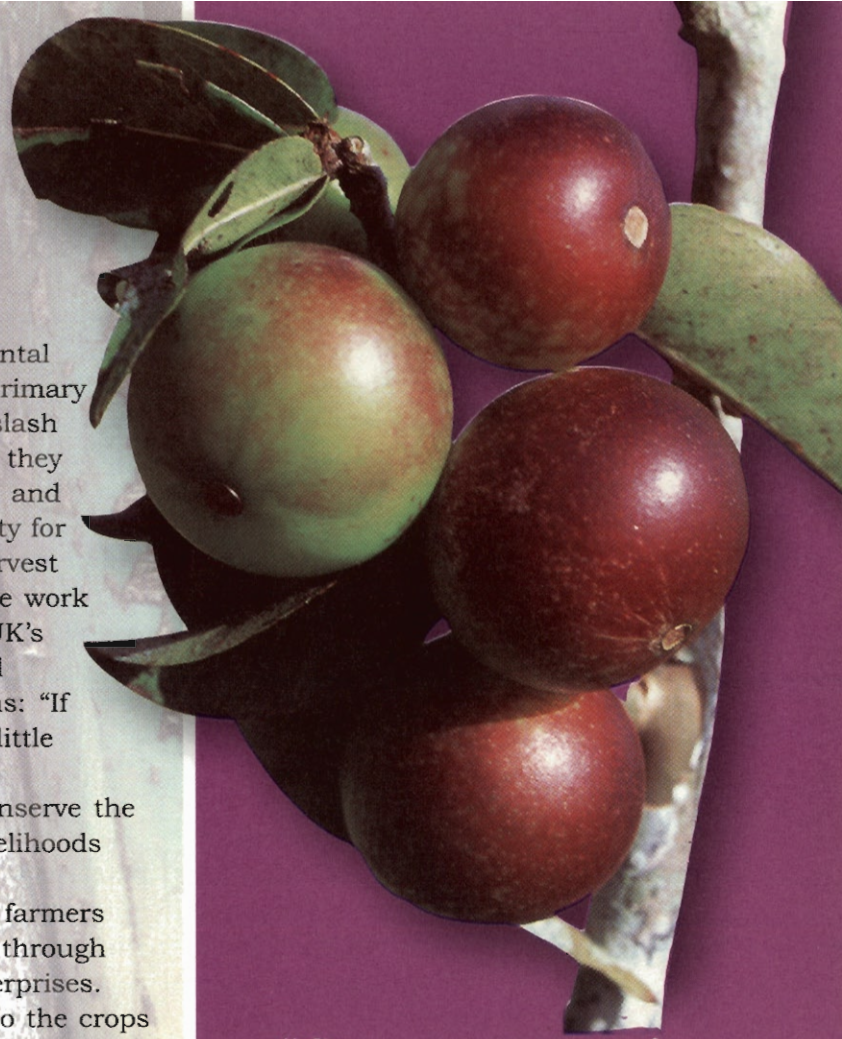
The legumes have survived during that time, and the farmer has seen significant increases in milk production. Rather than punching deeper into the forest, he is also using his land to cultivate fast-growing native trees that are useful for fuel, posts, and building materials.

A Portfolio of Alternatives

Identifying marketable products for agroenterprise development

Regardless of the environmental value farmers place on the primary forest, they will continue to slash and burn if it is the only way they have of feeding their families and if it offers the best opportunity for economic gain. CIAT postharvest specialist Rupert Best, whose work is supported in part by the UK's Department for International Development (DFID), explains: "If farmers are poor, they have little money to invest in improved production practices that conserve the resources on which their livelihoods depend. One way out of this predicament may be to offer farmers new ways of earning income through the development of agroenterprises. These can either add value to the crops farmers already grow or incorporate new and highly marketable species into their production systems."

The Pucallpa region is already demonstrating its receptiveness to such alternatives. Several farmer associations have been formed to grow oil palm, for example, which is collected by a community processing plant supported by the United Nations Development Programme (UNDP).



"*Camu-camu* contains more vitamin C than any other fruit in the world. It can be used as a supplement in juices, marmalade, ice cream, candies, tablets, and other products."

From a brochure published by Agrícola San Juan, S.A., Peru

Marin Cirilo is one of the farmers taking part in this project. The young Peruvian and his wife, Lucía Evangelina Huaman, came to Ucayali in 1991 from a village in the Andes, refugees from terrorism. Neighbors were growing coca, but the couple kept their eyes out for other, longer term possibilities. Cirilo knew about the palm oil processing plant, just a few kilometers down the Pucallpa-Lima highway. He figured that oil palm would be a likely prospect. Now he is a member of a palm-growers' association, and he cultivates 5 hectares of oil palm, which he sells to the plant. He expects his income from palm oil to increase in the next few years, allowing him to buy cattle.

The San Juan brewery, one of the region's leading industries, is thinking of its future economic prospects, too. The brewery is experimenting with several crops that could be exploited for agroenterprise. Francis Young, director of the brewery's agricultural division, explains that San Juan is vitally interested in *camu-camu* (*Myrciaria dubia*), whose purplish red fruit contains high concentrations of citric acid and vitamin C. The species thrives along seasonally inundated river banks, but it can also be cultivated in plantations. *Pijuayo*, or peach palm (*Bactris gasipaes*), is another important candidate for agroenterprise. The plant produces fruit that is sold in Amazonian markets but is best known to the rest of the world as the source of edible shoots called palm hearts. These are canned and exported to Europe, North America, and elsewhere.

Young says that inquisitive farmers up and down the Pucallpa-Lima road are frequent visitors to the brewery's experimental farm. "More than ever," she says, "they ask questions about the species' economic usefulness and agronomic characteristics." San Juan has begun a program of providing interested farmers with seedlings. Part of San Juan's message is that these potentially high-value crops should be grown with a minimum of chemical intervention. "The market demands that," Young says.

In connection with IDRC's Food Links initiative, CODESU and CIAT scientists are developing methods to explore further opportunities for small farmers to break into national and export markets. Currently, they are gathering inventories of crops that farmers can grow, particularly species that are native to the Amazon and show strong market potential. The participation of farmers and communities in identifying promising species and in planning and executing new agroenterprises is critical for their eventual success.

The shift to agroenterprise, says Rupert Best, can be a somewhat risky process, one that must complement the region's tradition of growing "staple crops whose value for nutrition and food security is important, but whose monetary value is low." The challenge for this new initiative is to reduce the risk by carefully analyzing the agronomic, market, and social feasibility, as well as the sustainability of each alternative. Then, growers must have help in finding ways to incorporate higher value crops into their current systems. "There may not be one solution, but rather a portfolio of alternatives," he says. "And the options won't necessarily be static, because the market isn't static." CIAT's contribution is to offer its research partners strategies for putting together the portfolio that is right for them.

Policies are Paramount

A precondition for sustainable land management

The development of agroenterprises and of new livestock production and agroforestry systems is a vital step for enabling farm families around Pucallpa to fulfill the hopes that brought them to the forest margins. Because these systems are relatively stable, durable, and intensive, they also have potential for reducing pressure on the forest.

But to accomplish this purpose, rather than create yet another incentive to clear more forest, new production systems must form part of an integrated research program that explicitly addresses the conservation imperatives of the Ucayali region. A new initiative that will help us do this involves the development of an integrated conceptual framework for research on tropical agroecosystems. The project is being funded by the Canadian International Development Agency (CIDA) and carried out by the University of Guelph and CIAT.

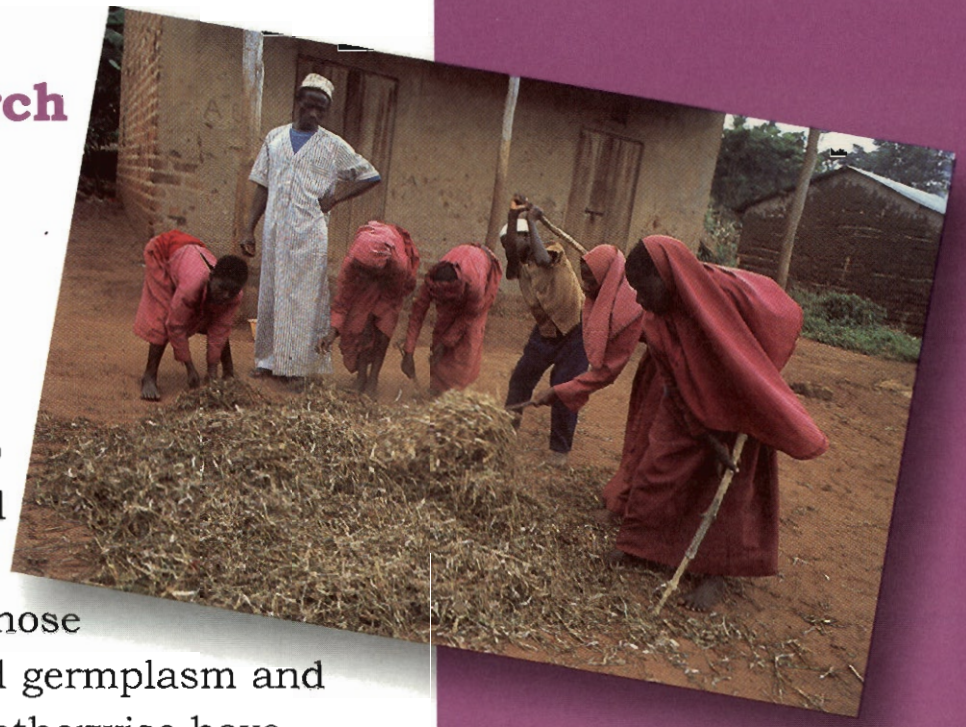
We and our collaborators in the Amazon are aware that all the research and technological expertise in the world will amount to nothing if government policies work against them. The dramatic history of unsustainable agriculture and land degradation throughout the region provides sad proof of that. Scientists know that a decision to offer a subsidy or extend a highway can instantly override the most heartening development in their search for stable production systems that reduce pressure on the forest. They also know that their job is to make the fruits of research available to the people who make and influence the policy decisions—national institutions, government officials, and nongovernment organizations.

Sam Fujisaka, who has studied the policy-related causes of Amazonia's degradation, sees it this way: "Neither CIAT nor any other international center can get directly involved in trying to influence or lobby or change policy. But certainly we can publish information that says, 'Here are the results of these policies. If you want a different outcome, then the policies need to be changed. Here are some scientific facts that can guide you.' And then leave it to the policy makers to synthesize the facts and design appropriate policies."

"I came here from Lima, because I wanted something more from life."

Marcelo Cabrera, Farmer, Peru

Tropical American Research with a Global Reach



Starting about 15 years ago, CIAT extended the reach of its crop research to sub-Saharan Africa and Southeast Asia. This work has benefited millions of farmers in those regions by offering them improved germplasm and related innovations that might otherwise have remained an ocean away.

Increasingly, the Center's crop research in Africa and Asia is integrated with work on biodiversity, soils, and other themes, carried out by our staff and cooperators in those regions, as well as in tropical America. In the following sections, we examine some of the fruits of this collaboration across scientific disciplines, continents, and national boundaries.

"I used my profits to hire extra labor and buy new clothes. I've never earned so much money from just one bean harvest."

Joyce Hayiza, Farmer, Uganda

The Beans of Standard 4

Genetic remedies for low soil fertility

Early on a Monday morning, the children of Standard 4 at the Olmotonyi Primary School, near Arusha, Tanzania, file out to a research plot growing on the edge of their schoolyard. When the agriculture teacher gives the word, Standard 4 surges like a wave across the field. The only sounds that can be heard are the patter of the children's bare feet and the snap of weeds pulled abruptly from the ground.

The sight makes Patrick Ndakidemi smile. He is the soil scientist from the Selian Agricultural Research Institute who decided to locate the plot here. "It gives our future farmers practical lessons in the basics of crop management," he explains. "We also get useful results, because the conditions here are fairly typical of those in farmers' fields."

The children do not know much about soil nutrient deficiencies or experimental design, but they are learning fast how to take care of a bean crop. The research plot may even offer solutions to problems the children's parents are facing and that pose a serious threat to Standard 4's future prospects in crop production.

The experiment is part of a project called Bean Improvement for Low Fertility in Africa (BILFA). Its purpose is to better enable scientists to identify and exchange bean lines that tolerate poor soils and use scarce nutrients efficiently. Participants in BILFA trials submit their most promising lines and then screen the entire collection under specific soil fertility stresses.

BILFA is coordinated by regional bean research networks, which provide the framework for a close-knit partnership between national bean programs and CIAT. The networks receive financial support from the Canadian International Development Agency

(CIDA), the Swiss Agency for Development and Cooperation (SDC), the US Agency for International Development (USAID), and the UK's Department for International Development (DFID).

To foster the exchange of germplasm and ideas, the networks recently conducted a "monitoring tour," in which Ndakidemi and colleagues from other countries traveled to various BILFA trial sites. "Initially, our main sources of tolerance to low fertility were bean lines with small seed, often black or cream colored," notes Vas Dev Aggarwal, CIAT bean breeder based in Malawi. "But now we're finding tolerance in medium and large seed types with preferred colors."

That is also the experience of BILFA participant Lunze Lubanga, who is a soil scientist with the National Institute for Agricultural Research (INERA) in Congo D.R. (formerly Zaire). "We've identified several lines tolerant to acid-soil conditions, including one from Burundi called *Ubusosera*," he says.

Lubanga gave some seed of this line to his wife to try in her garden. Pleased with the results, she shared seed with her neighbors, who in turn passed it on to others. Now, many farmers are growing *Ubusosera* on acid soils, which are a major constraint to crop production in central Africa. Part of this line's appeal is its seed type, which resembles that of a popular local variety that grows poorly under low soil fertility. "In recognition of Mrs. Lubanga's good deed, the farmers have renamed the variety after her, *Mwa Sole*," says INERA physiologist Elukessu Komba.

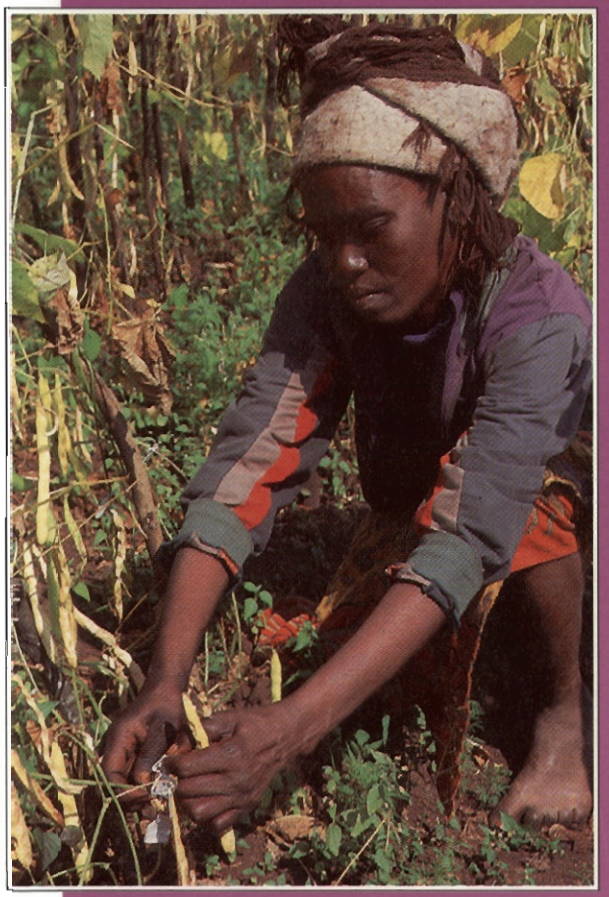
With neighbors like Mwa Sole, future farmers like the children of Olmotonyi, and scientists like Ndakidemi and Lubanga, solutions to the soil constraints of Africa's bean production should spread quickly across the continent.

Children of Pioneers

Farmer participation in cassava research and development

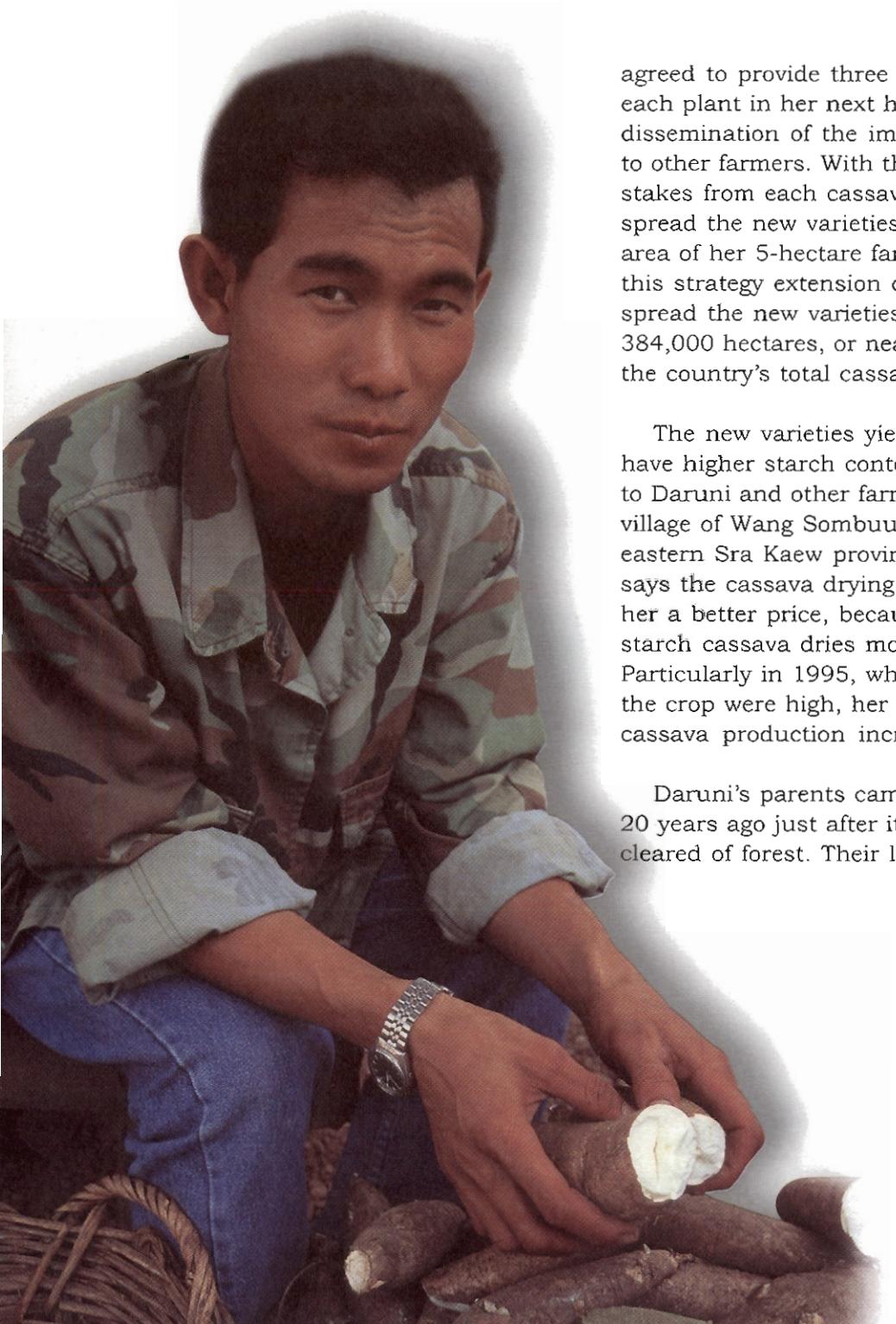
The daughter of a pioneer family, Thai farmer Daruni Sinlaa is not afraid to explore new ground. About 2 years ago, she adopted three improved varieties of cassava, obtained through a massive government program aimed at increasing the efficiency of the country's cassava production. The new varieties resulted from CIAT's Japanese-supported collaboration with the Field Crops Research Institute of Thailand's Department of Agriculture.

Daruni received planting stakes, or cuttings, from the Department of Agricultural Extension. In exchange she



"We're very excited about some of the bean lines that are coming out."

Patrick Ndukidemi, Soil Scientist, Selian Agricultural Research Institute, Tanzania



agreed to provide three stakes from each plant in her next harvest for dissemination of the improved varieties to other farmers. With the remaining stakes from each cassava plant, she spread the new varieties to a larger area of her 5-hectare farm. Through this strategy extension officers have spread the new varieties to about 384,000 hectares, or nearly a third of the country's total cassava area.

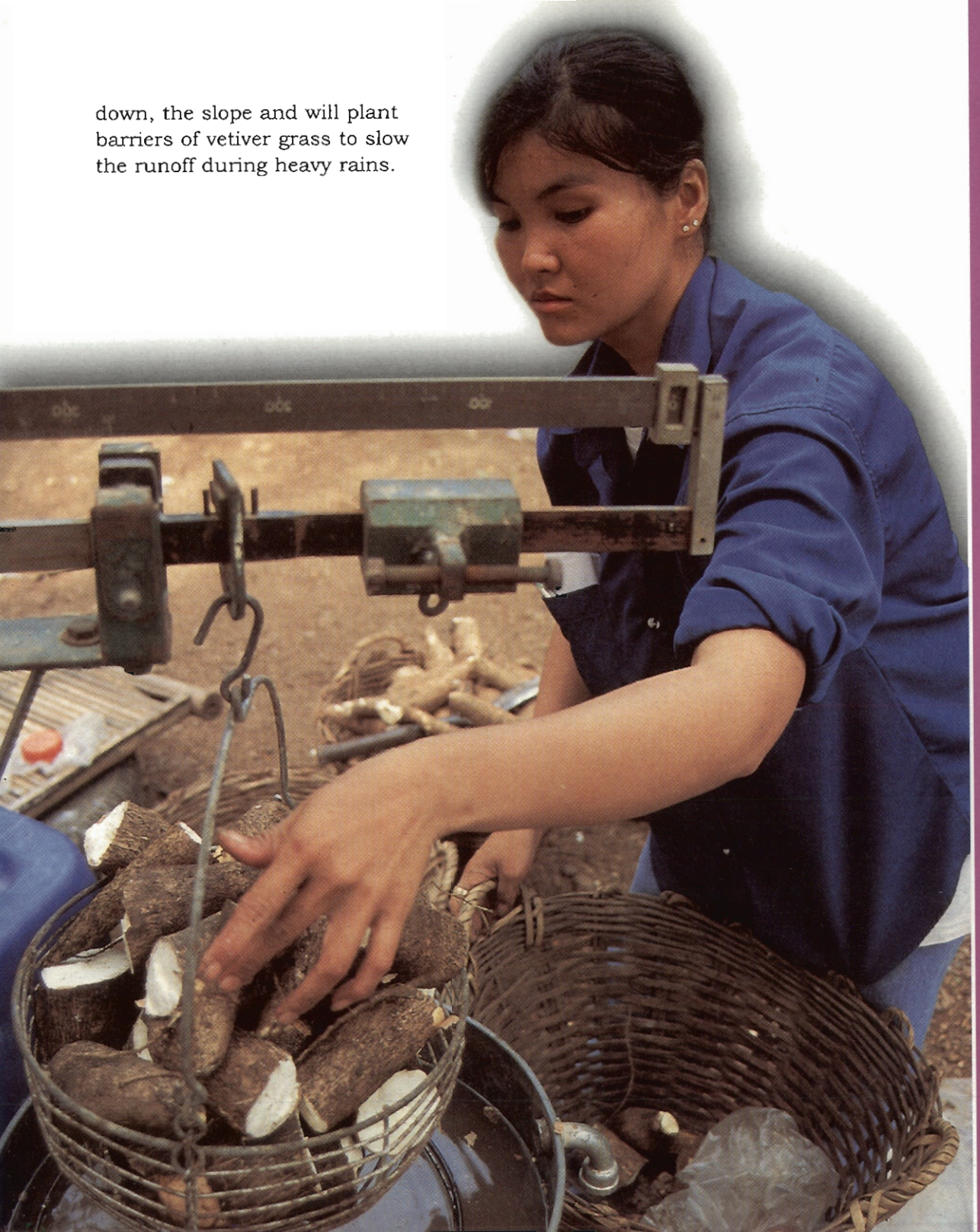
The new varieties yield more and have higher starch content, according to Daruni and other farmers in the village of Wang Sombuun in Thailand's eastern Sra Kaew province. Daruni says the cassava drying industries give her a better price, because the high-starch cassava dries more quickly. Particularly in 1995, when prices for the crop were high, her income from cassava production increased.

Daruni's parents came to this land 20 years ago just after it had been cleared of forest. Their lives were hard, and so is hers, though she claims to be better off. If her production of maize, cassava, and other crops continues to prosper, Daruni hopes to provide her two sons with a good education. Her dream is that, as professionals, they will leave behind the pioneer struggle of their parents and grandparents.

Prichaa Bunsorn, Daruni's unmarried neighbor, is also looking to the future, but his gaze is fixed more on the small farm he will inherit from his father and which he already manages. The city life holds no allure for Prichaa, despite its promise of a better income; he has been to Bangkok and hates the pollution and traffic. The only environmental problem he wants to confront is the soil erosion in his cassava field, located near the base of a steep hill.

As a participant in a soil erosion trial organized by extension officers under a project coordinated by CIAT and funded by Japan's Nippon Foundation, Prichaa has become more aware of the problem and has experimented with several possible solutions. Based on trial results, which he discussed with other farmers at a recent meeting, Prichaa will plant his cassava on ridges across, rather than

down, the slope and will plant barriers of vetiver grass to slow the runoff during heavy rains.



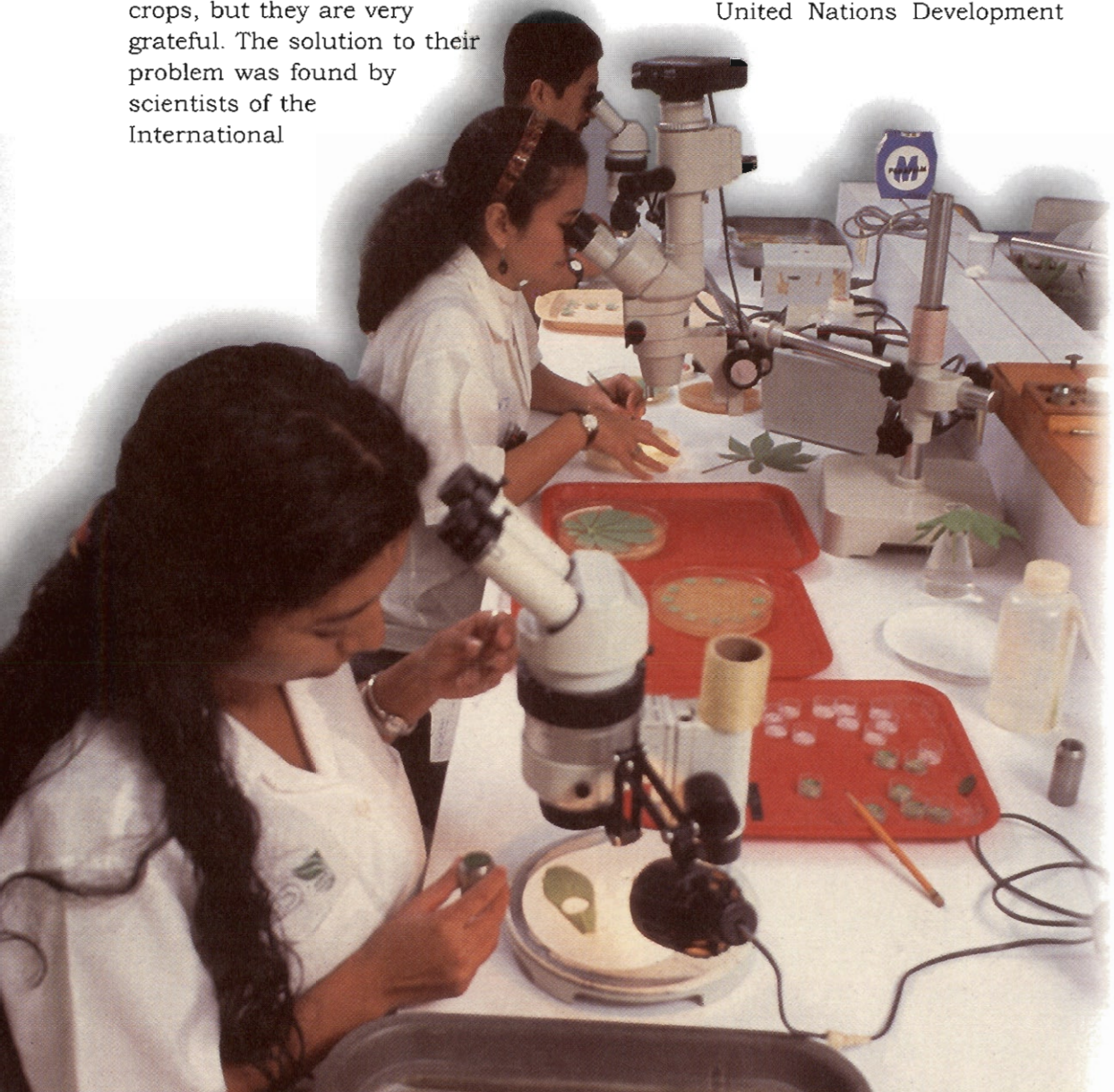
"I am delighted to inform you that Dr. Kazuo Kawano, cassava breeder and head of your Asian regional office, will receive our Foreign Minister's Commendations for 1997."

Kunio Nakamura, Ministry of Foreign Affairs, Japan

Mite Makes Right

A tiny predator from Brazil helps save Africa's food

Farmers in West Africa do not know why a devastating pest has recently disappeared from their cassava crops, but they are very grateful. The solution to their problem was found by scientists of the International Institute of Tropical Agriculture (IITA), CIAT, and the Brazilian Agricultural Research Enterprise (EMBRAPA). The research that led to a solution was funded by various donors, including the International Fund for Agricultural Development (IFAD), the United Nations Development Programme (UNDP), and the governments of Denmark and Germany.



The economic benefits of the research, which targeted the tiny but destructive cassava green mite (*Mononychellus tanajoa*), will be enormous for African farmers. One external assessment of the project's early impact on half of the cassava-growing zones in Benin, Cameroon, Ghana, and Nigeria estimated that the resulting increase in production is worth about US$60 million a year. Furthermore, the mite is being controlled without pesticides through a technique as old as plants themselves: biological control.

Plants have evolved with their natural defences, such as beneficial insects and mites that attack harmful pests. When a food crop is moved from its home territory, as cassava was when traders carried it from tropical America to Africa in the 16th century, it often leaves behind both its pests and natural protectors. The crop survived in its new home for hundreds of years in the absence of major pests. But in the early 1970s, explains CIAT entomologist Lincoln Smith, the cassava green mite (CGM) turned up in Uganda. In the absence of natural controls, the mite swept through Africa's cassava belt, reducing yields by about 30 percent.

The global effort to find a nonchemical cure led researchers to Northeast Brazil, whose climate most closely resembles that of the African regions where mite damage was worst. After evaluating many species of predator mites, IITA and CIAT scientists, working with Gilberto de Moraes, then of EMBRAPA, found several species that can survive in Africa. The most successful, *Typhlodromalus aripo*, can be easily reared by national programs and spreads rapidly. First released in 1993 in Benin, *T. aripo* has reduced pest populations by 30 to 90 percent in field tests and accounts for an increase of as much as one-third in cassava production. The predator is now established in 11 African cassava-growing countries.

The search for green mite predators in Latin America had an important side effect. CIAT entomologist Anthony Bellotti says the search produced "something like 80 potentially useful species, of which half had never been described before." One of these species has already proven helpful for controlling pests in European greenhouses and on indoor plants.

The scientists employed what is known as classical biological control—the introduction of natural control agents that attack only the target pest—into areas where they did not occur before. IITA entomologist Steve Yaninek (who started the project in 1983 and initiated the collaboration with CIAT, EMBRAPA, and others) notes that this is the first time anywhere that a mite pest on a field crop is being controlled on a continental scale using classical biological control. By restablishing the natural balance between the green mite and its predators, this approach provides a self-sustaining, environmentally sound solution to the pest problem.

A Village with Vision

Farmers experiment with forage legumes in Indonesia

The inhabitants of a hillside village overlooking the Makroman area of East Kalimantan in Indonesia enjoy a panoramic view of the marshy flatlands below. On one side of the hill, intensive rice production in the low-lying plain is under constant threat from heavy flooding. On the other, saline soils have made farming impossible.

In the face of these obstacles, many people in the village have a clear vision of what they must do to secure their food supplies and raise their incomes. Two farmer groups have decided that the welfare of the village depends on more adept management of their upland crops and livestock.

Distribution of *T. aripo* in Africa, 1996


THE NEW YORK TIMES INTERNATIONAL SUNDAY, MAY 25, 1997

Brazil's Mighty Mite Saves the Day for African Cassava Crop

By HENRY FOUNTAIN


NEW SCIENTIST

Mighty mite saves Africa's staple food

Fred Pearce

A NEW predatory mite is spreading through the cassava fields of Africa. And the man who introduced it from South America is delighted.

"To have a technology that is effective, self-replicating, and free is the best of all possible worlds."

Donald Roberts, Insect Pathologist, Boyce Thompson Institute for Plant Research, USA

Many group members have established stands of various grass species to provide fodder for their cows and goats. But one farmer, Pak Ruslan, has decided instead to experiment with a tropical American legume (*Centrosema acutifolium*), which he has sown in association with maize and cassava to improve crop yields. He obtained seed of the legume from Ibrahim, an extension officer with the East Kalimantan Livestock Service.

Ibrahim has helped evaluate these and other species under the Forages for Smallholders Project. The work is funded by the Australian Agency for International Development (AusAid) and is coordinated jointly by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) of Australia and by CIAT in seven countries of Southeast Asia. In Indonesia the project's work is carried out by the Directorate General of Livestock Services.

Two weeks after planting maize, Ruslan oversowed the crop with *Centrosema*. As a result, he did not have to weed the maize, got a better yield, and did not need to apply fertilizer. Planting the following cassava crop was easy, he explains, because the legume prevented the soil from hardening and protected it from erosion. Now, Ruslan is planting another maize crop after the cassava. He has also decided to plant some improved grasses for his livestock.

Wild about Rice

Using exotic genes to raise yields with the aid of molecular markers

Many scientists believe that if the world is to be fed without placing further pressure on marginal lands, dramatic improvements must be made in the yields of staple crops. Yet they know that the yield increases achieved in previous decades appear to be leveling off. This "yield plateau," often called "yield stagnation," is especially noticeable in rice.

CIAT scientists Joe Tohme and César Martínez believe that biotechnology can make a big difference. They and researchers from Cornell University, under the coordination of rice geneticist Susan McCouch, have embarked on a promising effort to use the yield-raising potential of wild rice germplasm.

For decades that germplasm has been carefully collected and then filed away in gene banks around the world. Breeders have preferred to work with a relative handful of cultivars that meet regional expectations for yield, taste, and adaptation to the environment.

The looming yield plateau has changed all that. Cornell researchers, led by tomato geneticist Steven Tanksley, came up with a different approach that breeds a variety farmers prefer with wild relatives. Wild species of rice have several undesirable characteristics—lodging and shattering are two—but they also can contain hard-to-detect genes for high yield. When crossed with high-yielding cultivars, some of these wild species can produce offspring that are superior to either parent.

This is where biotechnology comes into the picture. Molecular maps and markers are used to identify the traits responsible for better yield, so that those traits can be incorporated into new lines of rice. CIAT is part of an informal alliance, partially funded by the Rockefeller Foundation and USAID, that is using wild rice germplasm to increase yields in China, South Korea, and Colombia. Chinese researchers, who started a year before CIAT, have identified quantitative trait loci (QTL) genes, responsible for increased yield, on two of rice's chromosomes. CIAT is currently narrowing its search down similarly.

Joe Tohme is reluctant to make claims until all the data are in, but he is confident of success. A Malaysian accession of one of the donor species in the consortium's experiments, *Oryza rufipogon*, a wild relative of modern cultivated rice, has yielded around 2 tons per hectare of rice grain. The commercial varieties used in CIAT's experiments yield 6 tons. Some of the wild rice-based offspring, however, are producing significantly higher yields than their commercial parents at three locations. Now CIAT is employing molecular markers to find the genes responsible for superior yield.

The technique being used by CIAT and others promises to speed up the process of producing improved varieties. It also will make more productive use of the wild germplasm stored in gene banks. And, says Tohme, if all goes as planned, the transfer of QTL genes will result in the dream of stable increased yields for a world in need of more rice but with limited land on which to grow it.

"Results from tomato and rice indicate that exotic germplasm contains many useful genes that can significantly enhance agricultural production, even for complex traits like yield."

Steven Tanksley and Susan McCouch, Professors, Cornell University, USA

CIAT

Solutions That Cross Frontiers

Welcome to the International Center for Tropical Agriculture (CIAT), a nonprofit, nongovernment research organization dedicated to alleviating hunger and poverty and preserving natural resources in developing countries. Ours is one of 16 centers supported by the Consultative Group on International Agricultural Research **(CGIAR)**.

http://www.ciat.cgiar.org

An Overview of CIAT on the World Wide Web

We invite you to visit the thoroughly revamped CIAT home page to gain an overview of the Center and explore important details about our research. In addition to improving the site's design, we have restructured it to emphasize CIAT's new project organization, our research partnerships, and the central themes of our work.

In the following pages, we present some of the information available at our site that we thought would be useful for readers of *CIAT in Perspective*. Any comments about our new Web site or about this annual report will be most appreciated.

"Your Web site has evolved into one of the best I've seen. The amount of information, the logical formatting, and the handsome, consistent presentation are of the highest quality."

Thomas S. Schorr, Professor, University of Pittsburgh, USA

The CGIAR System

CIAT is one of 16 centers supported by the Consultative Group on International Agricultural Research (CGIAR). The CGIAR is a consortium of donor countries and organizations committed to sustainable agriculture in the developing world. The group is cosponsored by the Food and Agriculture Organization of the United Nations (FAO), the United Nations Development Programme (UNDP), the United Nations Environment Programme (UNEP), and the World Bank.

CIAT's Donors

CIAT currently receives funds through the CGIAR or under specific projects from the countries and organizations listed below. We gratefully acknowledge their commitment and contributions.

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- World Bank

Our Mission

What To contribute to the alleviation of hunger and poverty

Where in tropical developing countries

How by applying science to the generation of technology that will lead to lasting increases in agricultural output while preserving the natural resource base.

Our Project Portfolio

CIAT's research is conducted through the projects listed below. These provide a mechanism for integrating research within the Center and for organizing cooperation with our partners. (Brief profiles of the projects are available upon request.)

Crop Improvement

Improved Beans for Africa and Latin America

Regional Bean Networks in Sub-Saharan Africa

Improved Cassava for the Developing World

Rice Improvement for Latin America and the Caribbean

Tropical Grasses and Legumes for Multiple Uses

Agrobiodiversity

Integrated Conservation of Neotropical Genetic Resources

Enhancing Biodiversity Through Biotechnology

Pests and Diseases

Integrated Pest and Disease Management

Soils and Systems

Improving Soil Quality in Marginal Environments

Sustainable Systems for Small-Scale Farmers

Rural Agroenterprises for Small-Scale Farmers

Land Management

Community Management of Natural Resources in Hillside Watersheds

Land Use and its Environmental Impact

Institutional Links

Methods of Farmer Participation and Gender Analysis

Partnerships for Agricultural Research and Development

The Impact of Agricultural Research

Our Crop and Agroecosystem Focus

CIAT conducts international research on four commodities that are vital for the poor: beans, cassava, tropical forages, and rice. Our work on the first three has a global reach, while that on rice targets Latin America and the Caribbean region.

In Latin America our research on natural resource management is organized largely on the basis of three fragile agroecosystems: hillsides, forest margins, and savannas. CIAT scientists also address key resource issues in our crop research for Africa and Asia.

Institutional Links

CIAT is part of an emerging global system of agricultural research and development, whose strength depends, not just on the excellence of individual members, but also on the energy they invest in joint endeavors. For that reason we work hard to build ties with other institutions through research partnerships based on projects.

Our expanding circle of partners includes other international centers, national research institutes, universities, nongovernment organizations, and the private sector. We work with them under a variety of innovative arrangements, such as consortia and networks, at the local, regional, and global levels. Through strategic alliances with advanced institutes, we bring valuable scientific expertise to bear on the central challenges of tropical agriculture.

As a service to its partners, the Center provides varied offerings in training and conferences, specialized services in information and documentation, a broad program of communications, and information systems.

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PROTEJA

The Power of Perspective

A recent protest march against forest burning around the town of Yorito in northern Honduras offered an impressive display of these people's determination to change the way they manage their natural resources. This event also demonstrated the capacity of local organizations to promote collective action and their awareness of the need to involve young people, whose future depends on the outcomes.

Now that the citizens of Yorito are better organized, they need new science-based tools (information, methods, and genetic resources) to change the conditions that perpetuate poverty and environmental degradation in their hillside community—tools that confer on them wider powers of perspective.

"Different organizations were working in the area, some over here, others over there. But now, we're working together, and that makes me very happy."

César Romero,
The Agricultural Services Cooperative of Yorito and Sulaco, Honduras

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