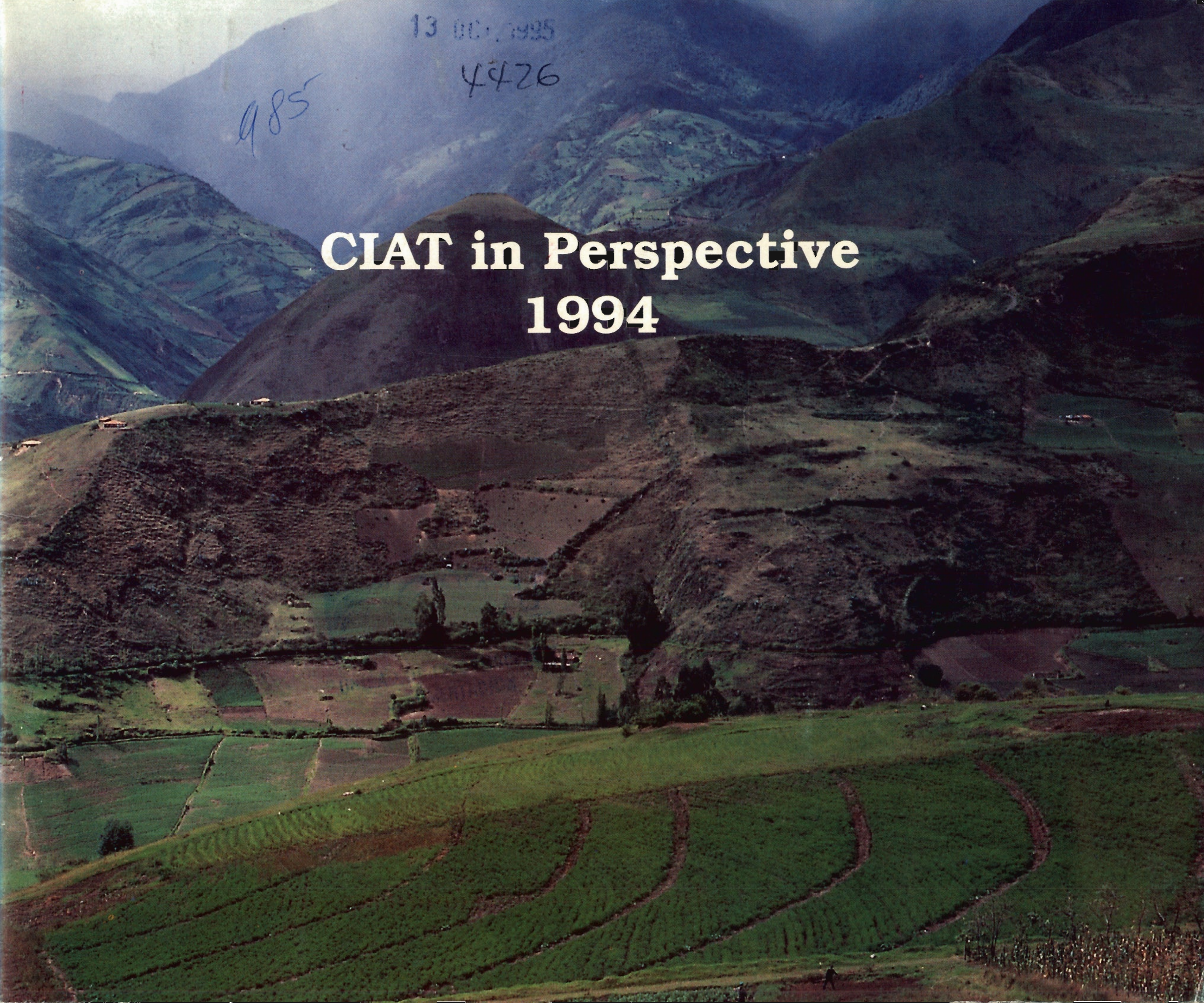
CIAT in Perspective 1994



Nathan Russell

Perspective in Practice


NATHAN RUSSELL

To "feed and green" the world, as Derek Tribe argues in a recent book, is a daunting task but well within human capabilities. How effectively researchers confront this challenge depends ultimately on the breadth and depth of their perspective.

At CIAT we examine agriculture and the environment from the viewpoints of the many people whose skills and knowledge are needed to solve urgent problems. With them, we seek new insights and develop effective technology that can lead to lasting improvements in human welfare.

"Development that does not improve the lives of the poor has no soul, and development that impoverishes the environment has no vision."

James Gustave Speth, Administrator, United Nations Development Programme (UNDP)

Signs of the Times

Lucia Vaccaro, Chairman, Board of Trustees

It is with particular satisfaction that we present this report on CIAT's work in 1994—a year of unprecedented challenges and correspondingly important achievements.

Adapting to a new environment

In a difficult environment characterized by severe cutbacks and continuing uncertainty, the Center started the year with a new organizational structure designed to foster scientific integration and efficient use of human resources.

We reduced the work program to the barest acceptable skeleton compatible with preserving the essence of CIAT's strategic plan. We also translated activities into project form to sharpen priority setting and accountability.

At the same time, the Center dedicated considerable efforts to preparing to play a lead role in ecoregional research for the Latin American tropics and its due part in the system-wide research programs of the Consultative Group on International Agricultural Research (CGIAR), which supports CIAT and 15 other centers. It is essential that we contribute strongly to both initiatives to achieve the Center's goals and those of the CG system.

Changes in leadership

At midyear Gustavo Nores stepped down as director general. With his characteristic conviction and enthusiasm, he left an indelible mark on CIAT's scientific evolution by leading the Center towards a prototype of integrated research on commodities and natural resource management, based on institutional partnerships.

After Dr. Nores resigned, CIAT was fortunately able to draw upon the wisdom and experience of a distinguished member of its Board of Trustees, Robert Havener, who has served since then as interim director general.

Early in 1995 we chose a new director general, Grant Scobie, who has wide experience in Latin America and other regions of the developing world and is highly respected in the CGIAR.

Renewed commitment

The Center has emerged from a difficult period strengthened in its dedication to its goals and better placed to achieve them.

Released!

Center management and staff are delighted to report that Thomas Hargrove, head of our Communications Unit, has just been released by the kidnappers who held him for 11 months. Tom was abducted on 23 September 1994 while driving from his home to work.

The Center is deeply grateful for the support it received during this difficult time from rural communities, especially in Cauca department; from Hargrove's colleagues in the media; and from many friends around the world who sent letters in support of his family and coworkers. We are also thankful for solid support from the Colombian government and authorities and from numerous local, national, and international organizations.

We have been particularly encouraged by the Colombian government's decision to make a substantial multiyear contribution to CIAT's core budget. In doing so, the country has become a member of the CG system and gained a voice in planning research to meet global challenges in agriculture.

Several other developing countries joined the system at a recent high-level meeting of donors in Lucerne, Switzerland. The positive results of that event reflect a new spirit of international cooperation and commitment to agricultural research.

The favorable conclusions of CIAT's fourth External Programme and Management Review also inspire greater confidence about the future. The reviewers provided a refreshing endorsement of the Center's course of action and made pertinent suggestions as to how it may be improved still further.

The appointment of Dr. Scobie as director general thus comes at an auspicious moment for both CIAT and the CGIAR. We look forward with great optimism to working with the Center under his leadership in the post-Lucerne era.

Gaining Perspective

Robert Havener, Interim Director General

The changes that took place at CIAT and in the CG system during 1994, paradoxically, seem at once astounding and unsurprising.

The resurgence of the CGIAR

In the 1990s financial support for international agricultural research fell precipitously. This was the result of sluggish economic growth in donor countries, their urgent need to reduce fiscal deficits, and increasing concern about new challenges on the world scene. For example, a number of donors diverted resources from traditional aid recipients to support economic reform in Eastern Europe and the former Soviet Union. CIAT was not spared from the consequent decline in core funding to the CGIAR.

In 1994, however, our fortunes changed abruptly. The CG system succeeded in essentially halting the erosion of support and began to secure new commitments to the centers through a series of dynamic initiatives with the donor community. As a result, CIAT's finances are now stable, and we're well positioned to continue implementing a project structure designed for growth.

"CIAT's contribution was fundamental in helping us to make a significant difference in agricultural productivity in Colombia."

César Gaviria, Secretary General, Organización de los Estados Americanos (OEA), and former president of Colombia

CIAT is a "good centre, . . . doing high-quality science and showing great resilience."

Declan Walton, chairman of the Center's fourth External Programme and Management Review

Much of the credit for this astonishing turn of events goes to the outstanding people who make up the CGIAR: from the system's chairman, Ismail Serageldin, to the scientists who maintained essential programs despite reduced funding.

A compelling mission, an innovative strategy

What is it about our own staff that makes their apparent victory over difficult circumstances seem unsurprising in retrospect?

First, they're committed to a compelling mission (see box). Few of our scientists would be here if they did not consider their research essential for improving the lot of the world's millions of poor and hungry people.

Second, we've persisted in implementing an innovative research strategy, despite the financial crisis of the 1990s.

In 1991, CIAT embarked on a bold plan calling for new initiatives in resource management research, integrated with a traditional commodity focus. This was our response to the growing realization that research aimed at increasing food production must simultaneously contribute to 1) conserving natural resources, 2) diminishing poverty, and 3) promoting equity (that is, the distribution of benefits to low-income people generally and to women particularly). These three goals express the essence of Agenda 21, the "blueprint" for sustainable development put forward by the United Nations Conference on Environment and Development, held at Rio de Janeiro in 1992.

CIAT's strategic plan assumed steady increases in core funding. When just the opposite occurred, we came perilously close to the financial threshold below which our strategy would have become unworkable.

Proceeding with the plan entailed considerable risks. To cut excessively into the Center's commodity efforts, on the one hand, would have crippled this important work. But a seriously underfunded program of resource management research, on the other, would have fallen far short of our intended contribution to sustainable development. Despite these hazards, we remained steadfast in our commitment to the strategy, because it offered the best hope for ensuring the continued relevance of CIAT's work.

Breadth plus depth

But there is something else that accounts for the Center's strong position today. After all, plenty of devoted people have failed on worthy

CIAT's mission

Our mission, as stated in the Center's strategic plan, is "to contribute to the alleviation of hunger and poverty in tropical developing countries by applying science to the generation of technology that will lead to lasting increases in agricultural output while preserving the natural resource base."

To fulfill this mission, CIAT scientists integrate two lines of investigation:

Commodities: The Center has a long and successful history of research on four commodities, for which its mandate is global (beans, cassava, and tropical forages) or regional (rice in Latin America).

Agroecosystems: Through new initiatives in the forest margins, hillsides, and savannas of tropical America, CIAT applies a wide range of expertise to research on the management of natural resources.

Strength in various disciplines enables us to conduct pathfinding research on strategic themes both within and across commodities and agroecosystems.

missions, and many well-conceived strategies have died in infancy.

That something else, I would contend, is the breadth and depth of CIAT's *perspective*. By this I mean both the broad viewpoint and strong analytic capacity we bring to our mission and strategy.

To ensure that the Center's research is relevant, our scientists address problems from many points of view: those of farmers, national institutions (including nongovernment organizations, universities, and the private sector), as well as international agencies. The results of this approach are evident both in the content of our work and in the way it is organized and conducted.

We add depth to the breadth of our perspective by digging beneath the surface of biological and social phenomena to determine why and how they occur as they do. The resulting insights better enable CIAT scientists and their partners to find effective solutions to problems in agriculture and the environment.

In the reports that follow, we describe a variety of initiatives that are highly relevant to sustainable agricultural development. We hope you share our excitement about these examples of the Center's perspective in practice.

"The world has never been in such a precarious position as it is today, nor has it ever had better prospects of solving the problems with which it is beset."

Derek Tribe, Executive Director, Crawford Fund, Australia

NATHAN RUSSELL

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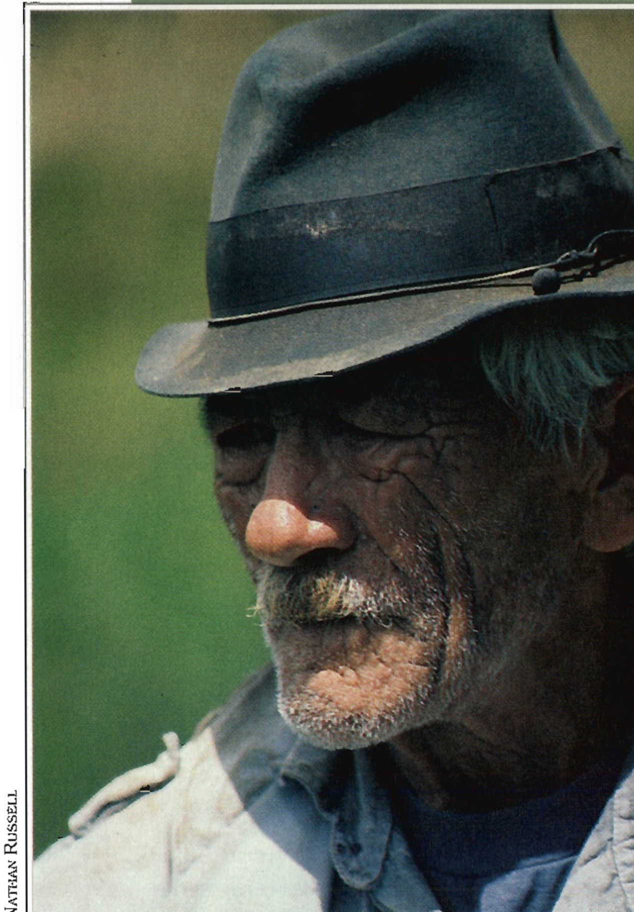
From Where the Farmers Stand

For rural people farming is not just a job, but their life and future. Through many years of collective experience, they've become intuitive investigators, whose knowledge and inquisitive spirit are essential to keep agricultural research relevant and effective.

Many years ago CIAT scientists began to evaluate new varieties and cropping practices from the standpoint of farmers. Now, we're also working with them in research on integrated pest control and natural resource management. This experience has produced new evidence that, as genuine partners in research, farmers and their communities can generate both the will and the means to achieve sustainable livelihoods.



NATHAN RUSSELL

"IPM systems have the greatest chance of wide-scale adoption when growers initiate the system."

The IPM Report

Good Neighbors Making Good Fences

They've painted the barbed wire yellow. To the casual observer, the splash of color just makes the fence stand out. But to people living in the watershed of the Cabuyal River in Colombia's Cauca department, it means community action.

The new barbed-wire fence separates pasture land from a narrow strip of steeply sloping woodland that runs down to a stream. The aim is to create a buffer zone that will protect the upper watershed's precious forest, soil, and water resources. The yellow paint sends a signal of social reproach to anyone tempted to raid the woodland for timber or fuel.

Agreement to erect the fence did not come easily. The owner of the pasture, to whom the strip of woodland also belongs, needed access to the stream to water his cattle. In return for his surrender of that right, the community installed water tanks on his pasture. It also promised him support for two new enterprises: the production of blackberry to be sold for fruit juice processing and small-scale dairying based on the introduction of improved pastures.

Luis Fernando Pino

"Good fences make good neighbors," said poet Robert Frost. A rural community in Colombia is learning that a fence can bring them together rather than keep them apart, when its purpose is to isolate ecologically fragile areas for social benefit.

Negotiating change

Can the community deliver? Acting in its name is a new type of institution that promises more than skeptical local people, bypassed or cheated by development in the past, have come to expect. CIPASLA, the Consorcio Interinstitucional para una Agricultura Sostenible en Laderas, is an alliance of 14 government and nongovernment organizations (NGOs) united by a pledge to work together for responsible management of scarce natural resources (see list on page 40). The Consortium receives funding from the Kellogg Foundation and Canada's International Development Research Centre (IDRC).

Its underlying principle is that action can be taken only on the basis of a consensus between all the interest groups and individuals concerned. Its modus operandi is barter—if an individual or group makes a sacrifice for the sake of the community, they should get something in return. The negotiated exchange of goods and services provides a way out of poverty and the environmental degradation that accompanies it.

CIPASLA is trying to develop an institutional model capable of delivering peace and prosperity and so stemming the rising tide of conflict among Colombia's rural dispossessed. The alternative is a continuing slide into social turmoil. Members of one of its NGOs are former guerrillas, who have laid down their arms to try another way.

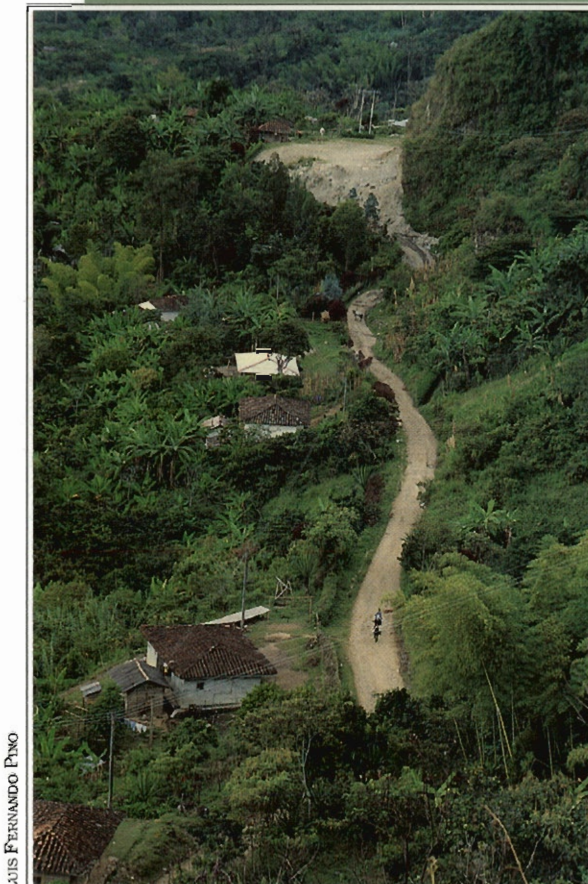
A landscape that unites

The inhabitants of the watershed scratch a living from small farms on acid, infertile soils, often with steep slopes vulnerable to erosion. Shortages of just about everything—land, water, labor, inputs, cash, credit, schools, clinics, roads, transport, and communications—frustrate their daily efforts to escape from poverty.

In this difficult setting, what difference can CIPASLA make? One of its most significant contributions so far has been to give local people a tangible, physical view of the landscape that unites them. Taking up much of the floor space in the Consortium's small office is a cumbersome but colorful relief model of the watershed (see page 48).

Built in papier-mâché, using maps generated by geographic information systems (GIS) at CIAT, the model was taken to each of the watershed's villages in turn, where local people painted in the streams, roads, fields, houses, and other familiar features. A standard color coding was used to denote land use—brown for coffee, deep green for pasture, dark brown for areas cleared by burning, bright red for eroded land, and so on.

The result is a powerful tool for stimulating group discussion and creating a sense of community. "At meetings, it gets even the most reserved people to contribute. They can't resist saying something when they see their own villages, even their own house, represented," says CIAT researcher Jorge Alonso Beltrán.



LUIS FERNANDO PINO

"People here have a new state of mind. Now, they're asking for trees to plant."

Rodrigo Vivas, Unidad Municipal de Asistencia Técnica Agropecuaria (UMATA), Colombia

The model focuses attention on key resource management issues, providing a means for agreeing on solutions. It has already inspired altruistic action. When children from a local school on the middle slopes of the watershed saw it, they grasped the significance of the deforestation problem on the upper slopes—an area that, for want of transport, they had never visited. The children immediately volunteered to help plant trees as their contribution to solving the problem.

A framework for research

The CIAT research for which CIPASLA provides a framework is both institutional and technical.

Institutional research addresses the crucial questions of whether CIPASLA's approach is effective, what principles underlie its achievements, and how these can be applied to other hillside areas. An important criterion of the approach's effectiveness is that it should give rise to agreements that stick. It must therefore be not only comprehensive but flexible, allowing negotiations between interest groups whose composition shifts with the issue under negotiation.

The Consortium has various mechanisms for ensuring that its activities respond to users' needs, including a beneficiaries' association with its own budget for projects. One of CIAT's research aims is to find ways of strengthening the role of this association.

The Center's technical research supports new productive enterprises that increase income-earning opportunities, while conserving or enhancing the natural resource base. A major opportunity identified so far is dairy production for nearby city markets, where demand for milk, butter, cheese, and yogurt far exceeds supply. CIAT scientist José Ignacio Sanz is investigating various options, including improved pastures intercropped with food crops—appropriate in flatter areas—and stall-feeding combined with cut-and-carry forages and legume tree barriers, which may suit hilly terrain.

Other possible new enterprises include fruit production linked to juice processing, market gardening, and handicrafts. Member organizations of CIPASLA have launched eight projects in these areas, emphasizing the needs of the poorest people living in the highest areas of the watershed, where options are most limited.

Real but fragile

CIPASLA's achievements are real but fragile. Working groups erected about 20 kilometers of fencing during the first year of the buffer zones project.

The Enchanted Lake

Through CIPASLA, communities in the Cabuyal watershed are slowly awakening to a new vision of themselves.

A potent symbol of the process is provided by the community of La Laguna, whose emblem, as the name suggests, is its lake—a once delightful spot, which according to local legend is enchanted. It had been allowed to deteriorate in recent years, becoming dirty and choked with weeds. Now a new project has been launched to clean up the lake in the hope of restoring both its enchantment and value as a natural resource.

Luis Fernando Pino

Their aim is to continue working down the watershed, securing agreements with each successive landowner. But will those agreements hold? "We keep our fingers crossed," says Beltrán.

CIPASLA's starting point is the simple credo of poor people everywhere: that by working together, sharing resources instead of competing for them, they can find a way forward. What's different, this time, is the all-embracing nature of the approach—its attempt to include all social elements, however marginal.

Dispelling Fear through Knowledge

In some areas of the Andean zone, farmers spray their crops about as often as they go to Mass—once a week. To them, the backpack sprayer has become an ordinary household item, just like the radio or bicycle.

The "chemical culture" embraced by these farmers is reinforced by habit and rooted in their fear of crop failure. Ironically, it may bring them the very thing they are trying so hard to avoid.

Luis Fernando Pino

Under a CIPASLA-sponsored project, extension workers from Colombia's Servicio Nacional de Aprendizaje are helping farmers establish organic gardens of aromatic and medicinal herbs, among other crops, for sale in nearby urban markets.

"Without CIPASLA I'd still be working with these same farmers. But with it I can offer them more."

Marco Tulio Zapata, Servicio Nacional de Aprendizaje (SENA), Colombia

"Each of the 20 women in the group stood up and described what she would do as leader. Some had never spoken out before. The quiet ones were the thinkers."

Roberto Hernández, Fundación para la Investigación y el Desarrollo Agrícola (FIDAR), Colombia

In a pattern ominously reminiscent of the buildup to previous disasters, the overuse of pesticides is leading to rising levels of resistance in key pests. Yields of common bean and other crops could crash unless farmers cut back, warns CIAT scientist César Cardona.

But the crash isn't inevitable. Through research funded by IDRC in Colombia, Ecuador, and Peru, Cardona and his colleagues in national institutions have become convinced that farmers can change their ways. The key to success is their participation in research that enables them to see for themselves that overusing chemicals doesn't pay—and that there are practical alternatives.

Getting to know the enemy

The first step was to diagnose the true extent of pest problems. These often turned out to be quite different from what farmers believed. For instance, the greenhouse whitefly, which they perceived to be a major threat, was not serious enough to warrant regular pesticide applications.

In contrast, farmers did not spray at all to control leafhopper, even though this pest reduced yields by as much as 40 percent. One pest, the leafminer, was virtually man-made: Until 1980 it had been insignificant, but continuous chemical control since then had increased its resistance while destroying its natural enemies.

Simple alternatives

Scientists then worked with the farmers to develop and test alternative pest control methods, known as integrated pest management (IPM), which can reduce chemical applications to a minimum.

Burning crop residues proved to be an attractive alternative. Farmers currently leave residues intact after harvest, providing a fertile breeding ground for insects that then infest other crops. At the scientists' invitation, farmers helped count the huge numbers of whiteflies and leafminers emerging from cages containing infested plant material. The experience convinced them to adopt the practice of burning on their own fields.

The potential of natural enemies was difficult to assess after years of chemical drenching. Nevertheless, the scientists were able to show that the natural enemies of leafminer would be capable of keeping this pest in check if their populations were allowed to recover. They succeeded in persuading some farmers to suspend spraying against the pest.

The scientists' biggest challenge is to induce farmers to replace routine spraying with the use of "action thresholds"—a more subtle approach requiring that they estimate the population levels of specific pests so as to decide when and when not to apply specific chemicals. If they are to adopt thresholds, farmers need simple sampling and monitoring methods that will nevertheless yield sufficient information to enable them to make the right decisions. Local institutions collaborating with CIAT have made

NATHAN RUSSELL

"Bathing" a bean crop in eastern Antioquia, Colombia.

good progress in developing such methods.

Farmers using the IPM package can achieve the same crop yields as when they spray routinely. They can also cut their pesticide use by as much as 70%, lowering the costs of production. This provides them with a good incentive to adopt the package, provided labor requirements can be kept low.

The real enemy

Ultimately, adoption depends as much on farmers' attitudes as on the technical or economic merits of the IPM package. "Some farmers are tired of spraying and are open to change," says Cardona. "Others are less likely to quit."

Sadly, pesticide use is taking a rising toll on farmers' health. CIAT's surveys show that up to 30 percent of farmers have suffered illnesses caused by exposure to chemicals within the past 10 years. Few wear protective clothing, and many eat or drink while spraying. As time goes on, increasing evidence of the health risks should persuade more and more farmers to cut down on spraying.

But if their yields crash, many farmers may be forced to quit sooner rather than later, and for economic rather than health reasons. The victims of previous crashes in Colombia and Peru were large-scale cotton growers. This time, small-scale farmers and a wider range of crops are involved. As a result, the crash may be more pervasive and far more devastating financially.

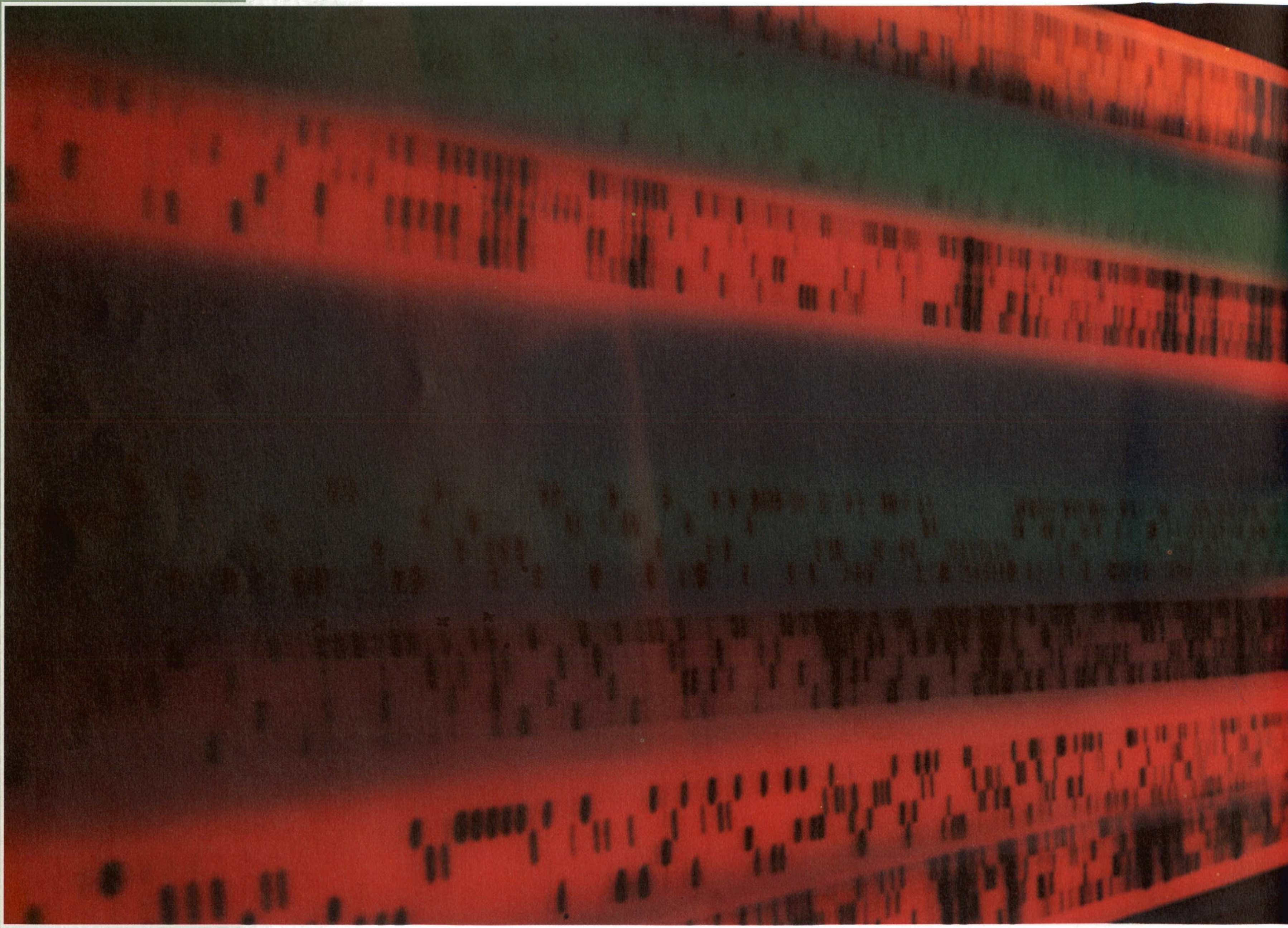
The farmers' real enemy is not so much the insects that attack their crops but the fear that drives their constant recourse to spraying. Only through knowledge can farmers dispel their fears and change their practices, paving the way for more sustainable crop production, a better environment, and healthier lives for themselves and their children.

The participatory on-farm research conducted by CIAT and its partners is a vital means of generating that knowledge.

NATHAN RUSSELL

"Farmers won't change just because the experts say so. They have to see proof."

María Teresa Ramón, Ministerio de Agricultura y Ganadería, Ecuador



Mauricio Antorveza

Enhancing our Vision of Plant Genomes

Specialists in the conservation and development of plant germplasm collect or select genotypes on the basis of careful observation. How well these scientists work depends on the power of the tools that help them see.

MAURICIO ANTORVEZA

Researchers at CIAT are rapidly adopting the use of molecular markers to enhance their vision of plant genomes and are better enabling colleagues in national programs to do likewise. With the aid of new biotechnology tools, we're discovering fresh approaches to old issues in plant genetic diversity and learning to perform tasks in crop improvement more efficiently.

"The first [complaint] is that PCR has made DNA research boring. . . . The solution is obviously to do things using PCR that were next to impossible before and are now conceivable but difficult."

Kary Mullis, discoverer of the polymerase chain reaction (PCR)

A Taste for Molecular Mapping

They won't forget Martin Fregene at the El Virrey restaurant. The Nigerian plant geneticist made quite a stir when he had lunch there while on holiday in the city of Tunja, central Colombia. Fregene had ordered *sancocho*, a thick soup accompanied by rice and chicken that is one of Colombia's best loved national dishes. One of its ingredients is cassava.

"It was the best I've ever tasted." His eyes light up with the memory. "I went straight into the kitchen and demanded to see the cook. I asked her where she got the plants and begged her to let me have some. She said her supplier was her uncle, whose farm was way up in the hills, at least half a day's journey away. 'Don't worry,' I answered, 'I'll pay your taxi fare.'"

A day later, a few precious sample plants were in Fregene's possession. They're now doing well in their new home at CIAT's research station.

It makes me dream

Fregene has good reason to be excited about his find. If the excellent taste and high starch quality of this Colombian cassava could only be introduced to varieties in Fregene's home country, the value of the African crop would rise, stabilizing farmers' incomes and increasing food security. "It makes me dream," he says.

Until recently, Fregene's dream was likely to remain just that. Cassava has two characteristics that make life difficult for the plant breeder. Its long time to maturity—12 months or more—means that at least 10 years are needed to develop a new variety. Worse still, most of the genes responsible for important traits are recessive, making breeding by conventional methods a game of blind-man's buff.

But now, with support from the Rockefeller Foundation, Fregene and his colleagues at CIAT are working on the development of a tool that could change all that—a molecular map of cassava.

Like a huge jigsaw puzzle

The CIAT team making the map combines advanced research skills with a strong users' perspective. Working with Fregene are plant breeder Merideth Bonierbale, who helped develop a similar map for potato at Cornell University in the USA; plant geneticist Joe Tohme; and molecular biologists Fernando Angel and Fernando Rodríguez.

The team began by crossing two contrasting plant types, a high-yielding Latin American variety bred by CIAT and a plant from Nigeria that yields less well but is resistant to

MAURICIO ANTORVEZA

CIAT scientist Martin Fregene observes the morphological traits of Colombian cassava clones noted for their superior taste.

African cassava mosaic virus, which causes extensive losses across sub-Saharan Africa. The progeny provided the raw material for the mapping exercise.

The map itself is made in three main phases. First, the scientists use restriction enzymes to cut each plant's DNA into fragments, forming what is called a genomic "library." This is really a misnomer, since the outcome at this stage is more like the jumbled pieces of a huge jigsaw puzzle. Next, they use segregating populations and markers to order the pieces into linkage groups—segments of DNA that are inherited together. These ultimately correspond to whole chromosomes. During this phase the pieces of the puzzle are fitted to form the broad outlines of the map. In the third phase, different markers are tested for their correlation with phenotypic traits in the parents and progeny. This phase, which requires a great deal of patience, refines the map's accuracy, pinpointing the position of individual genes on each chromosome.

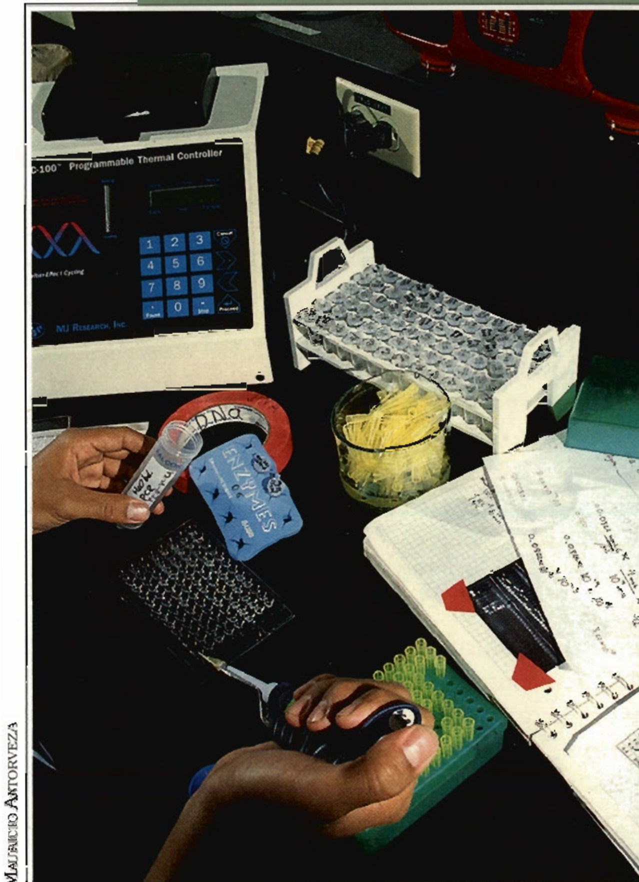
A lie detector

Molecular mapping is a painstaking task of mammoth proportions, but the final product should bring immense gains in the speed and accuracy of germplasm characterization and plant breeding.

"Using DNA markers, we will be able to screen hundreds of genotypes a day, instead of only 10 at present," says Carlos Iglesias, CIAT cassava breeder. "The markers will allow us to screen when plants are only a few weeks old, rather than wait until they reach maturity."

Problems with recessive genes will become a thing of the past. "Until now, we've had to depend on appearances for selection," says Iglesias. "Many cassava plants look alike but aren't. The map will be our lie detector, enabling us to delve beneath appearances to reach the genome." Iglesias hopes soon to be using markers to screen for recessive genes identified as responsible for resistance to African cassava mosaic disease. Other markers, for traits such as starch quality, will follow.

Who knows? Perhaps it won't be so long before millions more Africans can get the taste of Fregene's favorite Colombian cassava.



MAURICIO ANTORVEZA

"The advent of molecular markers has made it feasible to map and characterize the polygenes underlying quantitative traits."

Steven D. Tanksley, Professor, Cornell University, USA

The Extended Family of Common Bean

The problem with genetic diversity is that it's . . . well, diverse. You can never quite know where to find what you're looking for.

The extended nature of the bean family—five major cultivated species and a host of wild relatives—is a case in point. The germplasm collection held in trust at CIAT contains over 25,000 accessions of the common bean (*Phaseolus vulgaris*), any one of which could contain useful traits needed by plant breeders and farmers. Characterizing these accessions one by one would take researchers a lifetime.

"It's better to step back from the problem and adopt a more strategic approach," says Julia Kornegay, leader of CIAT's Bean Program. "The aim is to develop a predictive capacity that will guide plant collectors and breeders quickly and accurately to the germplasm they need."

In pursuit of this aim, CIAT researchers Steve Beebe, Joe Tohme, and Peter Jones are experimenting with a novel combination of technologies that will enable them to examine with precision the genetic diversity of food crops in developing countries. Their research tackles basic questions surrounding the domestication and spread of bean species.

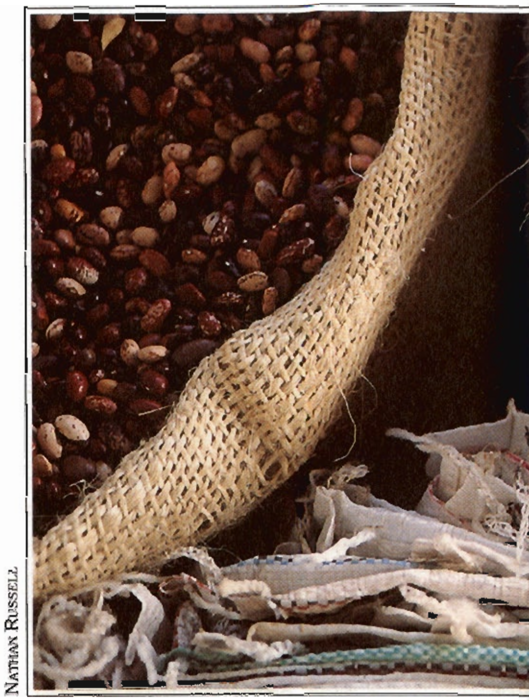
The raw material for their approach consists of two core collections of common bean, one domesticated and the other wild, selected as representative subsets of the main collection. The core collections are not a finished product but a research tool. They are continually refined by comparing their diversity with that of the main collection and including or discarding material accordingly.

Classification by molecular markers

Beebe and Tohme use molecular markers to evaluate the core collections for the real extent of their diversity at the genomic level and for desirable traits (see box).

They are first obtaining a general classification with a new type of marker referred to as amplified fragment length polymorphisms or AFLPs. Then, they will conduct further analysis using chloroplast and mitochondrial DNA.

One product of the research so far is a dendrogram expressing the genetic "distance" between different Latin American populations of wild



NATHAN RUSSELL

How diverse is diversity?

Appearances can be deceptive. In beans as in other crops, many important phenotypic traits, such as growth habit or seed color, are controlled by a few genes only. As a result, beans that look different from one another may in fact turn out to be genetically similar.

This raises intriguing questions. Africa today is renowned for the variety of its bean colors, shapes, and sizes, suggesting that farmers have done well in preserving or even enhancing the diversity originally brought to the continent by Portuguese traders 500 years ago. But how diverse is

their germplasm at the genetic level? Beebe and Tohme's research will help find out.

Greater diversity tends to occur in areas where there are fewer strict market preferences. In Rwanda and Malawi, for instance, farmers grow a wide range of beans in mixtures, partly because consumers are less particular about seed color and size and more concerned about cooking quality and other traits.

The diversity in farmers' fields plays a vital role in ensuring food security, since in any given season some bean types are likely to do well even if others fail.

P. vulgaris (see figure, page 20). Work is in progress on a similar dendrogram for domesticated populations.

Comparing the two will provide the scientists with clues as to where the common bean was first domesticated. They may also be able to spot untapped reservoirs of potentially useful wild genes and throw light on the vexed question of the so-called "founder effect." This is a narrowing of the genetic diversity in wild forms resulting from selective, localized domestication. The jury is still out on the extent of the effect in common bean.

"Once credible core collections emerge, these could be distributed to research institutions, giving them direct access to genetic resources that are now geographically remote."

Sir Otto Frankel, Honorary Research Fellow, Commonwealth Scientific and Industrial Research Organisation (CSIRO), Australia

Research cooperators observe a common bean core collection under evaluation in Tanzania.

JULIA KORNEGAY

A further objective will be to trace the probable pattern of man's past interventions in moving germplasm from one area to another. Where different germplasm occurs in ecologically similar areas, this should help determine what further new material might profitably be introduced.

Classification by agroecologies

Germplasm coevolves with the stresses it encounters in its environment. This means that a description of the environment can be a good indicator of the traits likely to be found there.

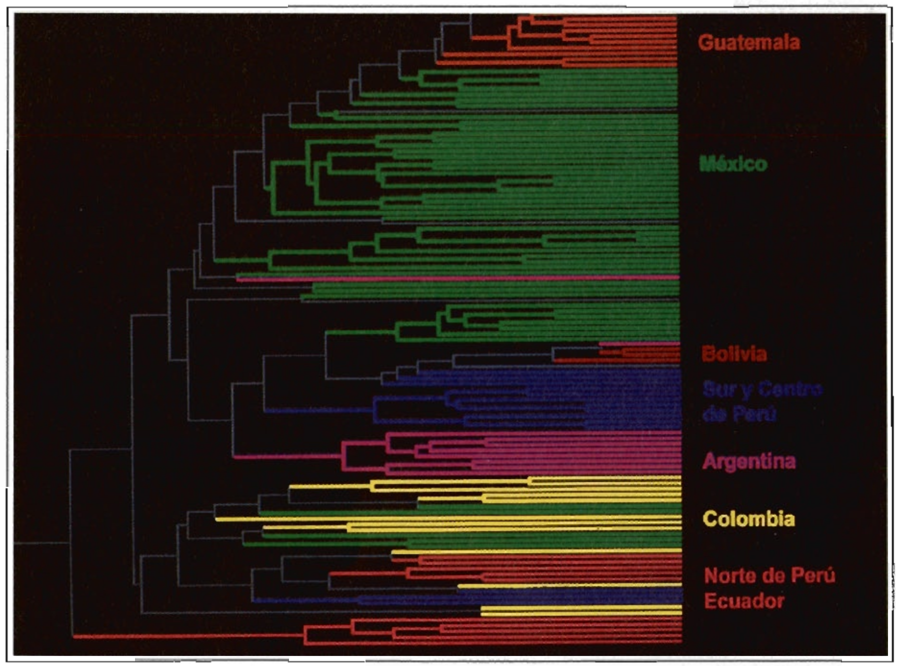
Using data on soils, water availability, length of growing period, and day length, Jones has come up with a total of 54 agroecologies around the world in which beans are or could be grown. These agroecologies, described in a GIS database maintained at the Center, can be used to sort accessions according to their place of origin.

The Latin American collection of wild *P. vulgaris* maintained at CIAT spans 8,000 kilometers from Mexico to Argentina. "We know the geographical coordinates for the collection site of each of the 1,000 or so accessions," says Jones. "So we look in the GIS database to find the climate at each site. We can then calculate the probability that other sites in the region will closely resemble those of the collection." The result is a computer-generated map showing all the areas in Latin America in which wild common bean could be expected to have evolved.

The map enables scientists to identify promising areas not well represented in the collection, providing guidance for future plant exploration missions. It can also help identify suitable sites for in situ germplasm conservation.

Combining the schemes

By putting the two classification schemes together, scientists hope to correlate genetic diversity as analyzed at the molecular level with diversity across agroecological classes. Their aim is to identify clusters—



This dendrogram describes the diversity of wild *P. vulgaris*. Its two major centers of diversity, the Mesoamerican and Andean gene pools, have long been known to scientists. But analysis at the molecular level has confirmed the existence of a third gene pool centered in the northern Andes and revealed the existence of subgroups within the main gene pools.

geographical areas strongly associated with a particular genotypic trait.

Of special interest are elusive traits that could be of value to farmers in marginal environments. An example is tolerance to low levels of phosphorus, which would increase the yields obtained on poor soils. Using the two classification schemes to analyze the core collections, scientists should be able to verify that, as previously documented, this trait is highly correlated with accessions from the state of Chiapas in Mexico. A breeder interested in selecting for this trait will then be able to request the gene bank to provide an array of material from the relevant geographical areas, drawn from both the core and reserve collections.

That's a lot more efficient than having to evaluate 25,000 accessions.

Molecular Espionage in Virology Research

The polymerase chain reaction (PCR) is about as close as you can come to creation ex nihilo. You start with a piece of plant tissue the size of a child's fingernail, from which you extract a single strand of DNA. After one cycle of PCR, there are two copies of this DNA; after 40 cycles, about a trillion.

PCR is a kind of genetic marker—a means of detecting the presence or absence of telltale pieces of DNA specific to certain organisms. But unlike other markers, it multiplies DNA, creating a broader base of genetic material from which to gain information. The essence of the technique is the use of a primer to trigger a chain reaction. The primer is a strand of DNA that "recognizes" and binds with its opposite number on a strand taken from the raw material to be analyzed.

The beauty of it

The beauty of PCR lies in its versatility, flexibility, and speed. All three characteristics give it advantages over conventional analytical methods and other genetic markers.

To take versatility first. "The number of applications is limited only

"First we have to find these plants . . . and describe them before we can hope to understand what each of them means in the great biological—and human—scheme of things."

Hugh H. Iltis, Director, University of Wisconsin Herbarium, USA

"PCR . . . has developed into one of the most powerful tools of modern biology, . . . and its applications are burgeoning."

***Daniel E. Koshland, Jr., Editor of* Science**

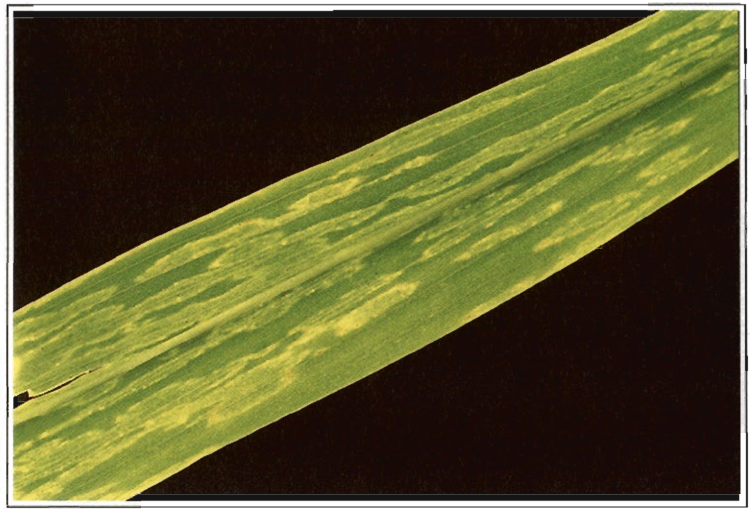
by our imagination," says Lee Calvert, who introduced PCR to CIAT's Virology Research Unit just over 3 years ago. In that short period, the technique has become routine, being used for such varied purposes as promoting the safe exchange of plant germplasm, detecting new viruses, verifying the efficacy of proposed biological control agents, and analyzing the genetic variability of pathogens.

The flexibility and speed of PCR are well illustrated by its applications in virology research. It can be used to detect either a whole family of viruses or specific members of that family. The degree of specificity depends on the kind of primer used.

"There are sequences of the virus genome that cannot change much from one species to another within a family," explains Calvert. "We use these to design primers that have variable base pairs, capturing the minute differences between sequences." These so-called degenerate primers, which are really amalgams of two or more pure primers, come in most useful when large quantities of material need to be scanned.

For instance, the CIAT collection of tropical forages contains over 700 species of grasses and legumes. Identifying all the viruses that attack

GUILLERMO GUZMAN



Symptoms of mosaic, caused by a potyvirus, on *Brachiaria* spp.

each one of these species would be a monumental task. Using a single test to detect whether any member of a particular family is present simplifies the job. Once a particular family of viruses is ruled out, no further tests are needed for it. CIAT now holds degenerate primers for all members of three major families of viruses—the gemini-, poty-, and cucumoviruses.

Pure primers are used for more precise identification. These tend to be longer sequences of DNA, unique to a particular species.

PCR's speed is perhaps its greatest advantage. The molecular fingerprint of an organism can now be obtained in a few days, instead of several weeks. It can then be compared with those available for other viruses in the ever-growing database of virus genomes maintained at CIAT. "PCR enables us to conduct business far more efficiently," says Calvert.

With PCR it's possible to amplify viral DNA direct from plant material, without having to isolate it beforehand. This saves both time and money, especially in the case of crops or viruses that are difficult to manipulate. It also makes the war against viral diseases safer, since whole live viruses need not be used, avoiding the risk of accidental release.

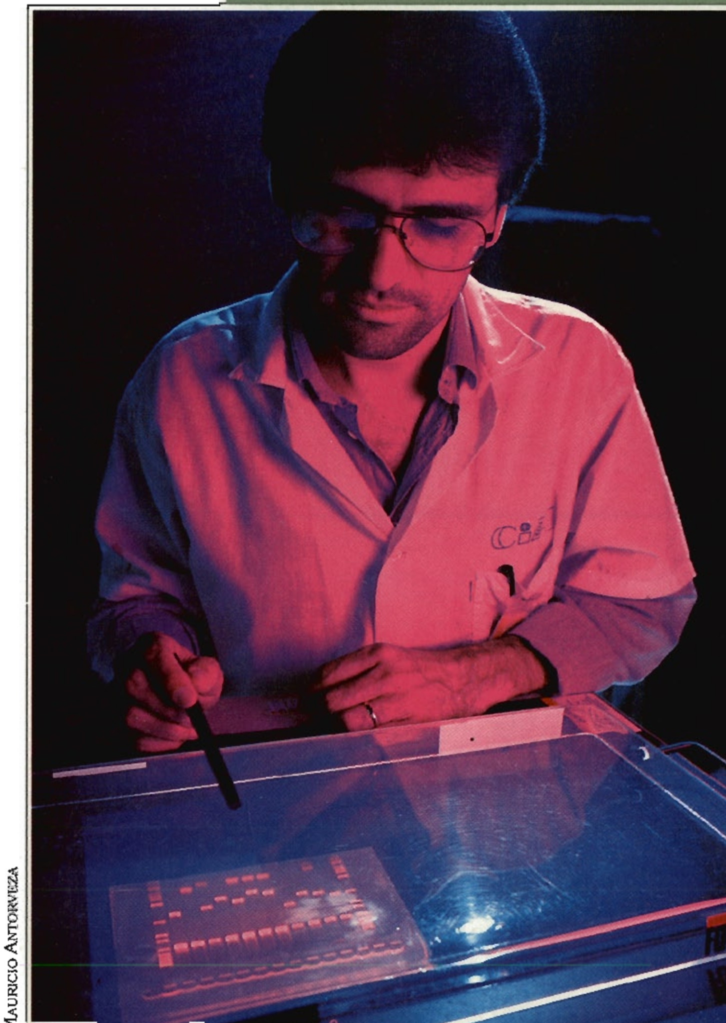
Speed is critical in studying the changing relationship between pathogens and their plant hosts. PCR can help scientists get on top of new disease threats as they develop. In a recent example, field researchers in Chile had noticed that beans were being attacked by a particularly virulent strain of what they took to be cucumber mosaic virus. In collaboration with Cornell University and the S.R. Noble Foundation in the USA and Italy's Institute for Applied Plant Virology, this virus was identified as a hybrid of cucumber mosaic virus and peanut stunt virus. Now, CIAT virologists have developed a PCR test capable of distinguishing the two viruses and identifying further hybrids. "Are we seeing viral evolution here?" asks Calvert. "We now have the tool to help us find out."

Surprisingly easy

Its versatility and low cost make PCR a highly suitable technique for national research programs. Brazil's Empresa Brasileira de Pesquisa Agropecuária (EMBRAPA) and University of Ceará, Fortaleza, have already acquired their own in-house capacity under a project funded by the United Nations Development Programme (UNDP).

In a demonstration at Ceará's Plant Virology Laboratory, there was a sense of excitement in the air as researchers discussed PCR's many possible applications, according to Calvert. "Many of them had thought of this as an exotic technique, expensive to introduce and difficult to use. They were pleasantly surprised to see how easy it is."

PCR is one of many new biotechnology tools developed in the industrialized North. As an international agricultural research institute, CIAT has an important part to play in applying such tools to the problems of tropical agriculture and in making new applications available to institutions in developing countries.



Mauricio Antorveza

Sam Fujisaka

From the Genetic to the Panoramic

Agriculture can be characterized as a hierarchy of complex, interacting systems that range in scale from the genetic to the panoramic.


ALVARO CUELLAR

At CIAT we believe that progress toward sustainable development requires research that examines intricate mechanisms within individual levels of the hierarchy and traces the links across them. The following reports describe seemingly disparate investigations on policy, soil science, and crop improvement that are, nonetheless, all related to severe problems of resource degradation in South America and even to environmental challenges at the global level.

"All landscapes have to be viewed from the angle of totality."

Shen Kua, 11th century Chinese art critic

The Decisive Factor in Deforestation

First the good news. Deforestation in Brazil's Amazon Basin, which aroused worldwide concern in the 1980s, has fallen to a fraction of its former level. From an estimated peak of 8 million hectares a year in 1987, satellite imagery shows a decline to 1.1 million in 1991 according to various institutes working with remote sensing.

And now the bad. The rate has stabilized and appears unlikely to fall much further. Two of the main forces driving deforestation—the need to grow food and the profitability of converting forest into pasture—remain as strong as ever.

The fall in the rate of deforestation suggests strongly that policy rather than technology is the decisive factor governing the fate of the world's largest remaining reserve of primary rain forest. The decline followed policy decisions taken by the Brazilian government in the mid- to late 1980s, when it withdrew tax breaks for ranching and wood products enterprises, put colonization on hold, and shelved much of its road building program.

The sequence of land use

Roughly a third of all deforestation in the Amazon Basin during the 1980s was associated with slash-and-burn agriculture. As part of a global search for alternatives (see box), CIAT scientists are conducting on-farm research in two heavily deforested areas of western Brazil, Pedro Peixoto and Theobroma, where the government, aided by the World Bank, launched colonization projects in the late 1970s. Both areas lie close to the main BR 364 road linking Cuiaba, in the south of the country, with Rio Branco, a frontier town where the

A quest for alternatives

Alternatives to Slash-and-Burn is a project that combines biophysical and policy research in an attempt to help save the world's last remaining reserves of primary rain forest.

Replacing slash-and-burn cultivation with more sustainable forms of land use requires technological interventions that cross sectoral boundaries and call on the resources of many different disciplines. It also requires strong policy backing. To meet these needs, the project pools the knowledge and experience of various international research centers besides CIAT (see list on page 40) as well as the relevant national institutions.

The project has selected benchmark sites at which to characterize the dynamics of deforestation before identifying and testing technological options that may help to prevent it. CIAT's research in the Brazilian Amazon is complemented by similar studies in Cameroon and Indonesia. Policy research and dialog with governments have also been initiated.

SAM FUJISAKA

tarmac, for the time being at least, comes to an abrupt end.

At both locations CIAT scientists and their collaborators with EMBRAPA's Centro de Pesquisa Agroflorestal (CPAF) found a sequence of land use typical of colonization projects. Settlers arriving from other parts of Brazil had been allocated 70- to 90-hectare parcels of uncleared forest. They clear small areas of this land at a time, by first slashing and then burning the vegetation. Burning releases the nutrients needed to support a high-value rice crop. But this the settlers can grow only during the first year of cultivation. Thereafter, they must resort to less lucrative crops such as maize and cassava.

After 2 or 3 years, the new farmers confront a crisis, as their crop yields plummet in the face of invading weeds and declining soil fertility. A few graduate to a higher management level, turning to perennial cropping and/or mixed farming, but most convert their land to low-grade pasture before either becoming cattle raisers themselves or selling up to larger ranchers. Nearly all decide to cut down more forest—and so a new cycle of slash-and-burn begins.

The limitations of technology

Under these conditions it is difficult to find technology that can increase productivity without provoking more deforestation, warns anthropologist Sam Fujisaka. "If we introduce a higher yielding rice, it may just attract more people, including nearby town dwellers, into the forest margins." Instead, breeders could try emphasizing such traits as rapid establishment and tolerance to low phosphorus, which might enable existing settlers to continue cropping rice in the second and third years.

Raising the carrying capacity of pastures has similar implications. Theoretically, it would take the pressure off surrounding forest areas. But at the same time it would increase

SAM FUJISAKA

The need to grow food is one of the main driving forces of deforestation.

"People migrating to the humid tropics seldom find a cornucopia. The equilibrium of shifting cultivation . . . is broken by the migrants and in some countries by land speculators."

***From* Alternatives to slash-and-burn: A global strategy**

the profitability of ranching, possibly providing fresh incentives to clear still larger areas and stimulating speculative investment in land.

Thus technology on its own is powerless. "It can reduce the need to deforest but not the incentives," concludes Fujisaka.

The incentives persist

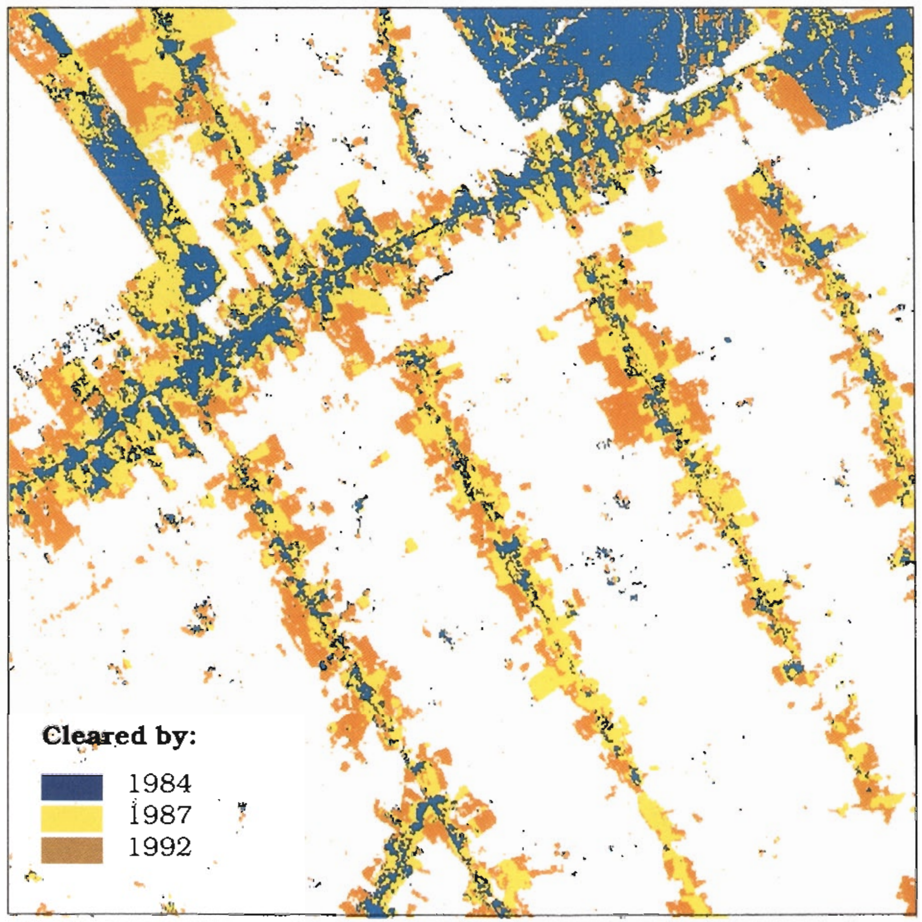
And despite the policy changes, the incentives persist. Ranching remains profitable, even without the tax breaks. Land speculation is rampant. Farmers can make more out of selling their land than they do out of farming. Merely clearing land is enough to raise its value considerably. Adding fencing, ponds, and housing drives prices up still further.

So what of the future? Are tropical rain forests destined to become no more than a powerful folk memory, or is there some hope of saving them? "Where settlement projects have been launched, my hypothesis is that clearance will continue until most land is converted to pasture, with smaller areas of annual and perennial crops and fallow land," notes Fujisaka.

In the vast remaining forest areas outside the colonies, the prospects look brighter, provided the current moratorium on policy incentives is maintained. But can it be? In a country where 70% of rural people are landless, the pressure to continue clearing is enormous. "Brazil has responded to international environmental concerns, but it has its own legitimate growth and equity objectives to pursue," says Fujisaka.

The country's government has recently announced its intention to extend the BR 364 from Rio Branco to the Peruvian border, opening a long coveted and potentially lucrative trade route to the Pacific coast and the markets of the Far East. Every new kilometer of tarmac spells more deforestation and escalating land prices.

Clearly, it isn't easy to find a middle road between conservation and development.



CIAT's research has confirmed the link between deforestation and road building. Tarmac gives the best access, so rates of clearance are highest along major roads.

An Unexpected Benefit of Improved Pastures

Deep-rooting savanna grasses introduced to Latin America in the 1970s may help reduce global warming by storing large amounts of atmospheric carbon in the soil. The discovery came by chance last year, when Raúl Vera, leader of CIAT's Tropical Lowlands Program, shared some data with a colleague.

It was a classic case of serendipity. The scientists had originally gathered the data as part of a study on nutrient cycling. CIAT has long been interested in deep-rooting grasses because of their ability to support increased livestock production on the savanna's acid, infertile soils.

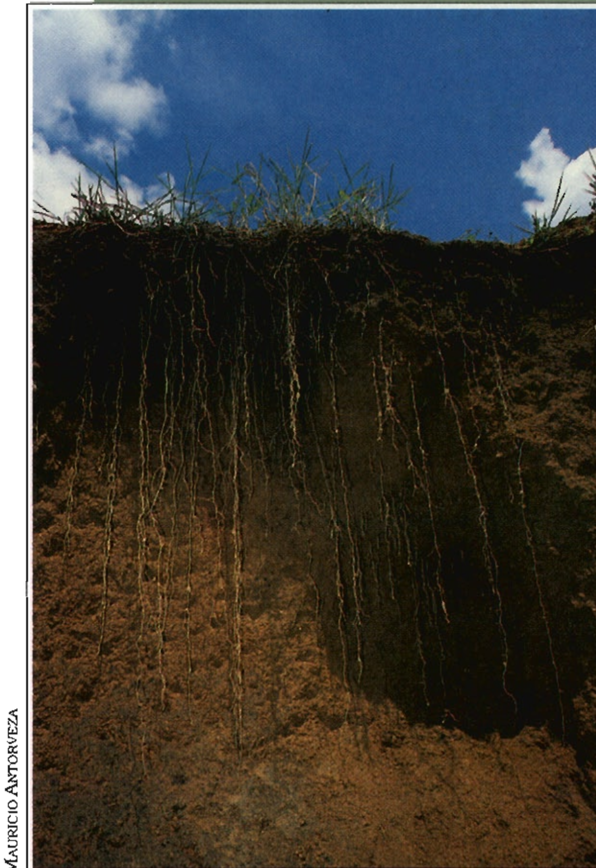
The missing sink

Ecophysiologist Myles Fisher and his colleagues checked their initial findings by collecting and analyzing further soil samples. In a letter to *Nature*, they published data on three improved pastures and adjacent native savannas at two sites in Colombia's Eastern Plains.

The improved pastures made a striking contribution to soil carbon, especially when grown as a grass-legume mixture. Each hectare of *Andropogon gayanus* or *Brachiaria humidicola* may store up to 53 tonnes of carbon dioxide as organic matter in the soil every year. "That's as much carbon as you get in the exhaust of a large car travelling 213,000 kilometers," says Fisher.

Carbon dioxide is a major "greenhouse" gas contributing to global warming. The burning of fossil fuels and tropical forests pumps an estimated 27 to 34 billion tonnes of it into the atmosphere yearly. Yet the annual increase in atmospheric CO_2 is only 13 to 15 billion tonnes. Oceans, tropical wetlands, and green plants absorb some of the difference, but the balance—the so-called "missing sink"—remains largely unexplained.

If Fisher's study sites are representative, deep-rooting grasses in the American savannas could account for 0.4 to 1.9 billion tonnes of CO_2 per year—a substantial part of the sink. "Most scientists do not sample soil organic matter at depths greater than 20 to 30 centimeters, with the result that the


Mauricio Antorveza

"This paper undoubtedly exposes an overlooked sink for atmospheric carbon."

Referee for Nature

carbon deposited at deeper soil levels simply wasn't detected," he explains.

Further research needed

But Fisher is the first to acknowledge the difficulty of extrapolating from his results. "These findings raise more questions than they answer," he says.

Carbon can only enter the soil through plants, so anything that restricts plant growth is bound to restrict carbon fixation. Of the 250 million hectares of South America occupied by savannas, about a seventh have been converted to improved pastures. When well managed, these produce about 10 times the biomass of native grasses. But much of the area converted has undergone degradation caused by overstocking. In addition, large areas are taken up by *Brachiaria decumbens*, which has a shallower root system and is susceptible to spittlebug.

On the plus side, unlike native savanna, improved pastures are seldom burned. So converting to them cuts carbon dioxide emissions anyway, regardless of the additional effect of the rooting system. Moreover, most of the carbon stored by the improved grasses is so deep in the soil that it will be undisturbed by the plow, if farmers decide to rotate pastures with crops.

Carbon fixation by deep-rooted grasses cannot continue indefinitely. "Though we don't know how or when, a new equilibrium will eventually be reached in the soil," Fisher explains. "While the phenomenon allows us some breathing space, it's no substitute for cutting global emissions of greenhouse gasses, especially those caused by deforestation."

Fisher plans further research at a wider range of locations to verify his findings and assess their implications.

Tiny Culprits behind a Huge Problem

Across huge tracts of once productive pasture, the grass is scorched and withered, as if by severe drought. Yet it has rained every day for the past month. Paradoxically, the more rain falls, the worse the problem gets.

Approaching the catastrophic

The culprit is the aptly named spittlebug, an insect whose larvae exude a frothy white mass to shield themselves from predators and maintain the moist habitat they need to survive and grow. Concealed by the froth, the larvae suck greedily on the juices of first the roots and then the stems and leaves of *Brachiaria decumbens*, desiccate tropical America's most productive and popular commercial variety of grass.

The damage caused by the pest approaches the catastrophic. The bug is thought to have munched its way through around 10 million hectares or 20 percent of Brazil's improved pastures. In a recent survey in Colombia's Eastern Plains, where there are 130,000 hectares of *Brachiaria*, 60 to 80 percent of all farms reported infestations. Losses to the livestock sector were estimated at US$60 per hectare.

The only effective solution is to develop and disseminate resistant varieties. That's the task of a joint project between CIAT and EMBRAPA.

The search for resistance

The center of origin of *Brachiaria* species is tropical Africa. A resistant line of *B. brizantha* from the region was identified by EMBRAPA and released in Brazil several years ago, but it performs less well than *B. decumbens* on the acid infertile soils of the savannas. Scientists returned to Africa to identify further sources of resistance. In collaboration with national research groups and a team from the International Livestock Research Institute (ILRI), they collected nearly 800 accessions in six African countries.

The scientists began screening to identify resistant accessions on research stations in Brazil and Colombia. But they soon ran into problems.

The spittlebug is highly sensitive to factors such as rainfall amount and distribution. It also has a unique life cycle, in which the hatching of some eggs is delayed until the season following the one in which they are laid. For these reasons it is difficult to establish the pest uniformly in field experiments and so to regulate the degree of challenge to which plants are subjected.

The search for solutions has yielded several promising alternatives. The bug can now be reared in large numbers in the greenhouse, where more reliable techniques for screening have been developed. Meanwhile, scientists are seeking to understand the mechanisms of resistance—work that may help them identify molecular markers for the trait.

A further difficulty in screening is that species of spittlebug differ across the continent, making it uncertain whether an accession performing well in one location will do so in others. "This is one reason why we value our

MAURICIO ANTORVEZA

collaboration with EMBRAPA," says John Miles, CIAT plant breeder. "We exchange materials and methods with them, and both partners are able to screen varieties over a wider range of locations."

Scientists have found 25 accessions of *B. brizantha* and 2 of *B. jubata* with high levels of resistance. The challenge now is to transfer this resistance to the more productive and better adapted genetic background of *B. decumbens*.

"The molecular genetic map of *Brachiaria* being developed at CIAT will help us improve the efficiency of our selection for spittlebug resistance."

Cacilda do Valle, Plant Breeder, Centro Nacional de Pesquisa de Gado de Corte (CNPGC), Brazil

NATHAN RUSSELL

Business *Not* as Usual

The recent high-level meeting of donors in Lucerne, Switzerland, reinforced a vital point about the planning, support, and execution of agricultural research for sustainable development: Business as usual is no longer acceptable; a broad agenda demands broader participation and more equal sharing of responsibilities.


NATHAN RUSSELL

CIAT has entered into various arrangements during recent years that demonstrate the possibilities for wider cooperation. We hope these undertakings will serve as prototypes for the research environment of today and tomorrow.

"This, more than ever before, is the time for a united front of the caring."

Ismail Serageldin, Chairman of the CGIAR System

The Best in North-South Cooperation

The search is on for ways of regenerating genetically engineered cassava plants. Eight different laboratories around the world are working together on the problem.

They probably wouldn't be, if it weren't for the Cassava Biotechnology Network (CBN), an imaginative North-South cooperative initiative coordinated from CIAT (see list of partners on page 41). Most biotechnology laboratories are still in the industrialized countries. They tend to work on problems and commodities with strong interest groups behind them, typically private-sector agroindustrial companies. He who pays the piper calls the tune.

Winning advocates

"Being a poor persons' crop, cassava has few advocates round the table when research funds are allocated," notes Ann Marie Thro, the Network's coordinator. "Our job is to change that." On this criterion alone, CBN has already been successful. When it began in 1988, fewer than 10 projects around the world were developing biotechnologies for improving cassava. Now there are over 50.

That isn't all due to the Network's efforts, but CBN plays an important part in building collaboration through its small grants program, explains Thro. The small grants, provided by the Directorate General for International Cooperation (DGIS) in The Netherlands, go mainly towards the planning of joint projects between developed and developing countries. They are conditional on participation by at least one national institution in the South. The projects themselves are funded mostly by other donors.

Geared to users' needs

CBN promotes research that is firmly geared to users' needs. Participants began by developing a list of priorities, based on what they knew of the problems facing small-scale cassava farmers and processors. A team of researchers visited villages in Tanzania, Brazil, and China, where

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CBN assigns high priority to research on cryopreservation or ultrafreezing for long-term conservation of cassava genetic resources.

cassava is a vital food crop, to find out how biotechnology could help them.

Top of the list of priorities is the development of reliable methods of regenerating genetically engineered cassava plants—a problem that is blocking progress in other areas. When new genes are transferred to a plant cell, the whole plant must be recreated from that cell; otherwise it will be only partially transformed.

This is notoriously difficult in cassava, in which cells that can be transformed lie close to the plant's surface and cannot be regenerated, while those that allow regeneration lie deep within the plant and are not easily transformed. Several laboratories have recently reported promising results, using methods such as embryogenic suspensions, agrobacteria, and particle guns. "As soon as we get a reliable protocol, we'll transfer it to national programs," says Thro.

Solving the regeneration problem will open the door to other applications directly related to farmers' needs. Several pests and diseases, for example, can be tackled through gene transfer.

The most urgent need is to control African cassava mosaic virus, a severe new form of which has broken out in Uganda and is threatening to spread rapidly. A project on this topic links laboratories in the USA and France with a team at the University of Zimbabwe. The scientists have identified genes within the virus itself that can be used to block its replication and movement, stopping the disease. These have been successfully expressed at the cellular level in cassava and at the plant level in tobacco.

Who benefits from such research? CBN is about changing the answer to that question. Many cassava-growing countries are among the world's poorest and lack trained staff and facilities for the more sophisticated forms of biotechnology research. By bringing new resources to bear on their problems, the Network exemplifies all that is best in North-South cooperation.

NATHAN RUSSELL

"CIAT has been a logical partner for us in operating CBN."

Th. J. Wessels, Head, Biotechnology and Development Cooperation, DGIS, Netherlands

Networking with a Difference

Asked about the new Fondo Latinoamericano de Arroz de Riego (FLAR), its executive director Luis Sanint strikes a note of cautious optimism. "I think it's moving strongly in the right direction," he says, "but the model still involves some risks at this stage."

The caution is understandable. The budget for CIAT research on irrigated rice was cut back severely in the early 1990s. In a trip round national collaborators, Sanint had to explain that, if Latin American countries wanted continuing cooperation in this field, they would have to pay for it.

And that's exactly what some of them are now doing. A new regional fund that harnesses a mix of public- and private-sector resources has been launched to overcome the cash crisis.

A lead role for farmers associations

Rice research in Latin America has proved immensely profitable in the past. "Everyone knows they derived great benefits from the new semidwarf plant types," says Sanint. Some of those same profits are now being plowed back into further research, this time driven strongly by farmers.

Countries that have been quickest to sign up to FLAR are those with strong rice farmers associations. Following a model widespread in the industrialized countries but still rare in the developing world, associations such as the Federación Nacional de Arroceros de Colombia (FEDEARROZ) and southern Brazil's Instituto Rio Grandense do Arroz (IRGA) have long supported national research. Now they have decided to chip in to international research as well.

Public-sector support for FLAR is coming from countries such as Uruguay and Venezuela, both of which are allocating funds through their government research institutions. At the regional and international level, contributions have been received from the Instituto Interamericano de Cooperación para la Agricultura (IICA), the International Rice Research Institute (IRRI), and CIAT.

Other countries are eager to join but have yet to find a funding mechanism. They include Argentina and Ecuador, where rice farmers

MAURICIO ANTORVEZA

Irrigated rice production in southwestern Colombia.

associations have been formed only recently. In the Dominican Republic, researchers and farmers are seeking government support for membership.

Forging a common agenda

If raising money for the new fund has proved easier than expected, deciding on a common research agenda is more problematic. When the private sector is involved, it must perceive research to be directly relevant to its needs. As one country representative remarked, "We want benefits now, not in the year 3000."

The two major priorities on which all members agree are the exchange of germplasm and the breeding of parent material for new varieties. After that it gets more difficult: Countries say they want to work together, yet none wants to subsidize research that benefits only the others.

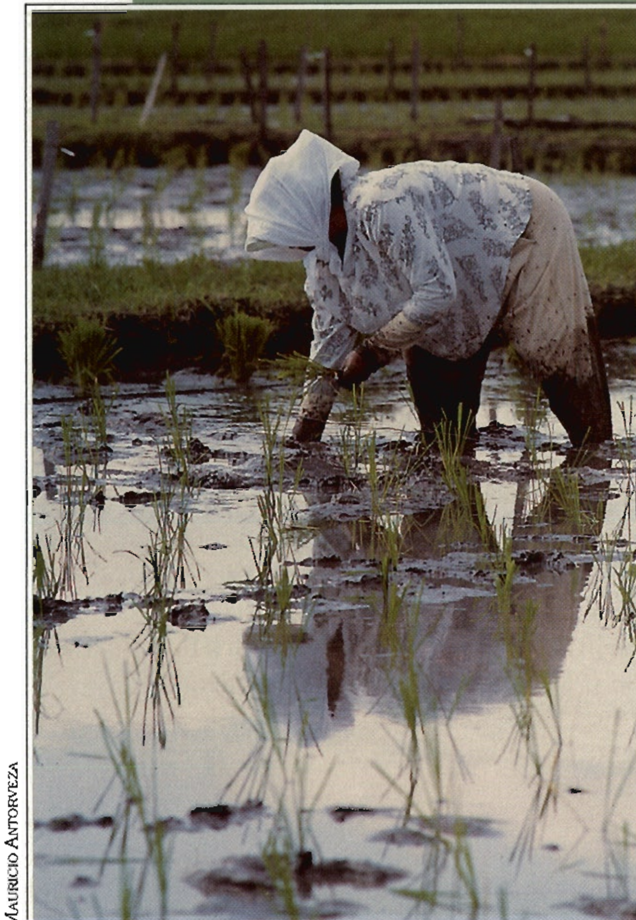
The region has two contrasting types of rice-growing environment: the tropical north, where resistance to a wide range of pests and diseases is needed, and the temperate south, where characteristics such as cold tolerance become more important. And within each of these broad categories, there is infinite variation. Varietal development for site-specific stresses is best left to individual members, concludes Sanint.

A promising start

The Fund was officially launched on 16 January 1995, when its founding members signed the Act of Acceptance. They lost no time in getting to work: A breeder has already been recruited to cover germplasm exchange and enhancement. "Let's get those two priorities covered before we address other concerns," says Sanint.

Despite the Fund's rapid start and the obvious commitment of its founding members, its budget for 1995 is still less than half the amount that CIAT used to allocate to irrigated rice. Sanint is anxious to build on the promising start by finding more research partners and raising additional funds.

FLAR is a new networking model that gives farmers a powerful voice in defining the research agenda. With its strong client orientation, it merits widespread support.



MAURICIO ANTORVEZA

"The Fund's results may range from good to revolutionary but will never be bad."

Carlos Mas, Regional Director, Instituto Nacional de Investigación Agropecuaria (INIA), Uruguay

Seeds of Hope

When troops of the Rwandan Patriotic Front swept southward through the country in April-May 1994, many farmers fled without harvesting their crops. It was feared that seeds needed for the next season's planting would be lost, leading to widespread famine. With them would vanish valuable genetic diversity—the heritage of future farming generations.

CIAT, which had supported bean research in the country since the mid-1980s, first consulted national research programs in neighboring countries as well as other centers in the CGIAR system (see list on page 41) about the need for vigorous joint action.

The international community responded promptly and generously to an appeal for help. In less than 5 weeks, a consortium of international agricultural research centers had raised US$1 million for a project that would pursue two strategies in close cooperation with NGOs and national research programs in several African countries. The first was aimed at helping NGOs find appropriate varieties and seed sources and the second at restoring lost genetic diversity.

Targeting seed aid

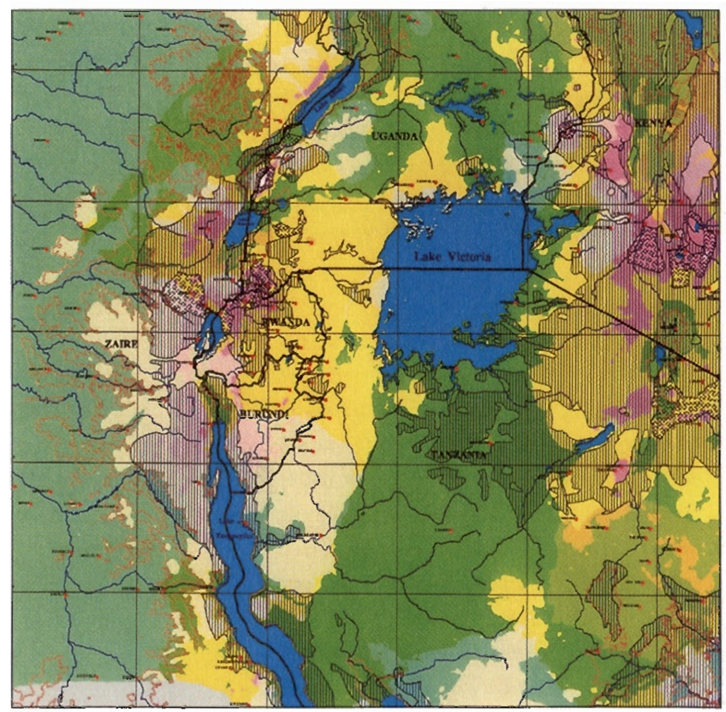
In disaster relief, seed aid is a vital complement to food aid, since it ensures the rapid recovery of agriculture after the emergency is over. The Seeds of Hope project demonstrated that the Centers can play a crucial part in ensuring that seed aid is effective.

"Seeds are our business," says William Scowcroft, former deputy director general for research at CIAT. Center staff advised the NGOs on where to get seed adapted to Rwanda's diverse environments. This probably prevented a huge influx of unadapted food aid beans for sowing according to Roger Kirkby, coordinator of CIAT bean research in Africa.

Restoring genetic diversity

To help farmers resume their practice of managing complex varietal mixtures (see box, page 19), bean researchers multiplied seed of about 230 Rwandan varieties for distribution in small amounts. A first round of bean seed multiplication began at CIAT headquarters near Cali, Colombia, in late April 1994. Other agencies and locations quickly followed suit for other crops.

National research systems of neighboring African countries played a vital role in seed multiplication. A major supplier was southern Uganda, which combined agroecologies similar to those of northern Rwanda with good road access into the north of the country. Distant Malawi increased seed of over 200 Rwandan bean landraces and sent 800 kilograms to Tanzania for further multiplication.



The major bean-growing ecologies of Rwanda and other countries in eastern and southern Africa.

In retrospect, the war may have had a less catastrophic effect on seed supplies than was at first feared. Initial surveys to gauge impact suggested that a sizable number of farmers had managed to save some seed, either burying it or hiding it in their homes, or else taking it with them when they left. Most farmers lost some bean varieties, but not all lost the same ones. They were able to swap seeds with their neighbors or buy them at local markets.

"But we had to assume a worst case scenario," explains Julia Kornegay, leader of CIAT's Bean Program. If the war had gone on longer or if the following season had been drier, losses of bean genetic diversity would almost certainly have been far worse.

One of the varieties worst hit by the fighting was an improved climbing bean recently introduced from Mexico by CIAT and the Institut des Sciences Agronomiques du Rwanda (ISAR). This is highly popular with Rwandan farmers because it grows relatively well on poor soils. Future seed multiplication and distribution efforts will concentrate on this and other varieties and species for which seed supplies still fall well short of demand.

Countless incidents reported by project staff testify to the dedication of some Rwandans, as they tried to save the seeds so vital for future harvests. A technician at ISAR's Rwerere Station stayed behind to harvest the seeds of Rwanda's multilocation bean trials and hid them in friends' houses as fighting in the region intensified. A woman working for World Vision was seen at the Ruhengeri Station harvesting potatoes from one end of a trial plot as soldiers dug up a free dinner at the other.

A shattered research system

A major casualty of the war was Rwanda's research system. Some of the country's agricultural scientists and technicians are dead; many more are in exile, in hiding, or in prison. The gene bank at the Rubona Station, near Butare, was ransacked during the fighting. Here and at other stations, vehicles, computers, and other equipment were stolen or wrecked.

There is an urgent need to train new staff, repatriate germplasm, and repair the material damage. As a step toward redeveloping national capacity, most seed multiplication has now been shifted to locations inside Rwanda.

"By 1986 all our materials had been looted, and farmers had eaten their seeds. We requested replacement seeds preserved by CIAT and other national programs. Now we must do the same for Rwanda."

Israel Kibirige-Sebunya, Director, Kawanda Research Station, Uganda

"We can provide farmers with small quantities of the varieties they prefer, so they can multiply them to meet the seed demand of their communities."

Jim Hooper, Agriculture Manager, World Vision, Rwanda

Seeking Synergy

CIAT staff have always cooperated with a wide range of national and international partners. But today we work on a more crowded stage than ever before.

That is a consequence of our commitment to research for sustainable development. A broader research agenda requires broader participation—"business *not* as usual." Clearly, this entails a greater investment in planning and organization. But the costs are far outweighed by the value of the synergy that institutions can generate when they apply their diverse talents in unison to a common cause.

In earlier sections of this report, we've mentioned various research cooperators. Here we acknowledge key players in projects reported in this publication that have particularly complex institutional arrangements.

A Hillsides Consortium

CIPASLA is an alliance of 14 organizations, including CIAT, that are working to improve resource management in a hillside community of southwestern Colombia (see page 8). The Consortium also provides a framework for Center research that is relevant to a wide range of hillside environments in the Andean Zone.

Colombian government:

Corporación para la Reconstrucción y el Desarrollo del Cauca (Corporation for the Reconstruction and Development of Cauca)
Corporación Autónoma Regional del Valle del Cauca (Autonomous Regional Corporation of Valle del Cauca)
Fondo de Cofinanciación para la Inversión Rural (Fund for Cofinancing Rural Investment)
Instituto Nacional de Adecuación de Tierras (National Institute of Land Management)
Secretaria de Fomento al Desarrollo Agropecuario del Cauca (Cauca Secretariat of Agricultural Development)
Servicio Nacional de Aprendizaje (National Training Service)
Unidad Municipal de Asistencia Técnica Agropecuaria/Caldono (Caldono Municipal Unit for Technical Assistance in Agriculture)

Nongovernment:

Corporación para Estudios Interdisciplinarios y Asesorías Técnicas (Corporation for Interdisciplinary Studies and Technical Assistance)
Corporación para el Desarrollo de Tunía (Corporation for the Development of Tunia)
Federación Nacional de Cafeteros (National Federation of Coffee Growers)
Fundación para la Investigación y el Desarrollo Agrícola (Foundation for Agricultural Research and Development)
Fundación Sol y Tierra (Sun and Earth Foundation)
Red Nacional de Cooperación para el Ordenamiento y Manejo de las Cuencas Hidrográficas (National Network for Cooperation in the Organization and Management of Watersheds)

Alternatives to Slash-and-Burn

The international institutions taking part in this project (see page 26), financed by the Global Environment Fund (GEF) under UNDP sponsorship, work with many national partners at locations in Brazil, Cameroon, and Indonesia:

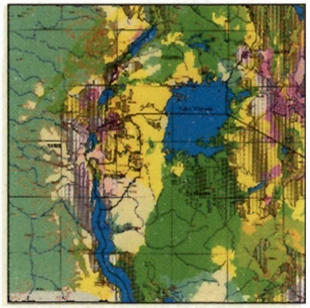
Centro Internacional de Agricultura Tropical, Colombia
Centre for International Forestry Research, Indonesia
International Centre for Research in Agroforestry, Kenya (global coordinator)
International Fertilizer Development Center, USA
International Food Policy Research Institute, USA
International Institute of Tropical Agriculture, Nigeria
International Rice Research Institute, Philippines
Tropical Soil Biology and Fertility Programme, Kenya

Cassava Biotechnology Network

The Network serves a large number of national research institutes in developing and developed countries (see page 34). Its principal members are:

Centro Internacional de Agricultura Tropical, Colombia
Directorate General for International Cooperation, Netherlands
International Institute of Tropical Agriculture, Nigeria
Natural Resources Institute, UK
French Institute of Research for Cooperative Development

Seeds of Hope



This project brought together hundreds of people working for many different institutions, including about 50 NGOs (see page 38). Space precludes mention of them all. Among the major contributors were the following:

International agricultural research centers:

Centro Internacional de Agricultura Tropical, Colombia
Centro Internacional de Mejoramiento de Maíz y Trigo (International Maize and Wheat Improvement Center), Mexico
Centro Internacional de la Papa (International Potato Center), Peru
International Centre for Research in Agroforestry, Kenya
International Crops Research Institute for the Semi-Arid Tropics, India
International Institute of Tropical Agriculture, Nigeria
International Livestock Research Institute, Ethiopia
International Plant Genetic Resources Institute, Italy

Nongovernment organizations:

Belgian Relief Agency
CARE
CARITAS
Catholic Relief Service
Concern
Food and Agriculture Organization of the United Nations
German Agency for Technical Cooperation
International Commission for the Red Cross
Médecins Sans Frontières
Swiss Disaster Relief
TROCAIRE
United Nations International Children's Fund
World Bank
World Vision

National research systems:

Burundi
Ethiopia
Kenya
Malawi
Rwanda
Tanzania
Uganda
Zaire

Donors:

Australian Agency for International Development
International Development Research Centre, Canada
Overseas Development Administration, UK
Swiss Development Corporation
United States Agency for International Development
World Vision, Australia

Core Donors

Australia
Belgium
Brazil
Canada
China
Colombia
Denmark
European Union
Ford Foundation
France
Inter-American Development Bank
Germany
Japan
Netherlands
Norway
Rockefeller Foundation
Sasakawa Foundation
Spain
Sweden
Switzerland
United Kingdom
United Nations Development Programme
United States of America
World Bank

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* Left in 1994.
** Left in 1995.

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J. Samuel Fujisaka, Anthropologist
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Thomas Hargrove, Editor and Head, Communications Unit

Scientific Publications

CIAT staff published about 35 articles in refereed journals during 1994. A complete listing of those and other publications is available from the Center's Information and Documentation Unit.

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Yoshimitsu Saito, Ecologist (Tropical Forages Program), JIRCAS
Valerie Verdier, Plant Pathologist (Cassava Program), ORSTOM

Acronyms

CATIE Centro Agronómico Tropical de Investigación y Enseñanza (Center for Research and Teaching in Tropical Agriculture), Costa Rica
CBN Cassava Biotechnology Network
CGIAR Consultative Group on International Agricultural Research
CIMMYT Centro Internacional de Mejoramiento de Maíz y Trigo (International Maize and Wheat Improvement Center), Mexico
CIPASLA Consorcio Interinstitucional para una Agricultura Sostenible en Laderas (Interinstitutional Consortium for Sustainable Agriculture in Hillsides), Colombia
CIRAD Centre de Coopération Internationale en Recherche Agronomique pour le Développement (Center for International Cooperation in Agricultural Research for Development), France
CNPGC Centro Nacional de Pesquisa de Gado de Corte (National Center for Research on Beef Cattle), Brazil
CORPOICA Corporación Colombiana de Investigación Agropecuaria (Colombian Corporation for Agricultural Research)
CPAF Centro de Pesquisa Agroflorestal (Center for Research on Agroforestry), Brazil
EMBRAPA Empresa Brasileira de Pesquisa Agropecuária (Brazilian Enterprise for Agricultural Research)
FEDEARROZ Federación Nacional de Arroceros de Colombia (National Federation of Colombian Rice Growers)

FIDAR Fundación para la Investigación y el Desarrollo Agrícola (Foundation for Agricultural Research and Development), Colombia

FLAR Fondo Latinoamericano de Arroz de Riego (Fund for Latin American Irrigated Rice)

GIS geographic information system

ICA Instituto Colombiano Agropecuario (Colombian Institute of Agriculture)

IDRC International Development Research Centre, Canada

IFDC International Fertilizer Development Center, USA

IICA Instituto Interamericano de Cooperación para la Agricultura (Inter-American Institute for Cooperation in Agriculture), Costa Rica

IIMI International Irrigation Management Institute, Sri Lanka

IPGRI International Plant Genetic Resources Institute, Italy

INIA Instituto Nacional de Investigación Agropecuaria (National Institute of Agricultural Research), Uruguay

INTSORMIL International Sorghum and Millet Program, USA

IPM integrated pest management

IRGA Instituto Rio Grandense do Arroz (Rio Grande Rice Institute), Brazil

ISAR Institut des Sciences Agronomiques du Rwanda (Rwandan Institute for Agricultural Science)

JIRCAS Japan International Research Center for Agricultural Sciences

NGO nongovernment organization

NRI Natural Resources Institute, UK

OEA Organización de los Estados Americanos (Organization of American States)

ORSTOM Institut Français de Recherche pour le Développment en Coopération (French Institute of Research for Cooperative Development)

PCR polymerase chain reaction

SENA Servicio Nacional de Aprendizaje (National Training Service), Colombia

UMATA Unidad Municipal de Asistencia Técnica Agropecuaria (Municipal Unit for Technical Assistance in Agriculture), Colombia

UNDP United Nations Development Programme

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Luis Fernando Pino

The Power of Perspective

Luis Fernando Pino

These farmers and other members of their community in Colombia's Cauca department have learned not only that "seeing is believing," according to the popular phrase, but that seeing is a start toward caring and acting.

By better enabling these people to visualize a shared environment, the locally made relief model shown here has awakened them to a new vision of themselves and to new possibilities for preserving natural resources and improving community welfare.

"As a farmer I do research every day. I look, think, and ask myself why. Depending on the answer, I act."

Pedro Herrera, farmer, Colombia

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