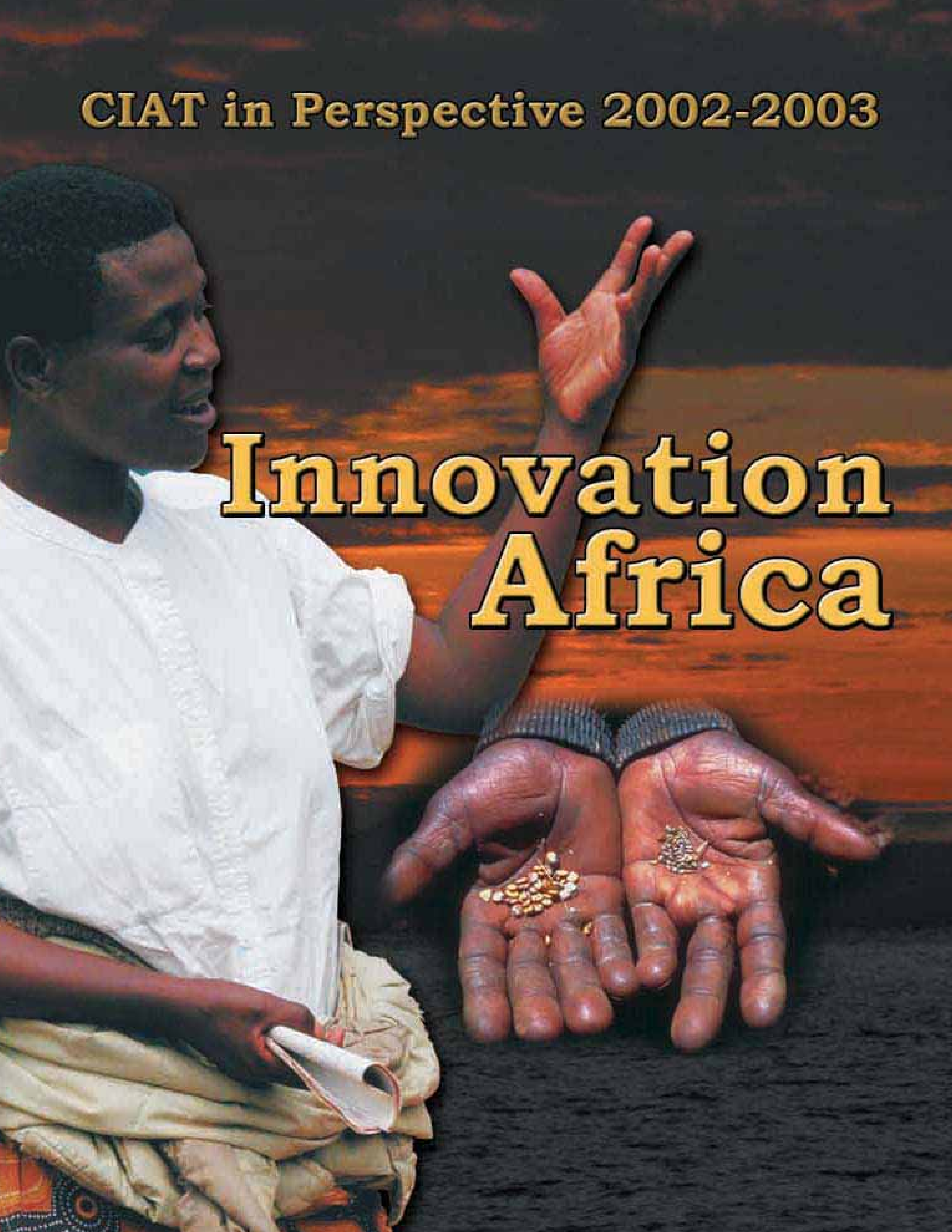
CIAT in Perspective 2002-2003

Innovation Africa



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Isaac Ekise of CIAT's Tropical Soil Biology and Fertility (TSBF) Institute works with the Mukhombe farmer field school in Emuhaya division of Vihiga District.

Perspective in Practice

The dire state of sub-Saharan Africa's agriculture may not be hard news for the international media. But for the International Center for Tropical Agriculture (CIAT) and other organizations devoted to improving rural livelihoods, it is one of two messages that bear constant repetition. The other—more optimistic and less frequently heard—is that African farmers, the poorest of the poor, are ready, willing, and able to confront many of their own problems through group action, backed up by socially and environmentally progressive agricultural science. "We see tremendous potential for community-based innovation," says CIAT research director Douglas Pachico. "The Center is fully committed to stimulating that process."

In this issue of *CIAT in Perspective*, our annual report for 2002-2003, we look mainly at how the Center is working with its many African partners to integrate the various threads of its research on competitive agriculture, natural resource management, and community empowerment. Our intention is to ensure that innovations in these areas, thoroughly tested by clients, reinforce each other at the level of day-to-day rural life.

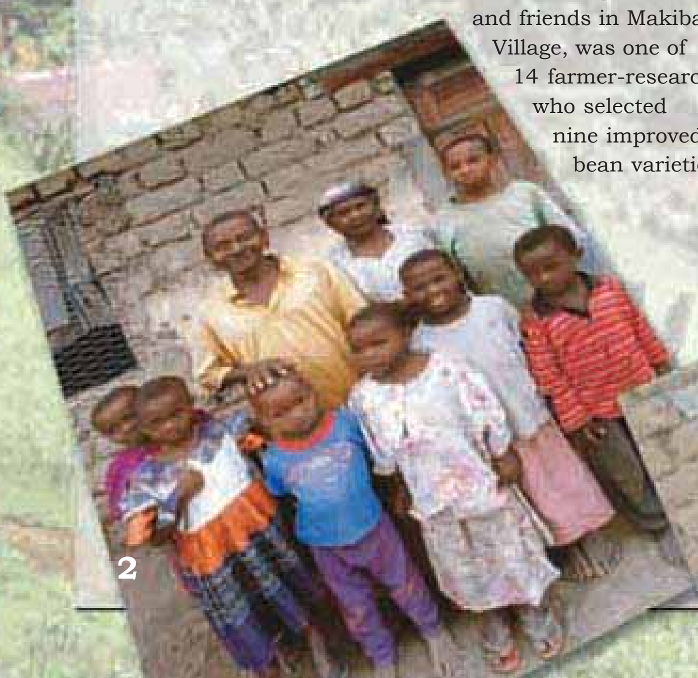
African Innovation and Global Problem Solving

Director General's Message

People armed with the tools, knowledge, and ambition needed to shape their own destinies are the epitome of human progress. They remind us that international development is all about social and political empowerment—through learning, research, organization, and local innovation.

CIAT is committed to reducing poverty in rural areas of the tropics. We do this by helping small farmers identify and exploit diverse new options for greater agricultural productivity, viable livelihoods, and sound stewardship of the environment. In Africa the focus of this year's annual report, we have made major efforts to provide small farmers with a range of tools and methods for self-directed progress in these three areas.

The associated changes we have consistently seen in rural African communities are highly encouraging. Many formerly passive farmers have become self-confident and often outspoken defenders of rural interests. Their comments, queries, and arguments are fueled by facts and figures from their own experiments with crops and natural resources. This is more than idle talk. As the articles in our "Innovation Africa" report demonstrate, farmers are launching new agroenterprises, building soil fertility, and using environmentally friendly methods to reduce crop damage by insects and plant diseases.



Beans that resist pests and diseases are critical for food security in northern Tanzania. Seventy-six-year-old Wilson Madole, shown here with wife Rosa, grandchildren, and friends in Makiba Village, was one of 14 farmer-researchers who selected nine improved bean varieties.

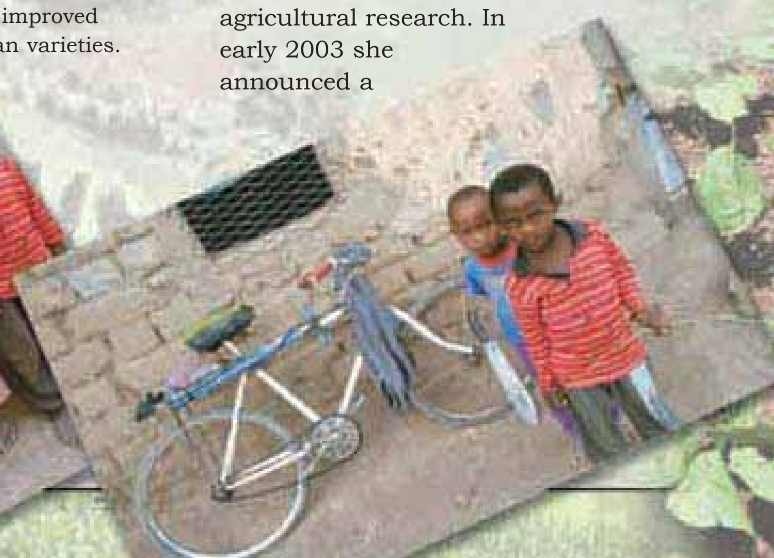
That African development must be managed by Africans is reflected not only in the content of CIAT's products but also in the way we work. Our research on the continent is now led mostly by African scientists. Similarly, scientific collaboration with national partners is coordinated through regional networks governed by African partner institutions, such as the Association for Strengthening Agricultural Research in Eastern and Central Africa (ASARECA). This practical, ear-to-the-ground approach is in line with current donor thinking on the importance of nationally and regionally led development. It is one reason the Canadian International Development Agency (CIDA) recently boosted funding of CIAT's work in Africa.

Agriculture's comeback

Over the past decade, agriculture and agricultural research have been assigned back seats in the delivery vehicles of international development assistance. Fiscal difficulties in most donor countries, plus expanding obligations in the new countries of the former Soviet Union, explain some of the budget cuts.

But the pendulum is now swinging back. The importance of environmentally sustainable agriculture for poverty alleviation in the tropics is increasingly recognized in donor countries and international agencies alike. Sustainable agriculture figured prominently in discussions at the Rio+10 summit in Johannesburg in 2002, for example. It is also seen as essential to achieving the UN's Millennium goals.

Canada's minister for international cooperation, Susan Whelan, is among those who have persistently advanced the international dialog on agriculture and agricultural research. In early 2003 she announced a



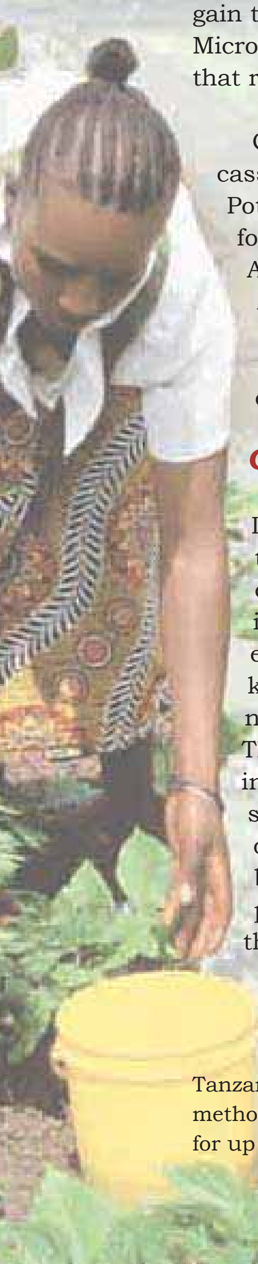
new strategy for agricultural aid and a US$30 million increase in funding for Future Harvest center research in Africa over 3 years. In keeping with the G8's support for the New Partnership for Africa's Development (NEPAD), the revised policy specifically targets Africa, especially its women. The UK's Department for International Development (DFID) has likewise been instrumental in reinvigorating agricultural programs as promoters of sustainable rural livelihoods in developing countries.

Recent private-sector support is also encouraging. The Bill and Melinda Gates Foundation recently approved US$25 million for the Biofortification Challenge Program of the Consultative Group on International Agricultural Research (CGIAR). The project aims to enhance the content of naturally occurring vitamins and other essential micronutrients in major food crops through plant breeding. CIAT and the International Food Policy Research Institute (IFPRI) are joint coordinators of this global research. Sub-Saharan Africa stands to gain the most from this "biofortification" effort. Micronutrient-related malnutrition is pervasive in that region, especially among women and children.

CIAT's contribution focuses on beans and cassava. In collaboration with the International Potato Center (CIP) and the University of Nairobi, for example, a diet of iron-rich beans and vitamin A-enriched sweet potato is being tested in African countries. New funding from the Gates Foundation will allows that work to be scaled up, and it will support micronutrient enhancement of other important plant species.

Global problems, African solutions

During 2002-2003, CIAT scientists identified three issues of global significance to which we can make significant contributions. This was intended as a research-grounding exercise, the establishment of an institutional "compass" to keep our work relevant to the needs of large numbers of poor people throughout the tropics. The selected research themes are rural innovation, the restoration of degraded lands to social profitability, and the scientific challenges of implementing international agreements on biosafety, biodiversity, and the exchange of plant genetic resources. Under each global theme, CIAT researchers will apply their expertise in clearly defined projects and locations across the regions in which we work.



Tanzanian farmers are testing new and traditional methods of pest control. Diluted cow urine repels insects for up to 5 days.

How does CIAT's work in Africa fit in with our R&D elsewhere in the world? The problem of land degradation illustrates how this integration is occurring. Participatory methods based on CIAT's experience with Latin American farmers are now taking root in Africa. Working with NGOs, national scientists, and extensionists, African farmers are conducting experiments with organic and inorganic fertilizers in an attempt to replace soil nutrients lost through years of continuous cropping.

Africans have also helped to perfect a CIAT method for integrating modern scientific approaches to soil-problem diagnosis with traditional indicators used by farmers. Originally developed in Latin America, the method and manual were adapted for use in eastern Africa. Feedback from that region has since been incorporated in an updated Spanish version, thus completing a cycle of South-South collaboration.

In the war against rural poverty, the hybridization of ideas is, I believe, one of CIAT's most important assets. It comes not only from long-distance sharing of information via scientific publications and the Internet but also from face-to-face meetings between researchers visiting each other's regions. African scientists continually tell me how direct contact with counterparts in Asia and Latin America has led them to pursue new opportunities for African farmers. I hear similar stories from Asian and Latin American scientists.

The success of our work also depends on constant contact with advanced research institutes, whose findings we can adapt and apply, and with tropical farmers, the final arbiters of utility and relevance. As we pursue our global science agenda, we have one foot firmly planted in the latest developments of science and technology, the other in farmers' fields, in Africa and elsewhere.

Joachim Voss

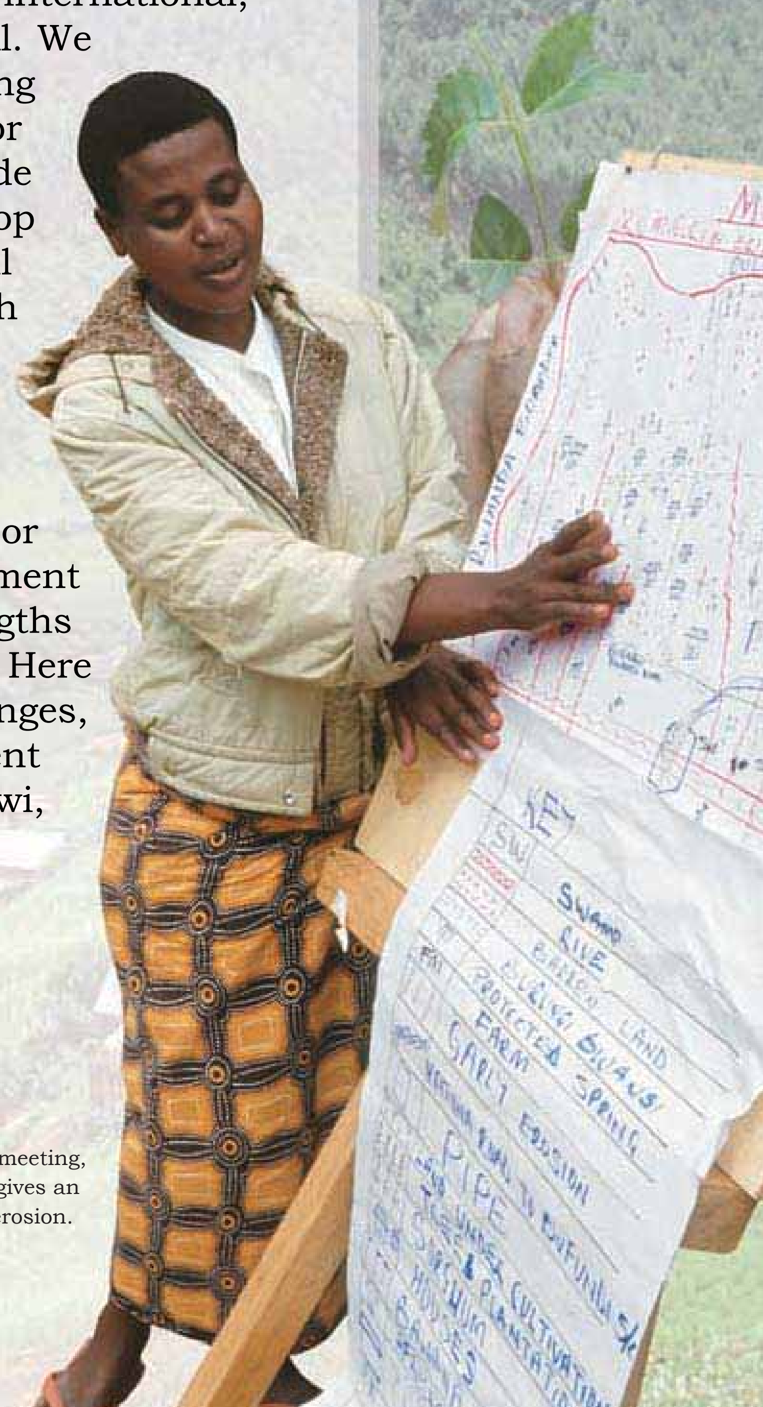
Agroenterprise in the making. Natural insecticides in pyrethrum flowers are a marketable commodity in southwestern Uganda.

Community planning and participatory research are helping farmers in southwestern Uganda to improve crop production, build soil fertility, and fight erosion.

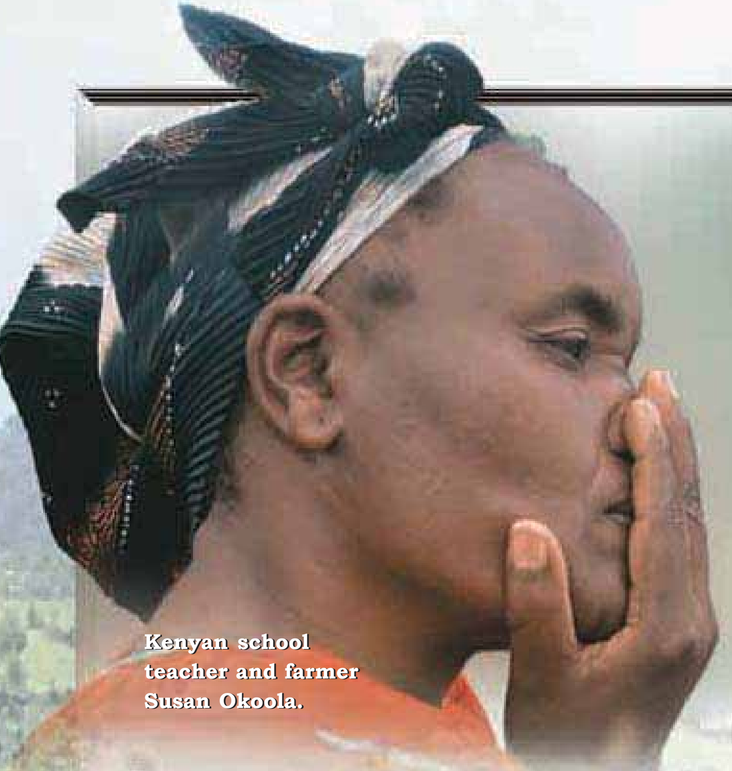
Innovation Africa

Many factors blamed for tropical Africa's food problems and poverty—such as discriminatory international trade policies and national indebtedness—lie beyond the scope of CIAT's mandate. But for other key constraints, the Center can and does provide solutions in partnership with other organizations—African and international, governmental and nongovernmental. We have expertise in several interlocking areas of research that are critical for reducing rural poverty. These include designing better germplasm and crop protection systems, enhancing soil fertility, empowering farmers through community organization, and strengthening their market orientation.

Within these domains what are major challenges for research and development in Africa? And what scientific strengths can be harnessed for rural progress? Here we highlight a few interrelated challenges, followed by articles describing recent CIAT work in these areas—in Malawi, Kenya, Tanzania, and Uganda.



Protecting the landscape. At a community meeting, Saturday Mercy, a farmer in Muguli, Uganda, gives an update on efforts to halt hillside erosion.



Kenyan school teacher and farmer Susan Okoola.

The Magnitude of Africa's Challenge

A statistic cited by Mark Malloch Brown, administrator of the United Nations Development Programme (UNDP), during the launch of the 2003 Human Development Report, places the magnitude of Africa's need in a wide perspective. Of the more than one billion people worldwide living in absolute poverty, one-third are in Africa. Yet the continent accounts for only about 13 percent of global population. And sub-Saharan Africa, the locus of greatest human hardship, makes up only 10 percent.

As if seemingly intractable poverty were not bad enough, the domestic food supply in sub-Saharan Africa remains precarious. It is barely keeping pace with population growth. Over the past decade, the region's annual food production per person, according to the UN Food and Agriculture Organization (FAO), has been hovering just above, and at times just below, the average level recorded during the years 1989-1991. Maintaining or, in some years, slightly boosting per capita production may seem like progress. But in Africa it simply means that the seasonal food shortages and human tragedies of the past are being repeated.

Even a cursory look at some of the literature on African development reveals deep differences of opinion as to why the region is so poor and hungry. If there is a "correct" set of explanations, it is undoubtedly as complex as Africa is diverse—in culture, climate, history, politics, and economics. Against this complex background of causes and effects, CIAT has carved out a highly relevant research agenda that harnesses the biophysical and social sciences to help Africans improve food production and farm incomes while protecting natural resources.

Reversing land degradation

About 65 percent of Africa's agricultural land is estimated to be degraded. Low and declining soil fertility, due to continuous cropping without the addition of adequate organic or inorganic fertilizers, is part and parcel of the dilemma. It is widely regarded as one of the biggest biophysical challenges facing African farmers and scientists.

In 2001, CIAT struck a formal alliance with a long-time partner, the Kenya-based Tropical Soil Biology and Fertility (TSBF) Programme, an international research group dedicated to protecting and improving soils. The new structure, known as the TSBF Institute of CIAT, is hosted by the World Agroforestry Centre in Kenya. This alliance is now putting into practice, through collaboration with African scientists and farmers, the considerable body of knowledge that has been built up over the past 2 decades.

Fighting pests and diseases

The nutritious common bean is a vital food staple for much of central, eastern, and southern Africa. As with other crops, though, beans are routinely attacked by pests and diseases, which take a heavy toll on the harvest.

Over the past decade or so, CIAT has had significant success in breeding and disseminating high-yielding, disease-resistant beans, in collaboration with African producers and researchers. More recently, beans that tolerate poor soil fertility have been bred and introduced in several

Integrated pest management in Tanzania: locally adapted solutions to local problems.

countries. These positive experiences now serve as a springboard for community-based experimentation with integrated management of pests and diseases, especially but not exclusively for beans.

Commercial insecticides are generally too expensive for small-scale African farmers. At several CIAT research sites in Africa, farmers are therefore experimenting with organic insecticides and repellents made from locally available materials. These tactics are combined with improved crop varieties, crop management practices, plus the application of green manures and other organic amendments to build soil fertility.

An accompanying article looks at farmer innovation to manage pests in Tanzania and at efforts to meet the enormous challenge of disseminating relevant information to other communities and countries. The project is a joint effort by local farmers, CIAT, NGOs, and national agricultural researchers. The article also examines the closely related problem of soil fertility.

Improving crops, downstream and upstream

The biological cornerstone of any cropping system is germplasm—seeds and other reproductive materials for planting. Small-scale farmers in Africa tend to grow a wide mix of crops. A staple cereal like maize, sorghum, or millet, or a root crop like cassava, may be complemented by legumes such as beans, cowpeas, or soybeans.

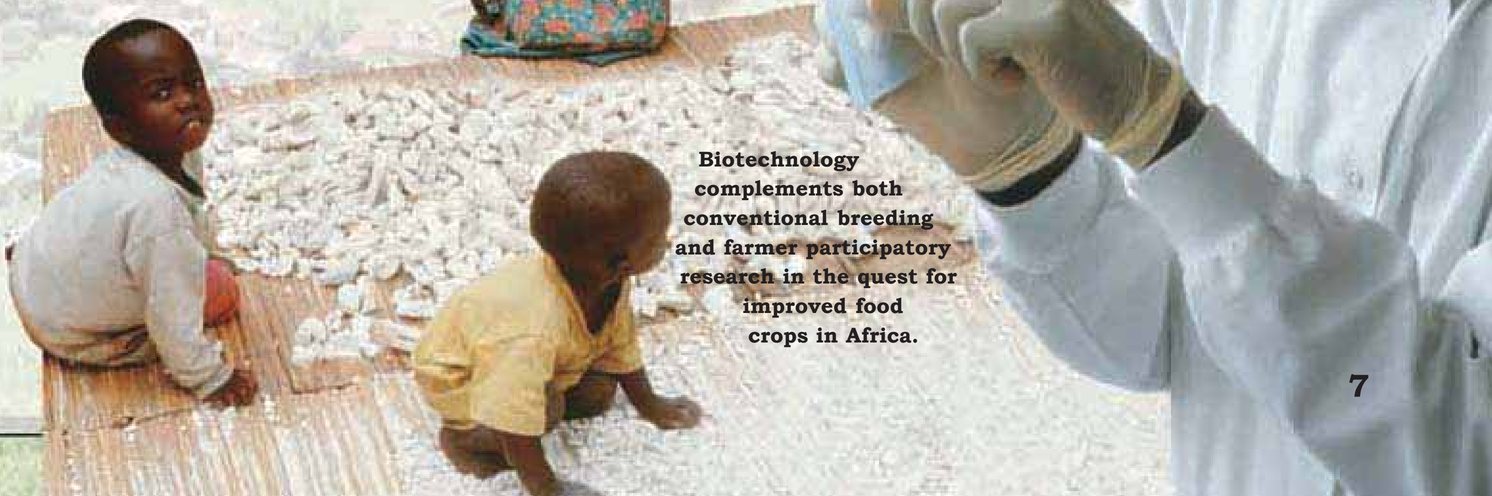
A major research challenge, then, is to design and distribute improved varieties of plants that both enhance food and feed production and fit into the highly variable mixed farming systems of Africa's different ecoregions. In the past African farmers have been slow to pick up on "improved" varieties and in some cases have rejected new germplasm outright. This technology adoption failure is usually attributed to three factors. First, officially released varieties often do not meet the taste preferences and agronomic requirements of small farmers. Second, public seed production and distribution systems are weak, and even when their products are available, poor farmers may not be able to afford them. And third, private seed companies favor large-scale, profitable cash crops, while ignoring the so-called "orphan" crops grown by small farmers.

A gradual shift from research station-centered plant breeding to a system that combines farmers' agricultural know-how and interest in seed production with conventional science is under way in Africa. This strategy is now beginning to pay off.

CIAT has been a pioneer in the design of farmer participatory research methods. In recent years it has been training NGOs and national research and extension agencies in their use, with the cooperation of rural communities. This triple focus—farmers, development agents, and scientists—promotes African ownership and relevance of technology, as well as research efficiency.

Molecular markers are fast becoming standard tools in crop improvement. Yet, sophisticated biotechnology for accelerating plant breeding and making it more reliable has largely been out of Africa's reach. This is due to the high costs of equipment and chemical reagents and to lack of training opportunities for African scientists.

CIAT is currently exploiting its considerable expertise in biotechnology to improve beans and cassava, vital crops for both Africa and Latin America. A recently completed biotechnology laboratory at the Kawanda Agricultural Research Institute in



Biotechnology complements both conventional breeding and farmer participatory research in the quest for improved food crops in Africa.

Uganda, where CIAT has its regional office, serves as a training ground for African scientists under an initiative involving CIAT, Uganda's National Agricultural Research Organisation (NARO), and the International Plant Genetic Resources Institute (IPGRI). Our "philosophy of biotechnology," which emulates that of our farmer participatory research methods, is to give young African researchers a chance to apply biotechnology methods and adapt them to local resources and working conditions. "If you make the breeders part of the biotechnology development process, you are more likely to have success," says CIAT plant pathologist George Mahuku.

One of the articles in this section describes the role of farmers in "downstream," community-based crop improvement in several African countries where CIAT works. It also explains how our scientists are applying "upstream" biotechnology to enhance disease resistance and other traits in the crop genotypes passed on to farmers for evaluation and selection.

Growing for markets

African farmers, especially those with little land, are caught between a rock and a hard place. Their explanation, remarkably similar from place to place, goes something like this: "At the best of times, most of us can't grow enough food to get our families through the hungry season between harvests. We need cash to buy the shortfall at local markets, usually when prices are high. To do this, some of us, usually the men, work for neighboring farmers or leave the area for temporary jobs in mines and city factories."

While sectoral diversification is critical to Africa's economic progress, agriculture remains the foundation on which that future will be built. As some donors, like the Canadian International Development Agency (CIDA), have explicitly stated, renewed investment in African agricultural development is essential. But there are major hurdles to overcome. These include poorly developed channels for information on market opportunities and prices, inadequate roads and transport, high input prices, and bottlenecks in seed-production systems.

Many observers also stress the need to eliminate protectionist policies in those foreign countries that might otherwise be lucrative exports markets for African products. Roger Kirkby, CIAT's regional coordinator for Africa, cautions, however, that creating a fairer playing field in international food trade, while desirable, is only part of the solution. "Some people assume that better market access will solve all problems. But if markets are opened up through new trade policies, the opportunities will be seized only by those who are already strong innovators and entrepreneurs."

To further stimulate that rural dynamism, CIAT has produced tools for planning and setting up sustainable agroenterprises. Farmer groups and support-service providers, such as NGOs, use them to analyze market opportunities and commodity chains, and to identify those production hurdles that can be best solved through local research. While we pioneered these methods in Latin America, they are now being tested and adopted in Africa.

As an article below demonstrates, African farmers are successfully experimenting with new market opportunities and are ready to take risks. Production of pyrethrum flowers in southwestern Uganda, for the international market in organic pesticides, is just one example. The long-term success of this and other efforts, says Kirkby, demands that the emerging spirit of innovation and entrepreneurship in Africa be welded to conservation of the continent's fragile natural resource base.

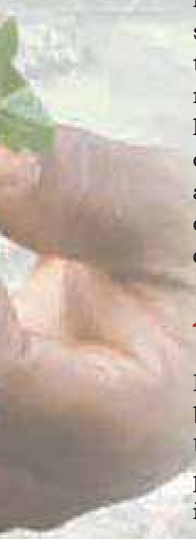
Fairer market access must be accompanied by strong agricultural entrepreneurship and innovation.

Solutions Above and Below Ground

Integrated approaches to pest, disease, and soil fertility management

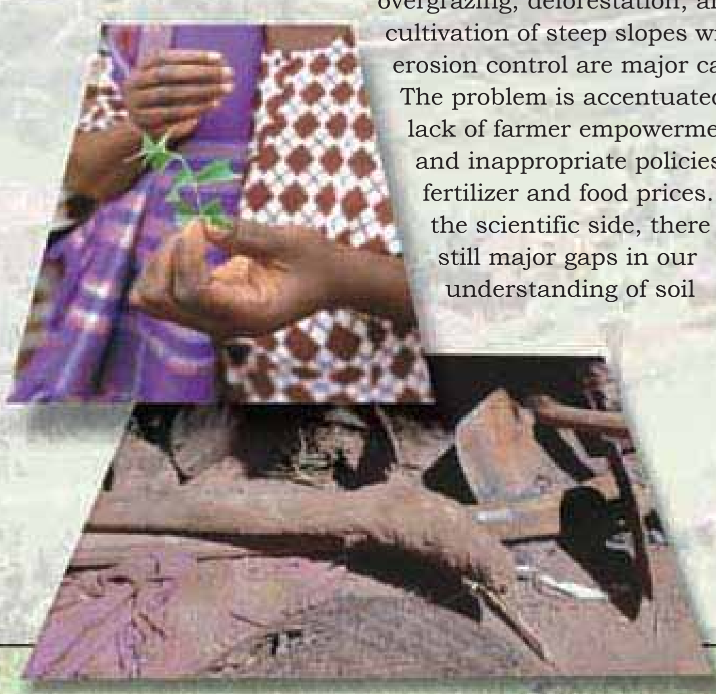
Commercial agriculture, especially in industrialized countries, has relied heavily on synthetic pesticides and inorganic fertilizers to manage the above- and below-ground environments of crops. But this monolithic, curative approach to soil nutrient depletion, plant diseases, and insect pests has well-known drawbacks. Apart from environmental impacts, it does not fit well into Africa's small-scale farming systems. Poor farmers rarely can afford to use commercial inputs at recommended rates.

The more holistic methods of integrated pest management (IPM)—often expanded to include diseases (IPDM)—and its younger cousin, integrated soil fertility management (ISFM), offer African producers cost-effective alternatives. CIAT is helping adapt these approaches not only to specific crops and agroecological settings but also to farmers' available resources and livelihood requirements. ISFM and IPM are, however, more knowledge and labor intensive than seed- and chemical-centered technologies. Widespread adoption requires hands-on learning and experimentation by farmers, in addition to documentation and intensive dissemination work.



A paradigm shift in soils research

Many scientists consider declining soil fertility the biggest obstacle to food security in Africa. Unfavorable geology and climate are part of the problem. But many interconnected human influences are also at work. Continuous cropping, overgrazing, deforestation, and cultivation of steep slopes without erosion control are major causes. The problem is accentuated by lack of farmer empowerment and inappropriate policies on fertilizer and food prices. On the scientific side, there are still major gaps in our understanding of soil dynamics, especially the biology and ecology of below-ground biodiversity.



Solving this problem requires a mix of strategies involving multiple partners, but especially farmers, the primary stewards of the soil. Fortunately, there has been significant progress on the technical and social sides, thanks in large part to the work of CIAT's Nairobi-based Tropical Soil Biology and Fertility (TSBF) Institute.

Over the past 20 years, TSBF has helped usher in a new paradigm for soil science. ISFM moves away from the earlier focus on inorganic fertilizers and puts greater emphasis on the role of organic matter and soil organisms in sustainable farming. The new approach also accords a central role to farmer innovation and technology diffusion as well as community action.

"The yield gap between research stations and farmers' fields can be bridged," says TSBF director Nteranya Sanginga, "if farmers are empowered and better organized. They need simple methods for diagnosing soil fertility problems and for identifying optimal combinations of organic and inorganic inputs." CIAT has made significant progress in both these areas of ISFM.

Dedicated national scientists

The main implementing mechanism for CIAT's soils research in Africa is the African Network for Soil Biology and Fertility (AfNet). "I'm convinced that the way to change things is through the dedication of

Walter Munywere of Kenya's Ministry of Agriculture acts as community facilitator for a farmer field school at the village of Amongura in western Kenya's Teso District.

national scientists," says CIAT-TSBF soil scientist and AfNet coordinator André Bationo. "But they need to be better organized through mechanisms like AfNet."

AfNet scientists in 16 countries help farmers combat soil nutrient depletion through both researcher- and farmer-managed trials. Funding is provided by the Rockefeller Foundation, the Technical Centre for Rural and Agricultural Co-operation (CTA), Danish International Development Assistance (Danida), US Agency for International Development (USAID), and Global Environment Fund of the United Nations Environment Programme (UNEP).

In one experiment Kenyan researchers showed that combining inorganic nitrogen fertilizer with locally available organic material (nitrogen-rich leaves and stems of tithonia, or false sunflower) nearly doubled maize yields. Such experiments across Africa are helping to quantify the nutritive value and effects of on-farm sources of organic matter, thus giving farmers critical information about a significant alternative or complement to costly inorganic fertilizers.

Farmer groups for learning

In western Kenya farmer field schools (FFSs) and demonstration plots are vital ingredients of TSBF's holistic approach. Working with CIAT-TSBF staff and a community facilitator from the Ministry of Agriculture, farmers meet weekly to learn about soil fertility technologies that can improve their food production for home consumption and local markets.

Mukhombe FFS is one such school. It operates in the Emuhaya division of Vihiga District, one of the most densely populated regions of Africa. Because of the difficult challenges that Emuhaya's agriculture faces, the Kenya Agricultural Research Institute (KARI) selected it as a research "benchmark" site under the African Highlands Initiative (AHI). Coordinated by the World Agroforestry Centre, AHI has collaborated actively with CIAT and TSBF since 1995.

On the last day of April 2003, about 30 students gather for a seminar on a gently sloping hill planted to beans and maize. The facilitator is CIAT-TSBF agronomist John Mukalama. Today's subject is improved production of beans and maize by combining organic sources of nitrogen with inorganic phosphorus. Previously, the farmers learned that their soils are deficient not only in nitrogen but also, more importantly, in phosphorus. They already knew that most organic inputs, like the farmyard manure that has been applied to some of the subplots, provide nitrogen but do not contain much phosphorus. Mineral fertilizer is also needed.

After noting the recommended dosage of inorganic phosphorus fertilizer—60 kilograms per hectare—Mukalama moves from subplot to subplot describing the different manure and mineral fertilizer treatments. "The plants with the phosphorus application look much stronger and healthier," comments a woman student. Another adds: "I believe those beans will produce more flowers than the ones in the other plot."

During a hands-on learning session with another group of farmers, in the village of Amongura, Teso District, Mukalama demonstrates simple tests for identifying local plants suitable as green manures. In this way he translates a scientific understanding of organic matter decomposition into terms farmers can readily understand. Plants with dark green leaves, for example, generally have more nitrogen than lighter colored ones, he explains. Those that tear easily

At Amongura in Kenya's Teso District, CIAT-TSBF agronomist John Mukalama explains visual, taste, and touch tests that help farmers identify local plants suitable as organic soil enhancers.

have low lignin content and therefore make good green manure because they decompose rapidly. The farmers put two plant materials to the test—tithonia and leaves from a local tree. They correctly conclude that tithonia is the better green manure.

Such activities have motivated farmers to solve soil fertility problems that previously they had dismissed as just "part of life." Besides serving as a venue for learning about soil fertility management, the 18-month-old Mukhombe Farmer Field School has been a catalyst for sharing knowledge with other farmers. Several students also belong to a local drama and singing group and have used information from the farmer field school as the basis for a play and songs. When time and money permit, they travel to nearby villages spreading the word about the importance of soil fertility and the advantages of group learning. Since most local farmers regularly listen to radio, the group hopes to record their songs and have them aired by radio stations.

Biodiversity below our feet

Apart from using green manures and livestock manure, farmers can build up soil organic material by planting leguminous cover crops and incorporating crop residues into their fields instead of burning them. But the organic content needs to be broken down to make nutrients available to crops. The various tasks of soil conditioning and nutrient cycling are performed by microorganisms such as protozoa, rhizobial bacteria, and mycorrhizal fungi, as well as by larger organisms like earthworms, nematodes, termites, and beetles.

"Below-ground biodiversity is sometimes overlooked," says CIAT soil scientist Jeroen Huising. "But now it's time to take a closer look at what's below our feet." He notes that in addition to making soil a suitable growing environment for crops, these organisms play a key role in the soil's capacity to provide so-called environmental services. These include water and nutrient cycling, elimination of toxins, and the storage of carbon that might otherwise end up as carbon dioxide, a major greenhouse gas, in the earth's atmosphere.

Despite the extent and environmental importance of below-ground biodiversity (BGBD), says Huising, only an estimated 5 percent of soil organisms have so far been identified and characterized by scientists. And BGBD has been largely ignored in biodiversity conservation efforts. To help fill this gap in knowledge and practice, CIAT launched a 5-year research project, called Conservation and Sustainable Management of Below-Ground Biodiversity, in August 2002. UNEP's

Under a new global project, CIAT-TSBF researchers are studying below-ground biodiversity and its role in soil health and plant growth.

Global Environment Fund is providing US$9 million to the project, which focuses on tropical soils at seven sites in Africa, Latin America, and Asia.

Learning to manage pests

Integrated management of plant pests and diseases is the other half of the above- and below-ground management effort so important to farmers.

"Since joining the farmer learning group, my bean production has increased by about half," says Reminiska Moshi, a 33-year-old farmer who, with her husband, works a 1-hectare farm in northern Tanzania. The group Moshi joined in 2000 is one of 52 with which CIAT has been collaborating in Hai District to stimulate farmer experimentation with, and adoption of, IPM methods. Scientists from Tanzania's Ministry of Agriculture and Food Security, along with two NGOs, are key partners. CIAT is building on that experience to scale up dissemination and adoption of IPM technologies in collaboration with other partners in Malawi, Kenya, and other areas of Tanzania through a 3-year project funded by the UK's Department for International Development (DFID).

Local bean growers were the catalyst for the participatory IPM project in Tanzania. Five years ago crop damage was so heavy that some farmers were forced to stop producing beans. Frustrated, they sent a delegation to speak with local authorities, who in turn asked CIAT and the Selian Agricultural Research Institute for help with problem diagnosis. Much of the bean damage in farmers' fields turned out to be the work of bean foliage beetles (commonly referred to by their genus, *Ootheca*).

Since then, hundreds of bean farmers like Reminiska Moshi have formed small groups and set up learning plots, in which they test and demonstrate IPM methods. The learning groups in Hai District focus not only on IPM practices for beans but also on seed production and experimentation with new crops such as soybean. Two NGOs, the Adventist Development and Relief Agency (ADRA) and World Vision International, assist the farmer groups with technology development and dissemination.

"I've been working with extension for 15 years now, and I haven't seen a method that passes on agricultural information as fast as this one," says Edward Ulicky, a district agricultural development officer, referring to the participatory methods used in the project.

Traditional and new practices

The centerpiece of the farmers' work is the testing of botanical pest control materials and practices,

Bean foliage beetles can rapidly destroy a bean crop. Tanzanian farmers are experimenting with a range of integrated pest management techniques, including the use of wood ash.

both traditional and new. Formulations based on neem oil and powder, for example, are used successfully against bean foliage beetle, aphids, and bean fly. Other treatments include cow shed slurry, wood ash, and various herbs. The farmers, like their counterparts in Kenya, are also learning improved crop management practices, dealing with factors like the timing of cultivation and planting, and optimal spacing of plants.

IPM testing and application is most effective when participating farmers are familiar with the biology and ecology of pests. In screenhouse experiments between 2000 and 2002, Ulicky, three CIAT colleagues, and farmers examined the life cycle of the bean foliage beetle. This allowed the farmers to see how IPM methods work.

Another joint experiment validated the farmers' traditional belief that applying manure to bean plants results in a healthier crop with a higher yield. But the improvement was not simply the effect of higher nutrient availability to the plants. In manure-treated beans, the research team observed less root damage by Ootheca larvae.

Sharing the message

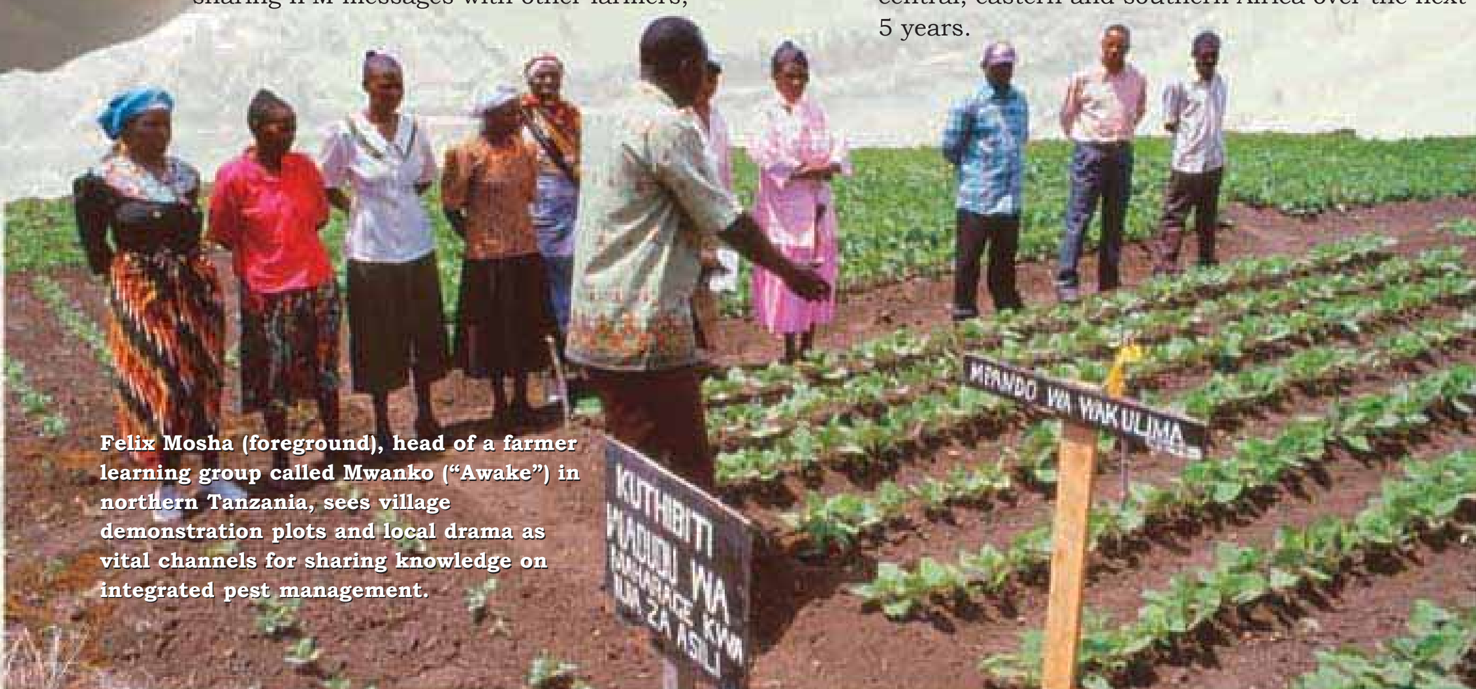
Felix Mosha, chairperson of a cluster of seven farmer groups from four villages, says he is now able to partially control the bean foliage beetle. However, he stresses that for IPM to work properly it must be a community effort. "So, we're using our learning plots to teach our neighbors."

As in Kenya, drama is a powerful vehicle for sharing IPM messages with other farmers, according to Mosha. During a field demonstration, he invites a local acting troupe, the Mshikamano Group (literally "Stick Together"), to stage a short play in Swahili. In the opening scene, a visitor arrives in a Tanzanian village. He tells his hosts about various methods he has learned to combat bean pests—for example, rotating crops between beans and sunflowers. The underlying message of the drama is clear: Learning by listening and exchanging experiences with other farmers will lead to a better life for all.

As part of a wider effort to disseminate technology and scale up adoption, ADRA produced a Swahili version of a field guide on IPM practices, aimed at farmers and extension workers. Posters, pamphlets, and radio programming are also being used.

Yona Gabriel Mbwana is the ADRA technical officer who adapted and translated the IPM guide. Farmer groups are helping by providing the local names of insects. Although there are some 200 languages in Tanzania, says Mbwana, the national literacy rate of 57 percent is high enough to ensure reader-to-nonreader diffusion of the information. "There is a critical mass of farmers who are schooled in Swahili."

Over the longer term, ADRA hopes to get the IPM materials into Tanzania's school curriculum, thus targeting the next generation of farmers. As for CIAT, it has begun feeding the IPM materials into a larger initiative of the Pan-African Bean Research Alliance (PABRA), aimed at making improved bean technologies available to millions of farmers in central, eastern and southern Africa over the next 5 years.



Felix Mosha (foreground), head of a farmer learning group called Mwanko ("Awake") in northern Tanzania, sees village demonstration plots and local drama as vital channels for sharing knowledge on integrated pest management.

Upstream Meets Downstream

Biotechnology and farmer research for crop improvement

Both "upstream" molecular analysis by biotechnologists and "downstream" variety evaluation by farmer-researchers today play vital roles in otherwise conventional plant breeding—in Africa and elsewhere. In fact, the up/down distinction is blurring as contributions to crop improvement from laboratories and farms become increasingly integrated.

Early in the process, farmers make known their plant-trait preferences and market requirements. For their part biotechnologists identify useful plant genes, characterize disease-causing organisms, and help conserve and expand biodiversity. As specific research targets are elucidated by farmers and researchers alike, biotechnologists help breeders speed up their work by providing molecular markers that precisely identify which plant progeny bear the desirable gene or genes. Promising lines coming out of marker-assisted selection (MAS) and more conventional breeding programs can then go to farmers and national scientists for detailed evaluation. Seed of the resulting selections is reproduced by farmers, stimulating early adoption, or by national programs for further breeding.

Participatory plant breeding in Africa

Participatory plant breeding is rapidly becoming the norm in bean research programs across Africa. The shift in thinking began in Rwanda during the late 1980s, when CIAT and Rwanda's Institute of Agricultural Sciences (ISAR) had major success working with women farmers on the selection and introduction of new bean lines. Since then, gender-sensitive participatory methods have gained wide acceptance in agricultural research across the developing world.

Desirable beans: Farmer participation in research gives plant breeders detailed knowledge of their customers' needs and preferences.

University of Nairobi professor and CIAT bean breeder Paul Kimani, who coordinates this work in the Eastern and Central Africa Bean Research Network (ECABREN), describes the underlying problem with earlier scientist-centered approaches to research: "You think you know exactly what everyone needs. But then farmers don't take up the new varieties." What is much better understood and accepted now, he says, is that the breeder must have "intimate knowledge of the customer."

That shift has paid off. Over the past 16 years, CIAT's collaborative bean research for Africa has produced a wealth of high-yielding, stress-resistant bean varieties. These products are known to be effective and relevant for small-scale farming, because participating farmers at pilot sites have enthusiastically tested, adopted, and shared them with neighboring farmers.

Malawi is one of several countries that have institutionalized participatory research in bean improvement work during recent years. Farmer evaluations are key ingredients in the complex process of moving from experimental breeding lines to officially released varieties.

An improved variety that sells itself

On a Wednesday afternoon in April, merchants at Chimbiya Market in Malawi's Dedza District weigh dry beans on scales suspended from tall tripods. Farmers with only a few kilos on hand sit patiently by the roadside waiting to sell by the bowlful.

As in many parts of Malawi, beans are the biggest source of dietary protein in this area, near the southern shore of the majestic African lake that bears the country's name. Most production is for the family dinner table. But dry beans are also a major source of cash for small farmers. The price they receive depends heavily on the seed type. While these nutritious legumes vary in size and shape, the most obvious difference, and often a selling point, is their color.

One young man summarizes his day so far: "I've been able to sell three bags of Napilira, but I

still have three bags of other types—Mozambican and mixed beans." Napilira, also known to CIAT breeders as CAL 143, is a red calima-type bean with white specks. The seller admits that, like his customers today, his own taste preference is for Napilira, also the most expensive.

"Napilira started to get to farmers in 1998," says Rowland Chirwa, a CIAT bean breeder and coordinator of the Southern Africa Bean Research Network (SABRN). "Now, after several seasons, farmers are really getting to know this variety."

Napilira means hardy or resistant in the Chichewa language. The name was chosen by a group of 15 farmer-researchers from the nearby village of Kalilombe. Besides appealing to consumers, this officially released bean variety has a special advantage for farmers: it can be grown successfully under conditions of poor soil fertility. Low levels of phosphorus and nitrogen are typical of the soils of Africa's bean-growing regions. This is partly because farmers, who find imported inorganic fertilizer very expensive, do little to replace the nutrients lost through cropping.

Kalilombe is one of six sites in Malawi where farmers have worked with CIAT, national bean scientists, extension workers, and NGOs to grow, evaluate, and select beans. After harvesting their field experiments, farmers performed cooking and taste tests. Cooking times were recorded and compared, and the beans were eaten in typical local fashion, as a garnish for *nsima*, a stiff porridge made from maize. One advantage noted by the farmers is that fast-cooking beans like Napilira reduced consumption of the firewood and maize cobs used as fuel.

Four of the eight bean lines evaluated in Kalilombe and released by the country's Department of Agricultural Research Services (DARS) were selections from the Working Group on Bean Improvement for Low Fertility Adaptation (BILFA), which is part of the Pan-African Bean Research Alliance (PABRA). Collaborating scientists from several countries follow the same research protocols to evaluate hundreds of bean breeding lines for tolerance to low soil fertility. This common approach, says Chirwa, leads to reliable conclusions about which lines will do well across a spectrum of African soil conditions.

Biotechnology for Africa

Extracting DNA in an environmentally controlled laboratory where everyone wears a white coat may seem light-years away from the food crop experiments done by African farmers in their fields and around cooking fires. Yet these contrasting forms of science are now merging into an integrated process of crop improvement. While CIAT continues to promote farmer participatory research methods, it is also working to build African capacity for biotechnology research on beans and cassava.

Over the past 2 decades, nearly all of CIAT's crop-related biotechnology for Africa has been carried out at our laboratory in Colombia or in advanced facilities in other countries. But since 1999 these arrangements have been evolving. Center scientists now conduct biotechnology research and training in a new laboratory at Uganda's Kawanda Agricultural Research Institute.

In the past lack of equipment and training in sub-Saharan African and other regions of the developing world meant that microorganisms and plant tissues had to be shipped abroad for DNA extraction and analysis. This was slow and cumbersome, in part because of quarantine rules designed to prevent disease transmission. DNA itself, though, is not bulky and shipping it poses little or no biohazard.

Left, Chimbiya Market, southern Malawi. Napilira beans fetch a high price. Right, farmer-researchers who selected and named this officially released variety, which tolerates low soil fertility.

CIAT and collaborating national scientists recently designed and tested a simple, inexpensive method for DNA extraction that gets around technical and financial hurdles involved in conventional procedures. In particular, it eliminates the use of two toxic organic compounds, phenol and chloroform, which African laboratories are generally not equipped to handle.

The new method, which is suitable for a range of organisms, including bacteria, fungi, and plants, allows for processing of more than 40 samples per day. Experiments have demonstrated that the resulting DNA is pure enough for most kinds of genetic analysis based on polymerase chain reaction (PCR), the standard means of DNA amplification.

Problem-solving applications

One of the main activities at the Kawanda biotech lab has been DNA extraction from bean plants and from the *Pythium* spp. fungi that cause bean root rots. Genetic characterization of these fungi is of special importance to Africa. Beans are highly susceptible to attack a week or two after germination, especially when soil moisture is high. In parts of Western Kenya, root rots were such a big problem several years ago that farmers stopped growing beans.

Control of bean root rots depends, among other things, on correct diagnosis of the disease agent. Of the 100 or so species of Pythium, only nine—what CIAT plant pathologist Robin Buruchara calls the “bad guys”—have to date been confirmed as pathogenic.

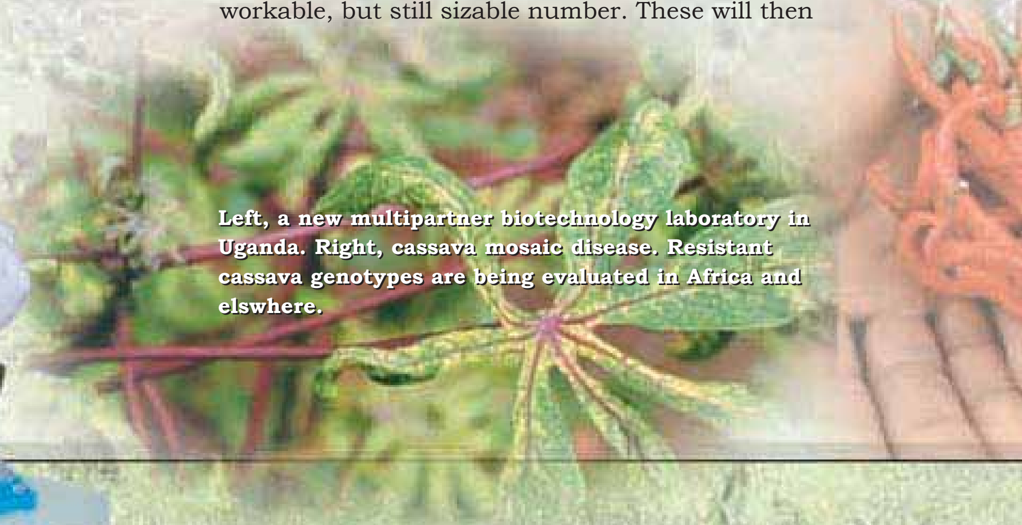
Conventional genotyping of fungi is difficult because of the presence of many different organisms in soil samples. CIAT scientists have thus adopted DNA profiling to distinguish between species of Pythium. During 2001 and 2002, this allowed them to organize hundreds of samples (“isolates”) of the fungi from Kenya, Uganda, and Rwanda into 24 clusters. Isolates representing major groups are now being selected for DNA sequencing. Once easy-to-use diagnostic tests are developed for the worst offenders, bean breeders can use them to target research on host plant resistance.

CIAT scientists recently identified molecular markers that can assist in the fight against another major bean disease—angular leaf spot, caused by the fungus *Phaeoisariopsis griseola.* The markers distinguish between virulent and nonvirulent strains, as well as between Latin American and African strains. The biotechnology laboratory in Uganda has helped to validate the utility of these molecular tools under African conditions.

There has also been progress in combating cassava mosaic disease (CMD), the most damaging disease of the crop in Africa. CMD2 is a resistance gene in cassava that was identified 3 years ago by CIAT molecular geneticist Martin Fregene. Molecular markers for the gene have since been used to systematically screen crosses of resistant and susceptible cassava varieties. This has paved the way for major projects in which African producers and scientists will evaluate and improve resistant genotypes.

In Tanzania, for example, CIAT will work on a 6-year project with the agriculture ministry’s Department for Research and Development, the International Institute of Tropical Agriculture (IITA), and farmer groups. With funding from the Rockefeller Foundation, researchers will cross germplasm resistant to CMD, cassava bacterial blight, and green mite with preferred local varieties adapted to specific ecological niches. Training of national scientists in biotechnology and participatory methods will figure prominently in the project.

Given the large number of parent plants involved, the breeders will use molecular markers to quickly pare down candidate progeny to a workable, but still sizable number. These will then



Left, a new multipartner biotechnology laboratory in Uganda. Right, cassava mosaic disease. Resistant cassava genotypes are being evaluated in Africa and elswhere.

be evaluated in the appropriate ecological zones by scientists and cassava producers. "It's a disservice to farmers not to give them a wide range of choices in view of the high risks they face," says Fregene.

If all goes well, this project will showcase the rapid convergence of biotechnology and participatory methods in the concerted push for greater food security and rural incomes. For Fregene, improved cassava has enormous commercial potential for his native Africa. "I'm really excited about all this," he says. "I always come to work with a spring in my step."

The final frontier of crop improvement

Increasing the efficiency of crop breeding, with the aid of participatory plant breeding and biotechnology, is a major accomplishment for Africa. Even so, to date the overall impact of new bean varieties in the region has not been massive, due in part to the relatively short period in which these innovations have had a chance to spread.

CIAT and its national partners in PABRA have therefore embarked on an ambitious multicountry promotional project to cross this final frontier in bean improvement. The project aims to deliver improved bean technologies to 10 million people over 5 years.

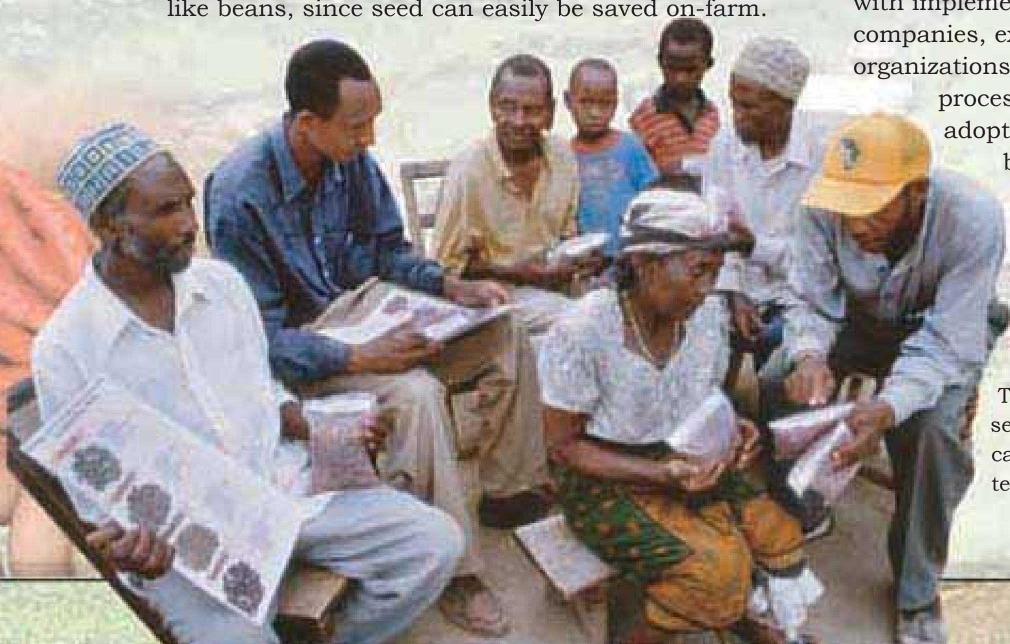
Farmer evaluation of improved beans is, of course, a prominent feature of this effort. And it offers the special benefit of allowing participating farmers to adopt new varieties early on and to save seed. But to have real national impact, seed production must extend well beyond the informal efforts of a relatively few farmer groups. In practice, most African countries experience bottlenecks in this area. One problem is that commercial seed companies have little interest in self-pollinating crops like beans, since seed can easily be saved on-farm.

For several years Malawi's Ministry of Agriculture and Irrigation has been promoting large-scale seed production. In April 2002 it asked for CIAT's assistance, based on the Center's considerable experience working with NGOs on seed production and promotion campaigns. CIAT provided 40 tons of seed of several bean varieties as well as technical assistance in contracting 1,600 small farmers to multiply the seed. Then, between October and December 2002, 1,000 tons of seed grown by those farmers were distributed in agricultural starter packets, which also contained soybean, groundnut, and maize seed, plus fertilizer.

An estimated 300,000 small-farm families directly benefited from the scheme in a single year. This achievement was especially timely and relevant given the devastating maize shortage that gripped Malawi in early 2002. Beans, the main food source when maize runs out, are clearly vital to the country's food security.

But Malawi is just one country in a vast region of Africa that relies heavily on bean production for sustenance and income. In Kenya and Uganda, farmer groups are now being trained to produce seed, using a manual on business skills for seed producers, developed by CIAT staff, along with a guide for trainers. Under the PABRA-sponsored project mentioned earlier, a total of 12 African countries will benefit from large-scale delivery of bean technologies. In each case seed production and distribution are central components of a 10-step action plan.

After selecting germplasm and other technologies suited to specific bean-growing zones, the national teams have already begun to produce quality seed for reproduction, set price structures, and design promotional materials. Consultations with implementing partners—NGOs, seed companies, extension agencies, and community organizations—are also under way. The entire process, from concept through delivery, adoption, and impact on communities, will be carefully monitored and evaluated so that lessons learned can benefit future efforts by CIAT and its partners to multiply impact.



Tanzanian farmer-researchers discuss bean seed production. A new multicountry campaign will deliver bean seed and related technology to 10 million Africans.

Learning to Compete

Agroenterprises for higher family income

Poverty alleviation is about helping people exploit new opportunities to improve their livelihoods. Promoting entrepreneurship to boost income is just one aspect of this complex process, but it is a powerful one. In one fell swoop, it can expand individuals' and communities' options for better education, health, nutrition, housing, and social and family life.

Over the past 2 years, CIAT has been working at three pilot sites in Africa to adapt, test, and disseminate its territorial approach for identifying market opportunities and building lucrative agroenterprises around them. This research is part of a larger CIAT initiative in Africa called Enabling Rural Innovation. It takes place under a project of the Pan-African Bean Research Alliance (PABRA), funded by the Canadian International Development Agency (CIDA) and the government of Belgium. The Center's approach for agroenterprise development is being further refined and scaled out through "learning alliances" between CIAT and both local and international NGOs, including Africare and Catholic Relief Services (CRS).

In much of eastern and southern Africa, semisubsistence farming traps rural people in an onerous cycle of food production geared largely to home consumption. It generates little money to pay for other necessities of life, like clothing, medicine, and school fees, and allows little time for personal enrichment. Off-farm labor is often the main source of cash. When harvests of staple crops are good, some revenue is squeezed from the surplus. But this extra food typically fetches low prices in local markets. With little or no value added through processing, it is often sold during or just after the harvest, when there is an oversupply.

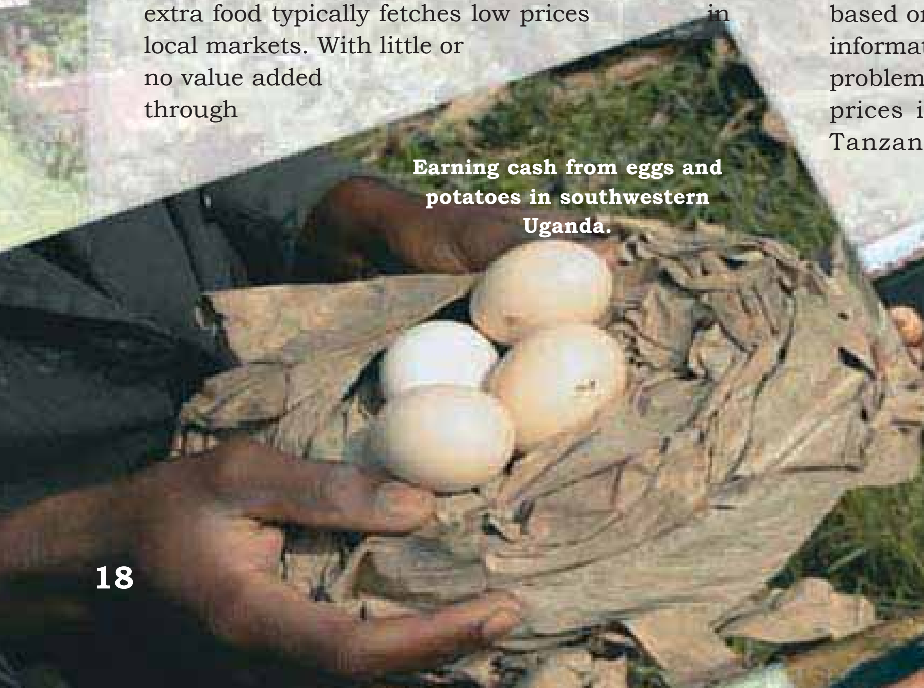
Coping with a tilted playing field

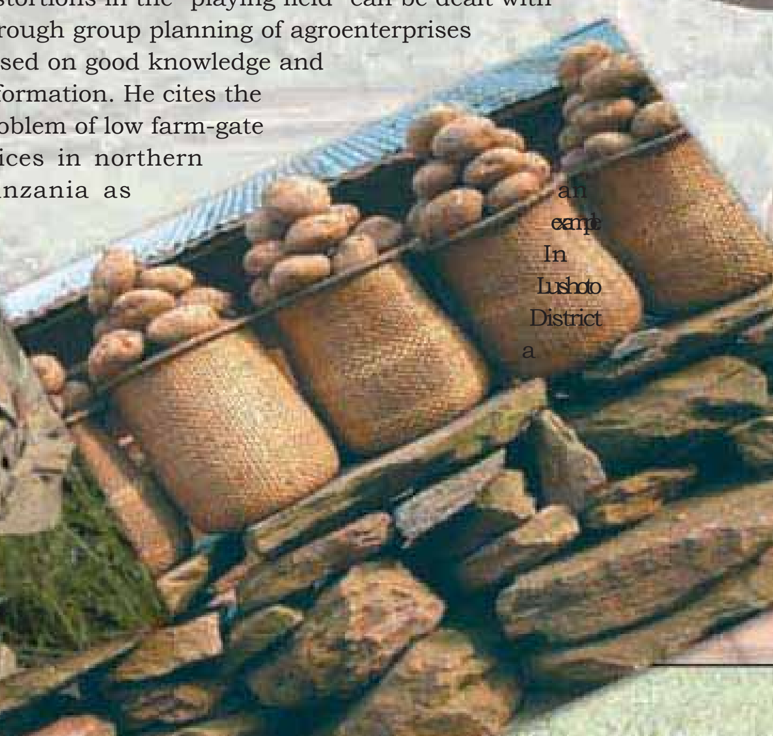
Production for markets is inherently more risky than raising crops and livestock for home consumption. For example, it is extremely difficult for individual farmers to achieve the consistency of product quality, quantity, and timing of delivery demanded by bulk buyers serving large consumer markets.

The risks of agricultural entrepreneurship in rural Africa are accentuated by persistent production-side bottlenecks: tight credit, high fertilizer costs, and weak business-support services. And on the distribution and consumption side, constant threats to small business viability include poor roads and transport, lack of timely market information, and unfavorable international trading regimes.

"The playing field is rather tilted against small farmers trying to set up agroenterprises," says Rupert Best, manager of CIAT's Agroenterprise Development Project. Despite the lip service paid to trade liberalization and globalization, inequities remain in international trade in agricultural products. "Technological interventions to help small farmers only go so far," says Best. "The policy environment has to be favorable too."

He is optimistic, however, that some local distortions in the "playing field" can be dealt with through group planning of agroenterprises based on good knowledge and information. He cites the problem of low farm-gate prices in northern Tanzania as an example. In Lushoto District a





Earning cash from eggs and potatoes in southwestern Uganda.

group of farmers participating in the Enabling Rural Innovation Project traveled to a neighboring community to learn about quality requirements for farm products, frequency and volume of delivery, and prices. They met with a group of successful farmers who are delivering 4 tons of produce to market per week.

"The Lushoto farmers had no idea that fellow producers just 20 kilometers away had organized themselves, introduced new production technologies, and captured a share of the high-value fruit and vegetable market in the capital, Dar es Salaam," says Best. "They became aware of the large markup, the gap between what farmers are paid and what consumers pay. So they decided to form an association to handle their marketing from now on."

When agroenterprises are carefully designed to cope with such constraints, they offer rural people an escape route from poverty. In southern Malawi farmers in Enabling Rural Innovation are experimenting with production and marketing of goats and rabbits, and in northern Tanzania, with beans and tomatoes. At a third CIAT pilot site, in southwestern Uganda, farmers have likewise selected two priorities for which they identified clear markets: chickens for local egg sales, and pyrethrum flowers for a local plant that extracts and exports crude organic pesticide.

Among both government and nongovernment organizations in Africa, says Best, demand for CIAT training and expertise in agroenterprise development and other participatory methods is on the rise. To scale up its impact, the Center collaborates with Foodnet, a program sponsored by the Association for Strengthening Agricultural Research in Eastern and Central Africa (ASARECA) and coordinated by the International Institute of Tropical Agriculture (IITA). Foodnet has supported over 50 market opportunity studies over the past 2 years and is designing methods to strengthen the collection and dissemination of market information for African farmers.

Budding business in a Ugandan village

Over the past 3 years, CIAT has provided training in participatory methods to Africare staff. These methods are now routinely used in the five districts of Uganda in which Africare operates. The main skills learned during the training workshops, in which development agents from other countries also participated, were participatory identification of problems and opportunities, community facilitation, and agroenterprise development. These approaches help ensure that new economic options are created for both women and men, that benefits are equitably distributed, and that increased income serves as an incentive for improved land management.

Muguli, located in Uganda's mountainous Kabale region, is a village of 65 households. Its residents are working with Africare and CIAT to build a community business around pyrethrum, a member of the chrysanthemum family containing natural insecticidal compounds. As at other project sites, this initiative is just one ingredient in an integrated, long-term community action plan designed by the villagers. Besides generating income, pyrethrum cultivation has two other important functions. It is a component of the community's land conservation work on upper slopes, and it is a test crop, along with beans, for learning about soil fertility, particularly the role of organic and inorganic amendments.

"Muguli, Let's Fight Poverty" is both the community organization's name and its motto. After a participatory analysis of villagers' resources, needs, and aspirations, members set up committees to execute the group action plan. The committees focus on land conservation, public health, experimentation with crops, and income generation through agroenterprises.

"The physical environment was in an appalling condition," says the organization's secretary,

CIAT agroenterprise specialist Rupert Best listens to presentations by members of "Muguli, Let's Fight Poverty," a farmer organization in southwestern Uganda.

Saturday Mercy, during a community meeting attended by 45 villagers and guests. On a large hand-drawn map of the village, she points to ominous clusters of X's. These represent the locations of deep gully erosion, and barren, vulnerable land on the high ground surrounding the village.

But thanks to recent work to implement the village action plan, there has been significant progress on erosion control. Hundreds of drainage trenches, explains Mercy, have been cut across slopes to prevent soil runoff and protective bunds have been stabilized. And on one high mountain meadow, farmers have planted barren land to pyrethrum flowers. Eventually they will also introduce perennial crops like coffee, banana, and avocado.

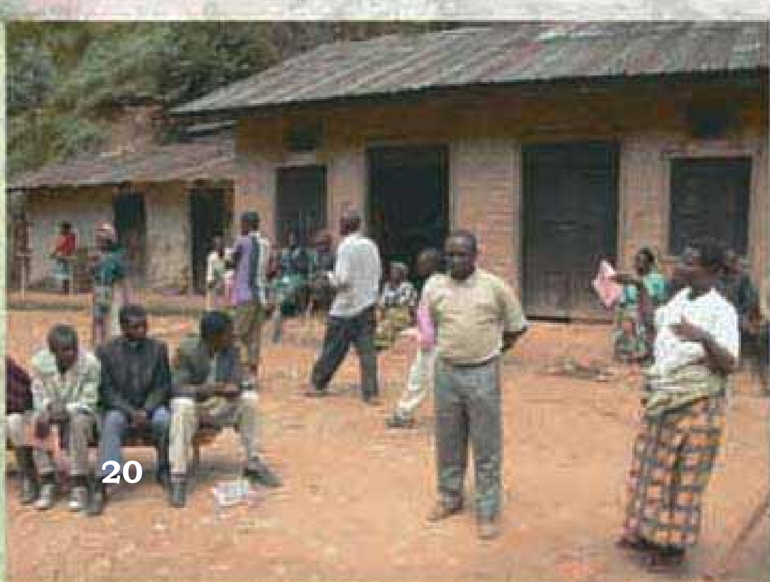
Later, a committee coordinator describes the origins and progress of the pyrethrum agroenterprise project. The villagers chose this crop because they had heard that other farmers in the region were regularly selling flowers to a local processing plant. Wanting to see for themselves, a delegation from Muguli traveled to a local town to meet with established pyrethrum growers and learn about their work.

Pyrethrins are the insecticidal compounds in pyrethrum flowers. However, production in profitable quantities occurs only at high altitudes with the right amount of daily sunlight. As it turns out, the mountainous environment of the Kabale region perfectly fits the bill.

The CIAT-Africare research team helped farmers cost out the agroenterprise and set up soil-fertility experiments aimed at maximizing production. The local processing plant, owned by Agro Management (Uganda) Ltd., which is headquartered in the USA, provided seedlings free of charge. The flowers are picked weekly and sun-dried before delivery to a drop-off point run by Agro Management's all-women collection staff. Because Muguli's soils are deficient in both nitrogen and phosphorus, the farmers are experimenting with various combinations of fertilizers to build soil fertility. These include farmyard manure, commercial NPK fertilizer, and a low-cost byproduct of pyrethrum processing, composted flower heads called marc.

Agro Management began processing pyrethrum in Uganda in 1993. According to the firm's chief agronomist and director Ronald Martin, "We have the best quality pyrethrum of any place in the world." The pyrethrin-extraction factory now draws on harvests from about 525 hectares of local farmland, providing work for 10,000 people. Yet this corresponds to only about one-third of the plant's operating capacity. There is thus ample room to accommodate production from new agroenterprises like that in Muguli.

From 25 tons of dried flowers, the company can make 1 ton of crude insecticide extract (42 percent pure). The extract is normally exported to a single commercial buyer who further refines the product



Left, community leaders in Muguli give an update on recent projects, including income generation from eggs and pyrethrum flowers. Right, a local factory where natural insectides are extracted from the flowers, then exported.

for sale to other customers. However, Agro Management is planning to have Ugandan pyrethrum refined on contract in Europe. This would allow the company to sell directly to other buyers, who require a more finished product for use in household insecticides. In the meantime payments to some pyrethrum farmers have been delayed.

Farmers in Muguli are aware of the financial risks of dealing with a single local firm that currently has only one large client. On the one hand, the global market for pyrethrum-based insecticides is growing. And, if all goes well, Agro Management will be able to diversify its client base to the benefit of Ugandan producers. On the other hand, if troubled waters lie ahead, the farmers will have to look for alternative products to grow. “There is no business without risk,” says Jeffrey Habarwasha, who chairs Muguli’s income generation committee. “We’ll try something else if there is no market for pyrethrum.”

Information for rural innovation

An essential ingredient of successful agroenterprise development is access to timely and reliable information on technical options, business services, and markets. In the Kabale region, the African Highlands Initiative (AHI), an ASARECA-sponsored program that is coordinated by the International Centre for Research in Agroforestry (ICRAF) and in which CIAT takes part, has set up two telecenters with assistance from the Acacia Program of the International Development Research Centre (IDRC). The telecenters provide a variety of services to local communities, such as Internet access, publication loans, photocopying, poster production, and computer training for students.

Recently, one telecenter began a marketing information service for farmers. Prices and other commodity information are collected weekly, translated into the local language, and distributed to a local radio station for broadcast. The information is also turned into printed pamphlets and distributed monthly.

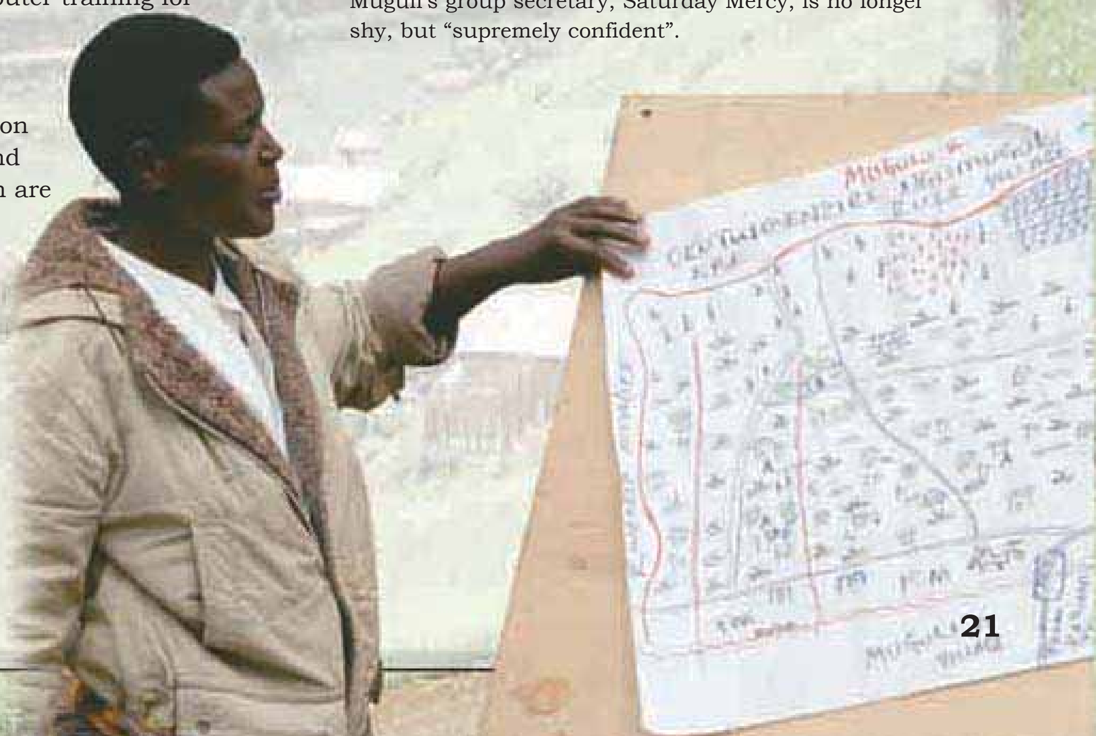
“Farmers are being cheated because of lack of information,” says CIAT’s regional coordinator for Africa, Roger Kirkby. Many end up selling crops at less than their true market value or they take a chance on cultivating new crops without adequate knowledge of the size and stability of the market. The integration of modern information and communication technologies (ICTs) with participatory agroenterprise development, he says, will go a long way to strengthening the emerging spirit of entrepreneurship in Africa.

Social and human capital

Through its work on agroenterprise development, CIAT is helping the rural poor design reliable, environmentally friendly sources of income. But we are also banking on the idea that participatory methods bring other benefits—to individuals and the community as a whole. Social scientists refer to these spinoffs, respectively, as “human” and “social capital”.

The notion of human capital is best captured by Saturday Mercy: “We women participate in the work just as the men do. Although I was a little shy at first, I’m now supremely confident in my ability to accurately document the work of our group.”

The related notion of social capital is evident in the work of Muguli’s farmer committees. There is a strong and growing sense of community spirit, cooperation, and trust. Jeffrey Habarwasha sums it all up: “We know that development and income generation are processes that don’t happen overnight. Despite the hardships and risks, we’re all ready to forge ahead and make a go of it.”



Muguli’s group secretary, Saturday Mercy, is no longer shy, but “supremely confident”.

Beans are vital for food security and human nutrition in western Kenya, in addition to serving as a key source of family income.

Perspectives on Research Impact

Improved bean varieties give Kenyan farmers more food and cash

Farmers in western Kenya have enthusiastically adopted several new varieties of beans that resist root rots and whose yield is more than double that of the commonly grown local varieties susceptible to these diseases. A recent impact study shows one of the new bush beans, called KK 15, was being grown by 80 percent of farmers surveyed in one district and by 42 percent in another. Two other varieties had almost identical adoption rates in both districts, roughly 35 percent and 70 percent. The rate of adoption was highest in Vihiga District, which is one of Africa's most densely populated regions, with 850 persons per square kilometer.

Next to maize, beans are Kenya's most important food crop. They are also a major source of family income. But during the 1990s root rots devastated crops in western districts, forcing some farmers out of bean production altogether. Continuous cropping without proper nutrient replacement had slowly robbed the soil of its fertility, creating an ideal environment for proliferation of the *Pythium* fungi that cause root rots.

In response to the root rot crisis, CIAT and the Kenya Agricultural Research Institute (KARI) worked with the extension service of the Ministry of Agriculture to introduce 27 improved bean varieties. In a complementary participatory research project, local farmers selected 11 of those varieties as the best, and they also experimented with soil management methods to improve control of root rots. Seed of the chosen germplasm was multiplied and distributed in a number of communities via women's groups, government extensionists, and an NGO.

The impact study, conducted jointly by CIAT and KARI, provides a snapshot of the situation in 233 households in 20 villages just after the June 2001 harvest. It was designed to determine the fate of the bean varieties and whether they had benefitted farmers. About two-thirds of survey participants were individual women. The preponderance of women respondents reflects their central role in Kenyan bean production.

Adopting farmers strongly favored three of the five bush bean varieties examined in the impact study. They attributed their preferences to, among other traits, early maturity, high yield, storability, good taste, short cooking time, resistance to root rots, and good marketability. Six of the farmer selections covered by the survey

Impressed with the high yields and disease resistance of new bean varieties, farmers in western Kenya have adopted them on a large scale.

were climbing beans. These resist root rots and yield better than even the best of the improved bush bean varieties. Even so, adoption rates in both surveyed districts were low.

In their report the impact study team, led by CIAT social scientist Soniia David and KARI economist Martin Odendo, notes that climbing beans require higher soil fertility, as well as poles and extra labor to stake up the plants. Some farmers planted the beans in gardens close to their houses, where it was easy to use kitchen wastes as compost to boost soil fertility. “While the survey results do not allow for conclusive observations about the potential of climbing beans for motivating farmers to invest in soil fertility,” write the authors, “they suggest an opportunity for promoting the technology to fit into specific niches.”

The introduction of new high-yielding varieties has sometimes been blamed for dwindling crop genetic diversity in farmers’ fields. The logic here is that the arrival of better germplasm, especially during a food crisis (like that triggered by root rots in Kenya), prompts farmers to abandon traditional varieties as no longer useful or productive. The CIAT-KARI survey found just the opposite. The vast majority of farmers who had planted new varieties in 2000 also grew one or more local varieties. Some reported doing so simply as an experiment to monitor the extent to which they could still grow and harvest beans of those root rot-susceptible varieties. The adoption of the new germplasm thus resulted in a net increase in varietal diversity, not a drop.

Another important finding was that adoption of the new bush bean varieties improved household food security. Nearly all farmers who had planted the new varieties reported having more food to eat. In addition, about one-third of respondents reported having more beans all year round—a major benefit given the perennial problem of the between-harvest hungry season.

About two-thirds of the adopting farmers were able o sell some of their harvest of the new bean varieties. Two bush varieties in particular—KK 22 and KK8—fetched good prices because of their preferred seed size and popular reddish color. The resulting earnings on the region’s quite small farms were, on average, the equivalent of US$15 to $16 per farmer.

Farmers reported using this cash to pay for immediate household and health needs, such as food, fuel, soap, and medicine, as well as for longer term investments, mostly school fees, books, clothing, livestock, seed, and fertilizer. Having more money to buy food and being better able to invest in children’s education were among the most important household-level benefits of these new bean varieties.

New forages boost incomes in Vietnam

An 8-year participatory research project in rural Vietnam has stimulated widespread adoption of improved forages, in turn leading to significantly higher rural family incomes. Equally important, there are major time and labor savings, especially for women and children, who traditionally spend many hours each day feeding and herding livestock.

Widespread adoption of improved forages in Vietnam’s northern Tuyen Quang Province is boosting family incomes by nearly a third, while reducing drudgery for women.

These are among the key findings of a recent evaluation of CIAT's Forages for Smallholders Project (FSP). The impact study looked at social and economic benefits in two of the six Asian countries that participated in the forages research. The Philippines was the other country covered by the study.

Operating from 1995 to 2002, FSP was initially funded by the Australian Agency for International Development (AusAID) and later by the Asian Development Bank (ADB). Early on, researchers screened 500 samples of forage grasses and legumes for superior performance and suitability for cultivation in Southeast Asia's small-scale livestock systems. They then worked with thousands of farmers across the region to test a selection of those materials on-farm.

In Vietnam two provinces participated in FSP: Daklak in the central part of the country and Tuyen Quang in the north. Two partner organizations, the National Institute of Animal Husbandry and the Department of Agriculture and Rural Development, implemented the project with CIAT's assistance. As of June 2002, when the impact study was conducted, 1,700 Vietnamese farmers were involved in FSP and actively cultivating improved forages.

The Vietnamese component of the impact study focused on Tuyen Quang. In that province farmers in six communes began experimenting with 12 improved forages in 1997, under the Vietnam Sweden Mountain Rural Development Programme. Among the most popular forages adopted were Napier grass (*Pennisetum purpureum*), Guinea grass (*Panicum maximum*), and two *Brachiaria* grass species (*decumbens* and *ruziziensis*).

A decade ago local farmers in the study area were allowed to graze their animals on communal lands. But these areas were divided up and distributed by the government to individual farmers in 1992. This cut off many livestock producers from a free source of forage. Combined with seasonal labor shortages, the land-tenure change forced many villagers to sell their cattle and buffalo, traditional sources of traction, transport, food, and income.

Not long after that, CIAT's FSP project began providing practical technologies for raising superior forage crops and feeding animals on-farm, thus reducing the need to herd and graze livestock over large areas. Participating farmers have since set up forage banks for cut-and-carry feeding and are intercropping the new forages in tea plantations. The new technologies are sufficiently flexible and varied to meet the nutritional needs of diverse livestock: cattle, buffalo, pigs, poultry, small ruminants, and even pond-raised fish, a critical component of the local livestock system. The introduced forage grasses have also been planted in rows across erosion-prone farm slopes, along

fishpond embankments as stabilizers, and as cover crops under fruit trees.

"The close involvement of farmers in every step of the project resulted in widespread spontaneous adoption of the new forages," write the study authors. And, as the farmers tell it, there were good reasons for participating. Among the concrete benefits reported by them are higher yields compared with local forage grasses, better control of soil erosion, and less time spent feeding animals. They also said their fish, cattle, and buffalo were healthier and grew faster, that animals sold for higher prices, and that more manure was available to build soil fertility and improve food crop production.

The impact study team found that net income per household from raising ruminants, such as cattle and buffalo, rose from US$144 to $179 per year for farmers who had adopted improved forages 2 to 4 years earlier. As for fish production from ponds, income went from $99 to $125. These are noteworthy gains, given that most farmers raise both fish and ruminants. From the point of view of labor efficiency, the gains were actually much higher. Net income per day from labor spent in these two enterprises roughly tripled, with a slight advantage for fish farming.

Cultivating new forages also yielded major labor savings, which translated into both social and economic benefits. On the social side, children had more time for recreation, rest, and studies because of the reduced labor burden of herding and feeding animals. On the economic side, household members, especially women, were able to spend more time earning money from other productive farm activities. Taking these financial spinoffs into account, the impact study team estimated the total income boost related to adoption of CIAT forage technologies at $152 per year, representing a 29 percent increase in total household income.

Social capital yields high economic returns to agroenterprises

"Firms should pay attention to social capital," says CIAT economist Nancy Johnson, "and so should governments, NGOs, and other institutions interested in promoting rural development through agroenterprises." This is the conclusion of a recent CIAT study on the nature and role of social capital and its potential impact on rural agroenterprises. The study was based on in-depth interviews with managers or owners of 50 small- and medium-sized firms in five regions of Colombia, as well as on econometric analysis.

Paying attention to social capital means recognizing the importance of building strong relationships within the community along their supply chains. Broad networks of business contacts allow firms to gather intelligence continuously and cheaply. Strong, trust-based relationships reduce transaction costs, for example, by avoiding the time and expense of entering into legally binding contracts, or by eliminating complex monitoring and control procedures. Sometimes small firms need to cooperate to compete, by making joint purchases of inputs to get better prices or by working together to fill large orders.

"For agroenterprises, being competitive isn't just about producing at the lowest cost," says Mark Lundy, an agroenterprise specialist at CIAT and coleader of the study. "It's about responding rapidly to the changing demands of the

Sugarcane processing for production of *panela* (brown sugar), in southwestern Colombia.

marketplace. Firms that are able to spot opportunities, or threats, and respond quickly—without compromising on quality—have a real advantage."

The numbers bear this out. According to the study, the quantity and strength of a firm's relationships contribute "positively and significantly" to its economic performance, as measured by revenue per employee. Furthermore, additional investment in these relationships—or "social capital"—yields higher returns than a similar investment in either labor or machinery.

Paying attention to social capital also means looking at the relationships within a firm, especially those among its owners. "We often treat firms as if they were individual decision-makers, but in fact a firm is an organization made up of people who may have different goals and different ideas about what's best for the firm," says Johnson.

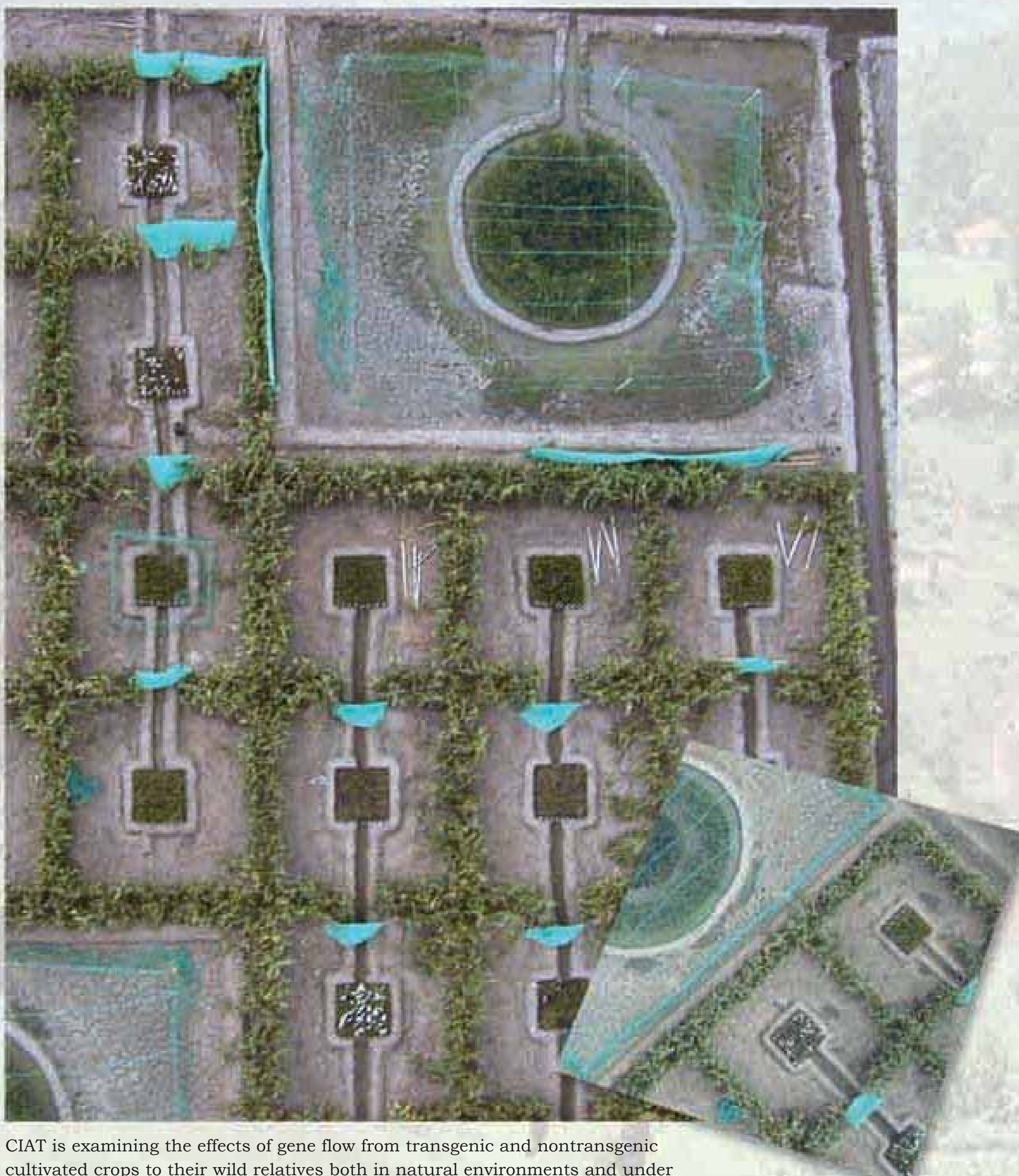
According to CIAT lawyer and economist Carolina González, the law implicitly recognizes that different types of personal relationships among owners imply different legal requirements. In the study, the authors develop a typology that builds on legal distinctions between the levels of trust between partners, and on their objectives in establishing the firm.

High-trust organizational structures, such as partnerships, generally have lower administrative costs, but partners share unlimited liability and therefore must know and trust each other. Low-trust structures, such as corporations, make up for the lack of strong personal ties among investors with higher levels of costly external regulation. Associative structures like cooperatives are formed to provide a collective service to their members, not to earn return on capital invested. Therefore, the ability of the members to work together is crucial to their success.

The significance of these differences is that many firms are encouraged to adopt formal legal structures, often as a condition of participation in support programs. Frequently, these decisions are made on the basis of legal costs alone or on perceptions about which structures are most equitable or socially beneficial. The study shows that no one structure is best, either economically or socially. What is important is that the structure suit the firm, its goals, and the existing level of social capital among the participants.

The study was funded in part by the Systemwide Program on Collective Action and Property Rights (CAPRi) of the Consultative Group on International Agricultural Research (CGIAR). Researchers from two Colombian organizations, the Center for Crop and Livestock Research (CEGA) and Corporation Colombia International (CCI), contributed to the study design, data collection, and analysis.

Cassava drying for sale to animal feed producers in northern Colombia.



CIAT is examining the effects of gene flow from transgenic and nontransgenic cultivated crops to their wild relatives both in natural environments and under carefully controlled experimental conditions.

Research and Development Highlights

Cratylia: A hardy forage shrub for dry areas

A drought-tolerant shrub that CIAT has been experimenting with for many years as a forage crop is proving highly attractive to small beef and dairy farmers in Colombia's vast savannas and piedmont area. During 2002 the Colombian Corporation for Agricultural Research (CORPOICA) released a superior CIAT genotype of *Cratylia argentea*, a protein-rich legume native to Latin America, under the varietal name Veranera.

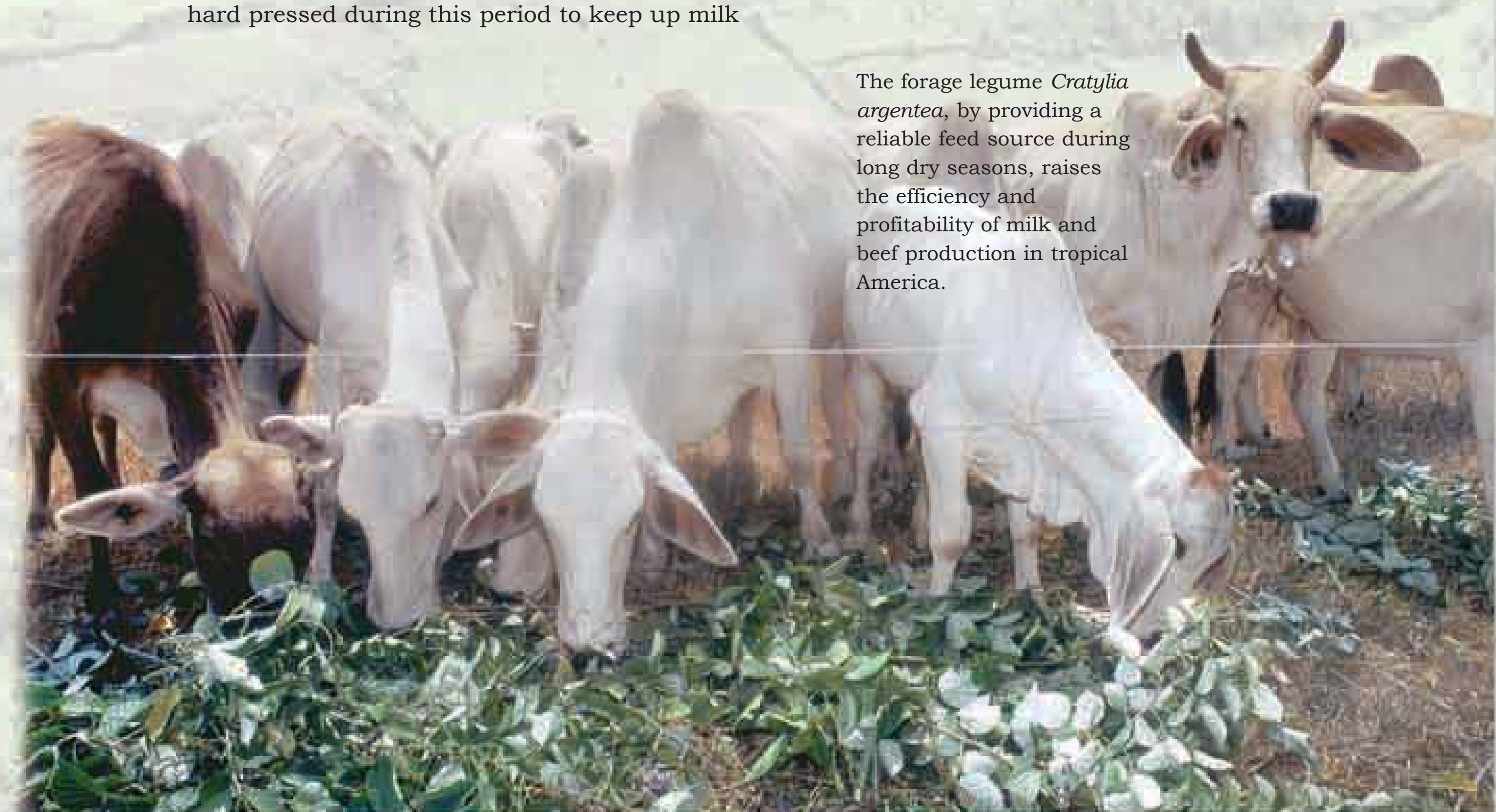
"The farmers we've been working with are using *Cratylia* not just in the dry season but all year round," says animal nutritionist Carlos Lascano, manager of CIAT's Multipurpose Tropical Grasses and Legumes Project, which is supported by the Japanese and Colombian goverments, among other donors.

In tropical America dual-purpose (milk and beef) farms account for 78 percent of the overall cattle industry and 41 percent of milk production. Most of these are small operations that depend heavily on pastures for animal feeding. In many livestock-raising areas, particularly Colombia's savanna and Central America's hillsides, there is a long, forage-scarce dry season. In the savanna, where it lasts 2 to 3 months, cattle producers are hard pressed during this period to keep up milk production and even maintain their animals' health. They have to buy expensive commercial feed supplements, which drives down their already low profit margin.

But a recent ex ante study on the economic potential of *Cratylia*, conducted by CIAT livestock economist Federico Holmann, provides good reason for optimism. The analysis covered several production scenarios. It showed that use of this shrub, which grows even under conditions of low soil fertility and acidity, can significantly lower farmers' production costs for beef and milk. For example, if 2,500 shrubs are planted for each hectare of grass pasture and replaced every 5 years, costs go down by 19 percent.

"Making these enterprises more efficient and profitable helps the rural poor by creating more jobs," says Lascano. "But if you want to have widespread impact, private sector links are vital."

During 2002, CIAT continued its *Cratylia* evaluations with 14 farmers in Colombia's piedmont—the transitional area between the savanna and the Andes, which serves as the breadbasket of the capital Bogotá and other cities.



The forage legume *Cratylia argentea*, by providing a reliable feed source during long dry seasons, raises the efficiency and profitability of milk and beef production in tropical America.

This participatory research is supported by Colombia’s World Bank-funded National Program for the Transfer of Agricultural Technology (PRONATTA).

The farmers tested several technologies for growing and using the legume. These include protein banks from which leaves are regularly cut and carried to corralled animals; establishment of shrubs in grass pastures for direct grazing by animals; and preparation of silage from fodder not consumed in the dry season. Farmers are also producing seed for sale to their neighbors.

The farmers’ experiences have been highly positive, says Lascano. They report being able to milk their cows during the dry season, and replacing expensive supplements with *Cratylia* has no adverse effect on milk production. With local demand for seed of the shrub on the rise, CIAT has contracted eight agricultural schools to grow Veranera seed.

A safe biopesticide now on the market

A baculovirus shown by CIAT to be highly effective against cassava hornworm, a major agricultural pest, is now available as a formulated commercial pest control product in Colombia. The biopesticide was developed under an R&D partnership between the Center and BIOTROPICAL, a biopesticide company. The new product, which kills the hornworm larvae during their early development, is easy to apply, relatively inexpensive, and ecologically sustainable.

BIOTROPICAL has received a manufacturing formulation licence for the baculovirus from Colombia’s Ministry of Agriculture and Rural Development. It now produces, markets, and distributes the biopesticide under the name “Bio Virus” and has been contracted by partners in Mexico to supply the product there as well.

The cassava hornworm (*Erinnyis ello*) is a migratory insect whose outbreaks in cassava fields are unpredictable. Under high infestation losses of the cassava root harvest generally range between 20 and 65 percent but are sometimes higher under repeated hornworm attacks. If the outbreak occurs early in the crop cycle—between the 2nd and 5th months—it takes only 5 larvae per plant to defoliate the crop. Later in the cycle, as plants mature, it takes about 30 per plant for total defoliation.

“The best strategy against the hornworm is to synchronize your response with the start of the insect attack,” says entomologist Anthony Bellotti, manager of CIAT’s Integrated Pest and Disease Management Project. “We needed a product that could be used exactly when the outbreak occurs.”

The arrival of Bio Virus on the market will provide major benefits to farmers. In Colombia cassava production is on the rise, especially for the commercial starch and animal feed markets. Between 1996 and 1999, for example, cultivated area grew nearly 15 percent.

As part of its pest management work, CIAT has taken part in training events aimed at familiarizing Colombian cassava farmers with the handling and application of the baculovirus. In a recent workshop in the southwestern area of Tolima, farmers applied the product to a cassava crop

severely infested with hornworms. At a dosage of 300 grams of the formulated baculovirus per hectare, the farmers observed a larval mortality rate of about 91 percent.

CIAT's work with BIOTROPICAL on hornworm control is just one step in a broader program: development of a research-based model for industrial production of biological pesticides to control the pests of cassava and other crops. The latest focus of research is another major pest, the cassava burrower bug (*Cyrtomenus bergi*), which also attacks crops such as onion, peanut, and coriander. A fungus called *Metarhizium anisopliae* has proven highly effective against the burrower bug. One CIAT isolate of the entomopathogen killed 70 percent of the target insects within 19 days.

The first-ever whitefly-resistant food crop variety

Fifteen years of collaborative cassava research by CIAT and the Colombian Corporation for Agricultural Research (CORPOICA) have finally paid off—and very handsomely. In May 2003 CORPOICA released Nataima-31, a variety that resists a highly destructive species of whitefly called *Aleurotrachelus socialis*. Whiteflies are among cassava's most important insect enemies, and *A. socialis* is the predominant species in northern South America.

Nataima-31, a cross between Ecuadorian and Brazilian cultivars from CIAT's germplasm bank, is the first whitefly-resistant cassava variety to be officially released anywhere. And it is apparently the first of *any* food crop to possess elevated whitefly resistance. The new variety also has other big advantages. It gives a high yield, resists thrips and mites, and is suitable for both human consumption and industrial processing into starch and other products.

The resistance is so good that farmers are being advised not to apply any pesticide. With some local varieties grown in Latin America, producers need to apply antiwhitefly chemical pesticides 6 to 10 times during the year-long growing cycle. Besides posing hazards to human health and the environment, this strategy tends to backfire. Whiteflies have a very short life cycle, just 30 to 35 days. Genetic adaptation, and therefore the emergence of pesticide-resistant whiteflies, are rapid.

Another whitefly species, *Bemisia tabaci*, is currently extending its geographic range. It transmits viral diseases to many plant species, especially horticultural crops, and also feeds directly on their leaves. However, in Latin America it rarely colonizes cassava—at least not yet. In Africa, *B. tabaci* transmits cassava mosaic disease (CMD), including a virulent form that has devastated crops on the eastern side of the continent. Researchers are concerned that if CMD jumps to Latin America, it could—with the help of a new biotype of *B. tabaci* that has been observed on cassava—eventually reek havoc. The problem is that the most widely grown types of cassava in the neotropics have no resistance to the disease.

This potential new threat, plus the need to transfer whitefly resistance to African cassava, has led CIAT to collaborate with the Natural Resources Institute (NRI) in the UK. The joint research aims to determine which cassava genotypes resistant to *A. socialis* whitefly might also resist *B. tabaci*. Results to date are encouraging.

CIAT's work on whitefly resistance, funded by the New Zealand Agency for International Development (NZAID), is just one element of a concerted global research effort called the Tropical Whitefly Integrated Pest Management Project, which is currently funded by several donors, including the UK's Department for International Development (DFID). Other topics of CIAT investigation linked to this project are management practices to combat whiteflies, the nature of resistance mechanisms, and biological control methods, such as the use of predator insects, parasitoid wasps, and entomopathogens.

An encouraging line of attack in the area of biocontrol has been the identification of a whitefly entomopathogen called *Verticillium lecanii.* With observed insect mortality rates of about 65 percent, this fungus is a good candidate for commercial development.

Exploring the environmental effects of GM crops

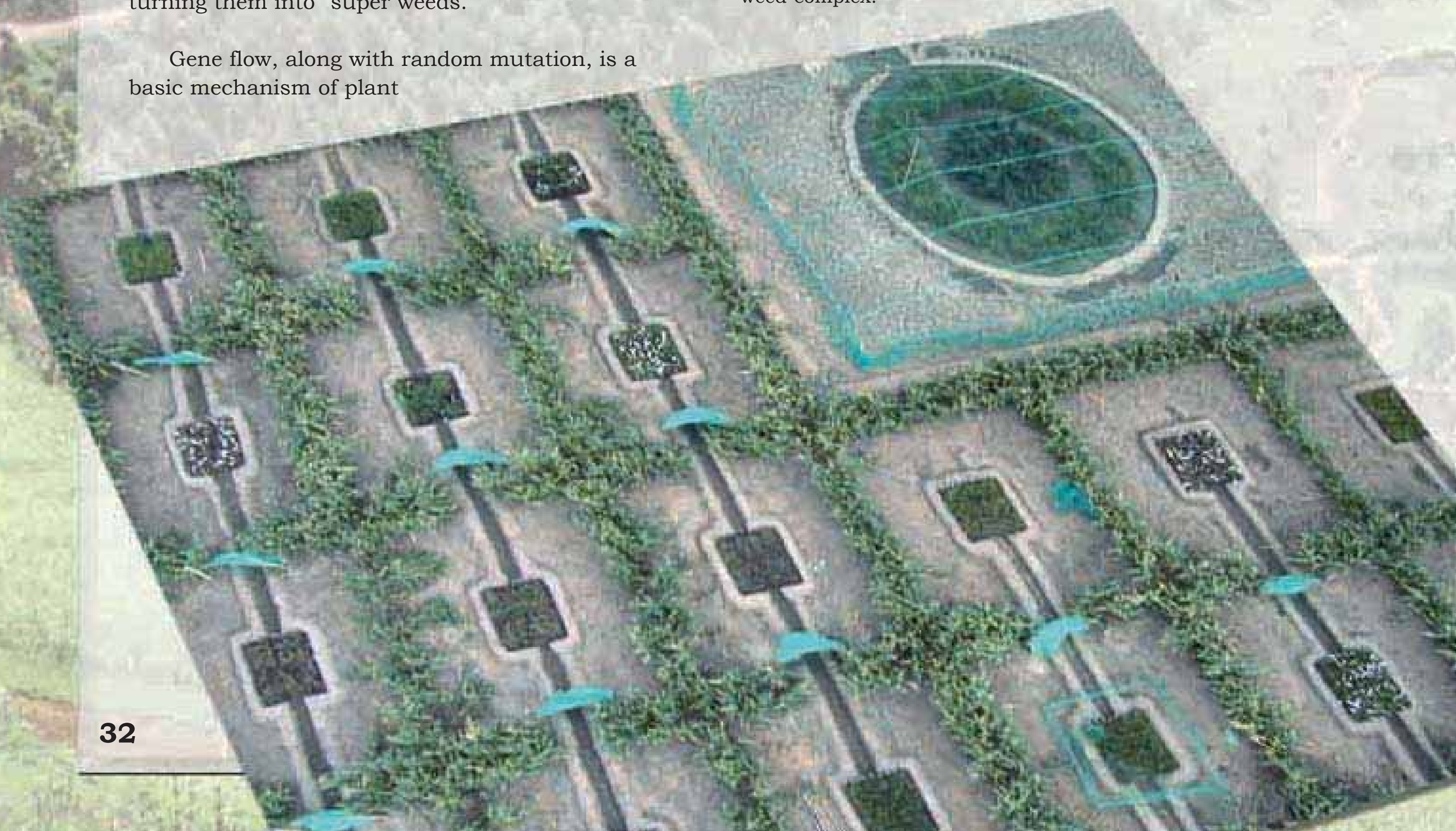
With funding from Germany's Federal Ministry of Cooperation and Economic Development (BMZ), CIAT recently launched a research project to improve understanding of how genes flow between cultivated crops and their wild or weedy relatives. Latin American rice and beans are the crop models for current field and molecular studies in Colombia and Costa Rica.

Gene flow has caught international public attention mainly because of concerns over the environmental safety of genetically modified (GM) crops. Genetic transformation of plants through biotechnology raises important questions: under what circumstances are "transgenes" likely to make their way into the DNA of other plant species, and will this have different effects from the gene flow of nontransgenic crops. A frequently cited fear is that a transgenically induced trait, such as resistance to a herbicide, pest, or disease, could be transferred to close relatives of the GM crop through a natural process called outcrossing, turning them into "super weeds."

Gene flow, along with random mutation, is a basic mechanism of plant evolution, an engine of biological diversity. Through hybridization genes from one wild plant population sometimes mix with those of another. Likewise, DNA may flow between conventionally bred crops and their wild relatives.

"Many of the questions being asked these days about the environmental and human safety of GMOs apply equally to conventionally bred plants. Gene flow has always been there. It's part of normal crop evolution. What we want to do in this new research is step back and take a look at the issue from a broad perspective," says rice geneticist Zaida Lentini, who led the CIAT team that produced the first transgenic rice resistant to rice hoja blanca virus, a major threat to Latin American rice production.

In recent work Lentini and her colleagues studied various physical and behavioral characteristics of red rice—a highly variable "weed complex" that often displays traits of cultivated rice, wild species, or both. They collected red rice plants and seeds from fields in the Tolima region of southwestern Colombia, where farmers were growing popular commercial (but non-GM) varieties of rice (*Oryza sativa*). These samples were sorted



An aerial view of experiments at CIAT headquarters in Colombia, designed to monitor gene flow from transgenic and nontransgenic rice into red rice, a highly variable weed complex.

according to the variety being grown in the field where they were collected.

The idea was to identify highly variable, easily recognized traits in red rice, since these can serve as practical tell-tale signs of gene flow from cultivated rice. Husk and grain color, the presence or absence of awns (tiny bristles on the flowering part of the plant), growth and flowering patterns were among the most variable traits observed. This so-called morphological and phenological analysis demonstrated clear similarities between a number of the red rice biotypes and their companion cultivated varieties. And in other cases there were strong trait associations with wild rice, particularly *O. rufipogon.*

A complementary element of the research is the use of molecular markers (microsatellites in this case) to pinpoint genetic similarities between cultivated rice, red rice, and wild species. From a pool of 50 candidate microsatellites, the researchers recently identified 14 that will be useful in tracking gene flow.

CIAT expects that these gene flow studies will add to the knowledge base needed by national biosafety authorities to decide wisely about the deployment and management of transgenic crops in specific circumstances and locations.

Rural youth inherit the planet

CIAT is capitalizing on the fact that today's children are tomorrow's stewards of the earth. It is doing so through two recently launched youth projects, one in Honduras funded by the Canadian International Development Agency (CIDA) and the other in Colombia, funded by the USA's W.K. Kellogg Foundation. The pilot projects are adapting participatory research approaches to the needs and abilities of young people.

Participants range from preschoolers to university students. In collaboration with local schools and NGOs, CIAT trains selected youth in participatory research methods, experiment design, and group facilitation. The youth facilitators in turn lead groups of children in experiments on natural resource management and food production. This approach aims to give fledgling youth research groups the continuity and leadership needed for their evolution into effective, permanent organizations.

In Honduras groups have been formed in six communities, involving a total of 143 youth. Research topics include methods for combating river pollution, evaluation of tree species for firewood, and the establishment of vegetable gardens. CIAT and Canada's University of British Columbia jointly organized a 3-day workshop to introduce the pollution research group to watershed management concepts and methods. With

Rural school children in southwestern Colombia planning experiments with vegetable production.

the help of computer-based presentations, the young researchers learned about water resource mapping and the use of vegetative buffer zones to protect streams.

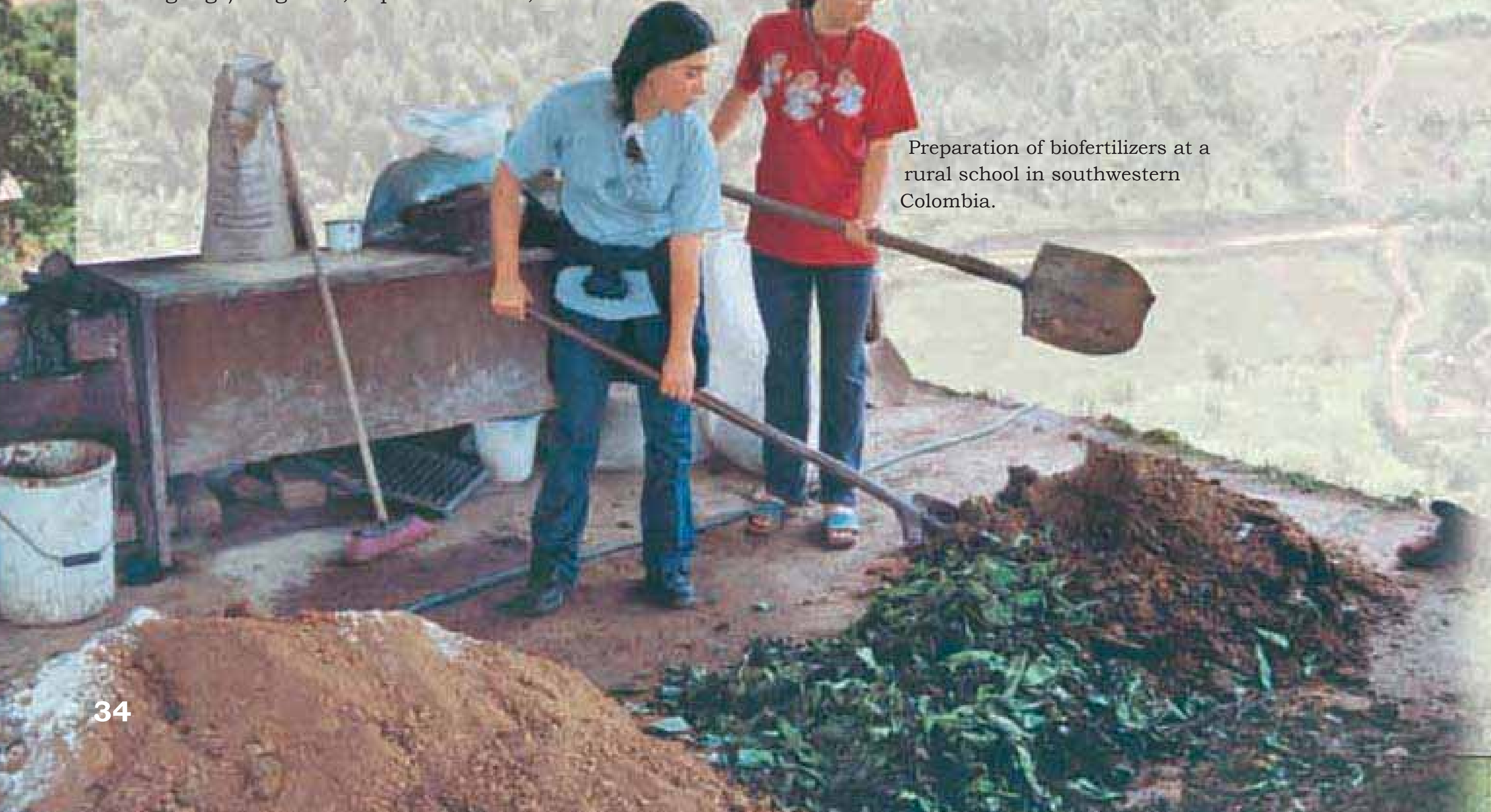
In southwestern Colombia CIAT has joined forces with three groups: an association representing 38 schools, an NGO specializing in research on sustainable agriculture, and a youth group dedicated to environmental conservation. The work is centered in the Garrapatas River watershed, an area covering 250 square kilometers on the western flank of the Andes Mountains.

Ten youth research groups have been formed under the umbrella of the Association of Educational Centers in the Garrapatas River Watershed (ACERG). Led by senior students at the region's only high school, youth researchers (both primary and secondary school students) selected their research topics themselves and are now experimenting with such options as biointensive vegetable gardens, bamboo production, and small-scale production of poultry, fish, and cattle.

"The school association has been keen to have agriculture play a greater role in our curriculum," says school director Adriana Abadía. The students' experiments are thus a good fit with one of the three broad themes promoted by ACERG: agroecological education. The other two are rural enterprise development and ethnoeducation (the study of local Andean history, culture, and language). Together, explains Abadia, these themes reflect the policy of the watershed's two municipalities to create viable rural livelihoods and make their mountain landscape a more attractive home for their children—economically, socially, and environmentally.

Marta Rodríguez, 18, is one of the students supervising the bean research. She has even replicated the experiment in her own community, 31 kilometers from the school. "If our experiments succeed, we'll get the results to other farmers," she says.

CIAT and ACERG have two local partners in the youth research project: the Center for Research on Sustainable Agricultural Production Systems (CIPAV) and an environmental youth group, Inheritors of the Planet, Bellavista, or HPB. CIPAV helps rural communities conduct nature-conservation research linked to improved farming practices. Its positive experiences have rubbed off on local youth. With funding and technical assistance from CIPAV, several children of one of the original collaborating farmers launched HPB in 1995. They began doing their own environmental research, conducted inventories of tropical fauna and flora, and eventually set up a 3-hectare biodiversity reserve for study. The group, which now has 36 members, is collaborating with ACERG in mentoring younger children in research techniques.



Preparation of biofertilizers at a rural school in southwestern Colombia.

An Overview of CIAT

The International Center for Tropical Agriculture (CIAT) is a not-for-profit organization that conducts socially and environmentally progressive research aimed at reducing hunger and poverty and preserving natural resources in developing countries. CIAT is one of 16 food and environmental research centers working toward these goals around the world in partnership with farmers, scientists, and policy makers. Known as the Future Harvest centers, they are funded mainly by the 58 countries, private foundations, and international organizations that make up the Consultative Group on International Agricultural Research (CGIAR).

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.

- Asian Development Bank (ADB)
- Australia
  - Australian Agency for International Development (AusAID)
  - Australian Centre for International Agricultural Research (ACIAR)
- Belgium
  - General Administration for Cooperation in Development (AGCD)
- Brazil
  - Brazilian Agricultural Research Enterprise (Embrapa)
- Canada
  - Canadian International Development Agency (CIDA)
  - International Development Research Centre (IDRC)
- Colombia
  - Colombian Institute for the Development of Science and Technology (COLCIENCIAS)
  - Ministry of Agriculture and Rural Development
  - National Program for the Transfer of Agricultural Technology (PRONATTA)
- Denmark
  - Danish International Development Assistance (Danida)
- European Union (EU)
- Food and Agriculture Organization (FAO) of the United Nations
- France
  - Center for International Cooperation in Agricultural Research for Development (CIRAD)
  - Institute of Research for Development (IRD)
  - Ministry of Foreign Affairs
  - National Institute for Agricultural Research (INRA)
- Germany
  - Federal Ministry of Cooperation and Economic Development (BMZ)
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  - Directorate General for International Cooperation (DGIS)
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New Zealand
- Ministry of Foreign Affairs and Trade (MFAT)

Norway
- Norwegian Agency for Development Cooperation (NORAD)
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- Ministry of Agriculture and Land Affairs

Spain
- Ministry of Agriculture

Sweden
- Swedish International Development Agency (SIDA)

Switzerland
- Federal Institute of Technology Development (ETH)
- Swiss Agency for Development and Cooperation (SDC)
- Swiss Centre for International Agriculture (ZIL)

Thailand
- Department of Agriculture

United Kingdom
- Department for International Development (DFID)
- Natural Resources Institute (NRI)

United Nations Environment Programme (UNEP)

United States of America
- The Ford Foundation
- The Rockefeller Foundation
- United States Agency for International Development (USAID)
- United States Department of Agriculture (USDA)
- The Wallace Foundation
- W.K. Kellogg Foundation
- World Resources Institute (WRI)

Venezuela
- Fundación Polar

The World Bank

Our mission

To reduce hunger and poverty in the tropics through collaborative research that improves agricultural productivity and natural resource management

Our project portfolio

CIAT's research is conducted through the projects listed below. These provide the elements for integrating research within the Center and for organizing cooperation with our partners.

Agrobiodiversity and Genetics

Conserving and Using Tropical Genetic Resources
Bean Improvement for the Tropics
Cassava Improvement for the Developing World
Rice Improvement for Latin America and the Caribbean
Multipurpose Tropical Grasses and Legumes
Tropical Fruits, a Delicious Way to Improve Well-being

Ecology and Management of Pests and Diseases

Integrated Pest and Disease Management

Soil Ecology and Improvement

Overcoming Soil Degradation

Analysis of Spatial Information

Land Use in Latin America
Confronting Global Climate Change

Socioeconomic Analysis

Communities and Watersheds
Participatory Research
Rural Agroenterprise Development
Information and Communications for Rural Communities
Impact Assessment

Crop and agroecosystem focus

Within the CGIAR, CIAT has a mandate to conduct 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. Increasingly, the Center also helps national programs and farmer groups find solutions to production problems encountered with other crops, such as tropical fruits, by applying research capacities developed through work on the mandate commodities.

In Latin America our integrated research on crops and natural resource management is organized largely on the basis of three agroecosystems: hillsides, forest margins, and savannas. CIAT scientists also work to improve crops and natural resource management in midaltitude areas of eastern, central, and southern Africa and in upland areas of Southeast Asia.

Institutional links

CIAT builds ties with other institutions through research partnerships based on projects. Our expanding circle of partners includes other Future Harvest centers, national research institutes, universities, NGOs, 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. As a service to its partners, the Center provides varied offerings in training and conferences and specialized services in information and documentation, communications, and information systems.

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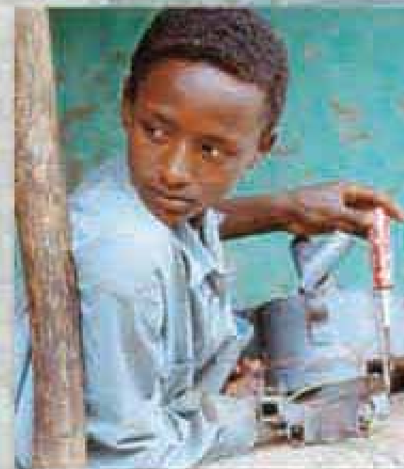

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Mathew Blair, Bean Germplasm Specialist and Breeder
Hernán Ceballos, Cassava Breeder and Project Manager, Cassava Improvement for the Developing World
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Daniel Debouck, Genetic Resources Specialist and Head, Genetic Resources Unit
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Ecology and Management of Pests and Diseases
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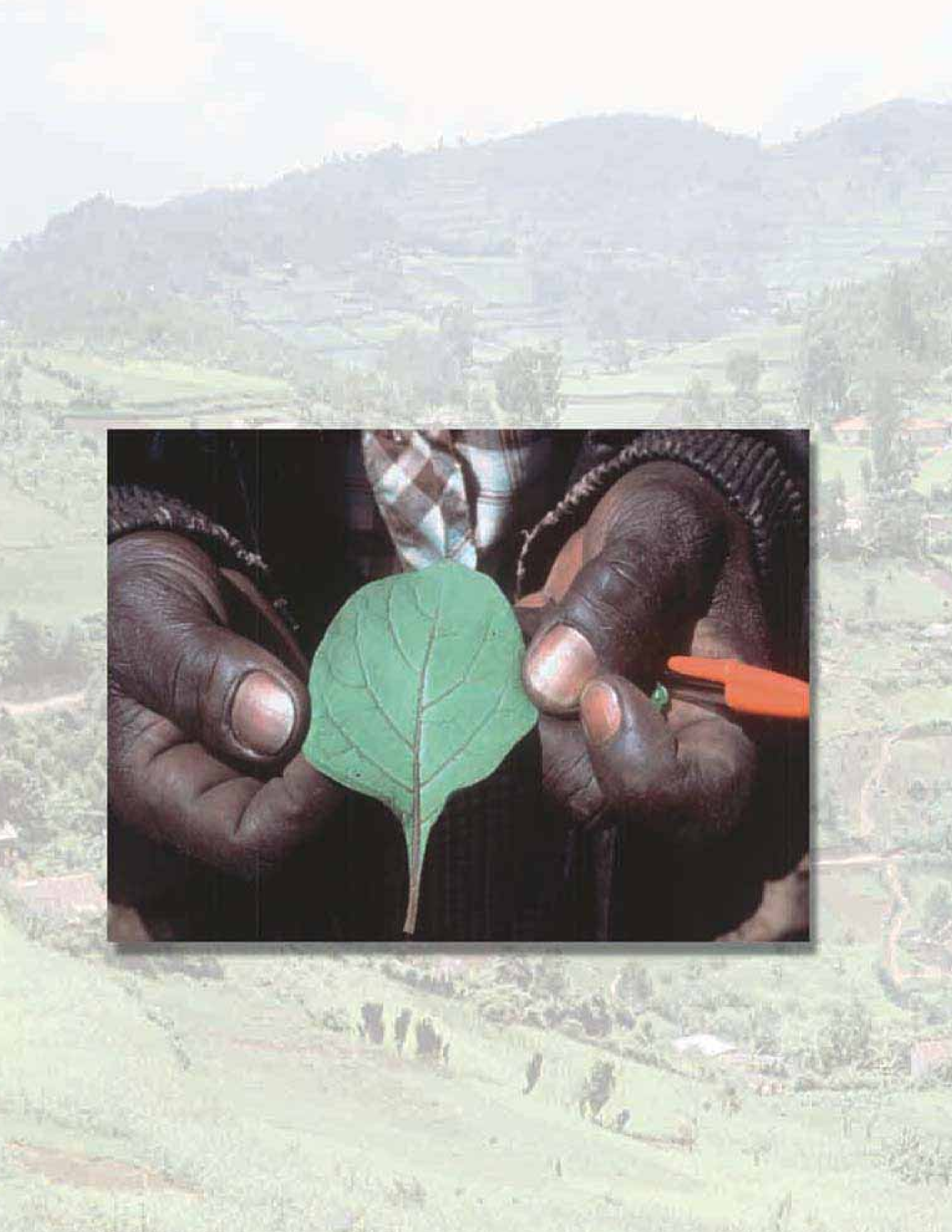
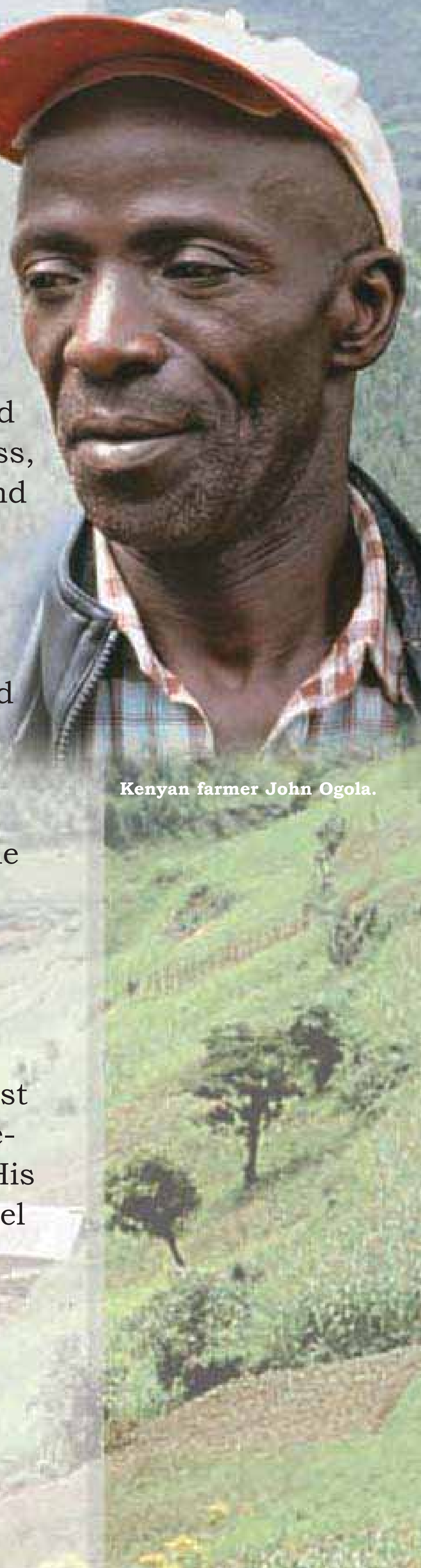


The Power of Perspective

John Ogola is a man of many talents. On a tiny, terraced hillside plot in western Kenya's densely populated Vihiga District, this dedicated farmer grows more than a dozen crops—for food, forage, green manure, erosion control, lumber, and fuel. Good composting is his main recipe for success, especially with horticultural crops like cabbages and kales. He also raises chickens and one cow, and is about to add rabbits, goats, and bees to his menagerie.

Ogola is a member of the Mukhombe Farmer Field School. This is a joint venture by local farmers, CIAT's Tropical Soil Biology and Fertility (TSBF) Institute, and Kenya's agriculture ministry. The open-air school gives farmers a chance to learn the dynamics of soil fertility and to experiment with organic and inorganic soil enhancements (for more information see pages 10-11).

"Because of the land shortage, I decided to try something new—horticultural crops—instead of just grazing my cow," says Ogola. His penchant for life-long learning and experimentation are paying off. His intensive production methods have become a model for other farmers in the village.



Kenyan farmer John Ogola.

Solutions That Cross Frontiers

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