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Solutions That Cross Frontiers

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CIAT
Centro Internacional de Agricultura Tropical
International Center for Tropical Agriculture

A Vicious Circle

In fragile agroecosystems of the tropics, many millions of rural families are trapped in a vicious circle of poverty and natural resource degradation. Pushed to less favorable lands, these people struggle to make a living in areas characterized by unstable, infertile soils. To keep food on the table and meet their families' other needs, farmers overwork the same plots or clear new ones, sparking a chain reaction that results in deforestation, the loss of biological diversity, soil degradation, and reduced availability of water.

Environmental destruction, in turn, aggravates the poverty that set the wheel in motion. About 1.1 billion people in the developing world, over half of them in rural areas, just barely survive on less than a dollar a day. Many more, with somewhat better incomes, still lead lives of deep deprivation. All aspire to an adequate diet and livelihood, but the natural resources needed to fulfill even these modest hopes are rapidly being undermined.

Poverty in rural areas results inevitably in social disintegration. Families break up, children move to urban slums, while violence and unrest escalate.

Newspaper headlines bear witness to the high human costs. Ongoing conflicts in the Andean zone and parts of central Africa and Southeast Asia are directly related to the downward spiral of poverty and natural resource degradation.

The poor, of course, are not solely to blame for the environmental consequences. Wasteful practices by the rich cause an even greater share of the damage. Yet it is clearly the poor who suffer the worst consequences. They are not the only losers, however. In an interdependent world, everyone is affected by the vicious circle—through the pressures created by urban sprawl, rural violence, and massive emigration from troubled regions; through reduced supplies of fresh water; through the loss of plant species that hold the key to new foods, medicines, and other necessities of life; and eventually perhaps through changes in the global climate.

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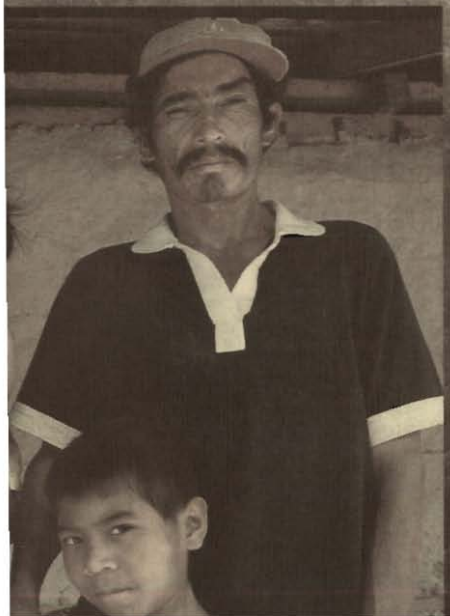
Solutions That Cross Frontiers

Patterns in the management of agricultural land are the cumulative result of decisions and actions taken by millions of farmers and by the relatively few individuals who shape development policies and strategies. Our best hope for breaking the vicious circle is to offer these people new and more effective means to overcome hunger and poverty, while protecting nature's endowment.



Toward this end the International Center for Tropical Agriculture (CIAT) conducts research on five closely related themes:

- Crop improvement
- Conservation of biological diversity
- Pest and disease management
- Soil quality and production systems
- Land management

The impact of our work over the past 30 years demonstrates beyond doubt that persistent research on key crops can go far toward alleviating hunger and poverty, while lessening environmental problems. Recent experience further suggests that, by closely integrating crop improvement with research on natural resource management, we can accomplish even more to improve human welfare and preserve fragile agroecosystems.

CIAT contributes to those aims by developing improved seeds, methods, and information. We refer to the products of our work as "solutions that cross frontiers," because they transcend national boundaries and overcome other barriers as well, bringing together diverse institutions and expanding the limits of human knowledge.

The Difference Science Makes

The impact, so far, of our joint endeavors with international and national partners:

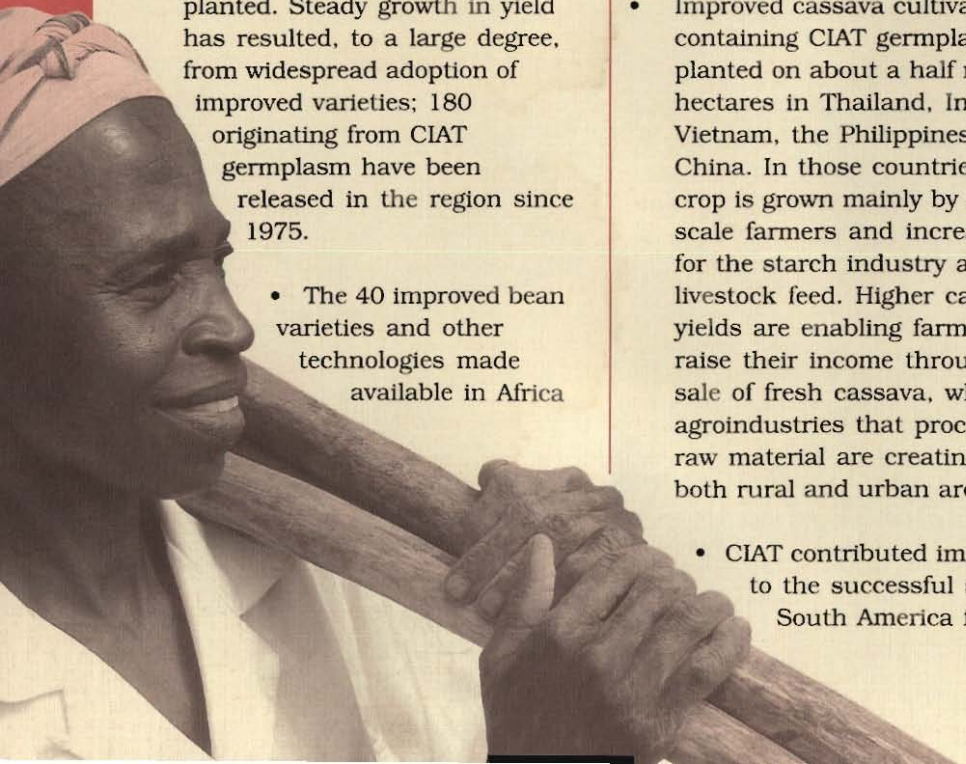
- Over the last decade, bean production in Latin America has increased by a third, despite a substantial decrease in area planted. Steady growth in yield has resulted, to a large degree, from widespread adoption of improved varieties; 180 originating from CIAT germplasm have been released in the region since 1975.

- The 40 improved bean varieties and other technologies made available in Africa since 1985 are starting to have an impact. In Rwanda, for example, 43 percent of farmers had adopted new climbing beans by 1994, generating benefits worth about US$12 million per year.

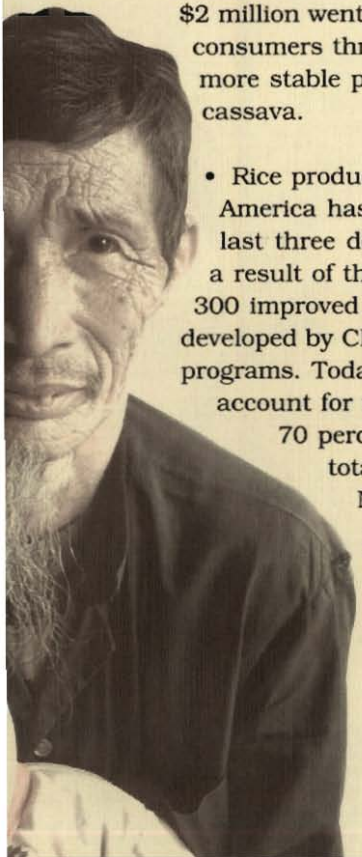
- Improved cassava cultivars containing CIAT germplasm are planted on about a half million hectares in Thailand, Indonesia, Vietnam, the Philippines, and China. In those countries the crop is grown mainly by small-scale farmers and increasingly for the starch industry and for livestock feed. Higher cassava yields are enabling farmers to raise their income through the sale of fresh cassava, while agroindustries that process this raw material are creating jobs in both rural and urban areas.

- CIAT contributed importantly to the successful search in South America for natural enemies that could control the cassava mealybug and cassava green mite in sub-Saharan Africa. These pests devastated production across the continent, threatening a major source of calories for about 200 million Africans. The biological control campaign was undertaken by our sister center in Nigeria, the International Institute of Tropical Agriculture (IITA).

- In the 1980s the Center launched a series of integrated projects aimed at devising a research and development strategy that would empower farmers to establish, operate, and manage local cassava-based industries. The approach has been applied successfully in Brazil, Colombia,



and Ecuador. Between 1984 and 1992, one project in Colombia put more than US$16 million in the pockets of low-income producers and processors. Another $2 million went to poor urban consumers through lower but more stable prices for fresh cassava.



- Rice production in Latin America has tripled over the last three decades, partly as a result of the approximately 300 improved rice varieties developed by CIAT and national programs. Today these varieties account for more than 70 percent of the region's total rice production. More efficient production has helped lower the price of this vital staple by about 40 percent. Lower prices have benefited the poor in particular, since they spend a large proportion of their income on food.

- Forage grasses identified by CIAT (in the genera *Brachiaria* and *Andropogon*) are now being grown on more than 10 million hectares in tropical savannas and in hillside areas of Central America and the Andean zone. The forage legume *Arachis* is being widely used as a soil cover to improve soil quality and to provide high-quality feed for intensive farming systems in the tropics. These new species increase livestock productivity by 20 to 100 percent, depending on the species they replace.

- A participatory approach by which farmers are organized into local agricultural research committees (or CIALs) has increased the effectiveness and efficiency of adaptive research. Developed originally in Colombia, the CIAL method is now being used in more than a half dozen other countries of Latin America. Participatory methods developed by CIAT are also being applied in Southeast Asia as well as eastern and central Africa.

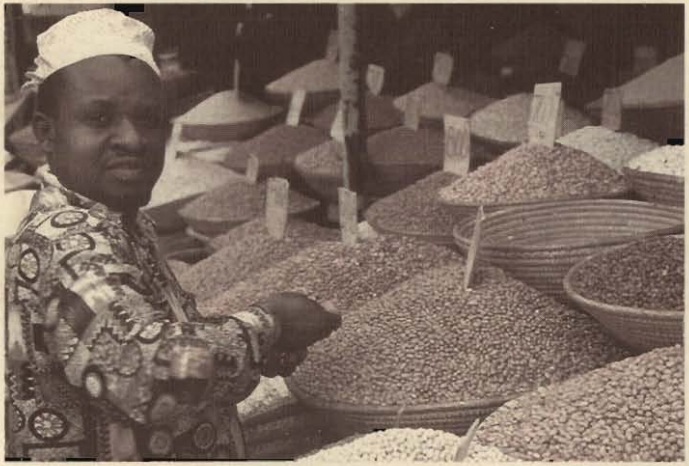
Crop Improvement

Seeds That Travel the Globe

CIAT has built a solid record of achievement in research on common bean, cassava, tropical forages, and rice (see box on page 8). The main product of this work is higher yielding germplasm with natural tolerance to diseases, pests, and physical stresses such as low soil fertility.

Improved crop varieties are vital for bolstering food security in rural and urban areas and for increasing farm income. They can also prompt farmers to adopt environmentally sustainable production systems. Forage legumes, for example, help regenerate degraded soils, in addition to providing better feed for livestock. Rice varieties adapted to acid soils in lowlands generate income that can be invested in land improvement.

To better realize the potential of its target crops, CIAT carries out genetic improvement on a regional and global basis, drawing on expertise in various disciplines. Our biotechnology specialists, for example, combine new molecular techniques with field research aimed at understanding major plant diseases and at harnessing the power of plant genetic diversity.



Bringing Genetic Solutions to Light

The biological diversity (often called "biodiversity") on which agriculture depends is being eroded at an alarming rate as fragile agroecosystems are destroyed. With the loss of this resource, many of the solutions to problems that plague the poor are being lost irretrievably.

Recognizing the importance of biodiversity for crop improvement and better land management, CIAT conserves more than 27,000 samples of beans, about 6,000 of cassava, and 21,000 samples from about 155 genera of forage grasses and legumes. We continually seek better ways to safeguard and evaluate these resources and to make them more widely available to researchers and farmers.

Through these efforts the Center has built a strong base of knowledge and expertise for effectively preserving and using plant genetic resources. For example, we have developed a novel approach for using geographic information systems (GIS) to determine where to find new agrobiodiversity, and we exploit state-of-the art molecular techniques to better understand and use this resource.

In addition to applying those capacities to its four target crops, CIAT now offers them as a service to partners in tropical America who are conducting research on other species. Our aim is to help countries that are rich in agrobiodiversity better conserve this natural heritage and use it to improve human welfare.

Our crop focus

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

Common bean—This is the most important food legume for more than 300 million people, most of them in the developing world. Common bean (*Phaseolus vulgaris*) ranks second as a source of protein in eastern and southern Africa and fourth in tropical America, where the crop was domesticated. Beyond their contribution to human nutrition, beans have considerable economic importance, generating income for millions of small-scale farmers. In Africa the vast majority of bean producers are women.

Cassava—A root crop of tropical American origin, cassava (*Manihot esculenta*) provides food and a livelihood for about 500 million people in the developing world. The crop tolerates seasonal drought and poor soils and has an unequalled ability to recover after stems and leaves have been damaged by pests and diseases. In recent decades various countries, mainly in Southeast Asia and Latin America, have begun to tap the potential of cassava's starchy roots for local value-added processing.

Tropical forages—As tools for controlling erosion and improving the soil, grasses and legumes have many uses beyond their traditional role as livestock feed. Nitrogen-fixing legumes, for example, enhance soil fertility, increasing the productivity of other crops. As livestock feed, they boost meat and milk production, helping to improve human nutrition and raising farm income.

Rice—Rice is the most important food grain in most of the tropical areas of Latin America and the Caribbean, where it supplies more calories in people's diets than do wheat, maize, cassava, or potatoes. More efficient rice production is a central prerequisite for bettering the lot of the region's urban and rural poor.

Overcoming Fear Through Knowledge

Small-scale farmers fear few things more than insect pests and plant diseases, which jeopardize their food security and income. In many places (particularly in sub-Saharan Africa), rural people are virtually defenseless against these hazards. Where farmers have easy access to pesticides (as in much of Latin America), they often fall into a pattern of indiscriminate chemical spraying, especially on high-value crops for domestic and export markets. Complete dependence on pesticides threatens the health of farmers and consumers, poisons the environment, and, ironically, can make pest problems even worse.

The best antidote for farmers' fear is knowledge—about the nature of pest and disease attacks and about diverse countermeasures. To develop and deliver such knowledge, CIAT scientists conduct research with national institutions on integrated pest management (IPM). This is an effective and environmentally sound approach that draws on a combination of control practices, based on a thorough understanding of pest and disease behavior and ecology.

IPM specialists at CIAT develop a range of alternative measures, such as genetically resistant germplasm and biological controls. With those components researchers and farmers at specific locations can then formulate IPM strategies. To make the process more efficient, the Center develops farmer participatory methods and promotes these and other techniques through regional and global projects.

Thinking Globally, Acting Locally

The steady degradation of tropical soils is robbing small-scale farmers of their best hope for giving themselves and their children a better future. Crops and livestock may survive on infertile, eroded soils, but they cannot thrive.

CIAT scientists are exploring various options that enable farmers to intensify agricultural production, while preserving fragile soils in marginal agroecosystems (see box on page 12). For example, crop-pasture systems, particularly those including forage legumes, increase crop and livestock production, while improving soil quality through enhanced biological activity and physical structure. In many cases developing new agroenterprises (such as value-added processing of tropical products) is vital for strengthening farmers' financial incentive to adopt practices that regenerate natural resources.

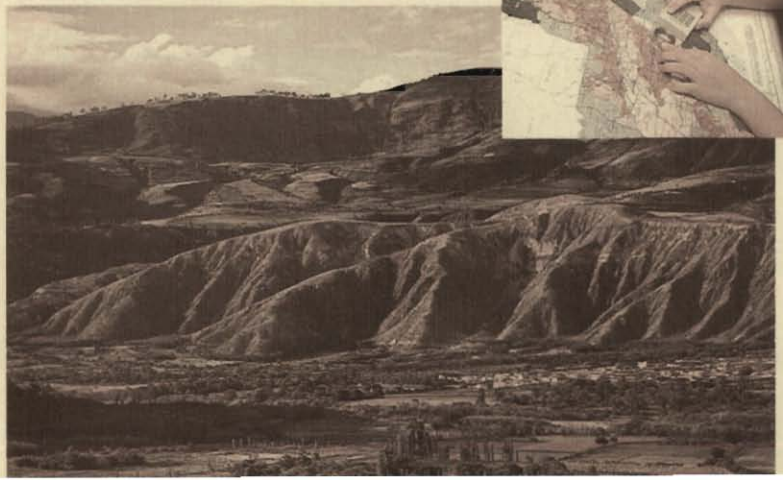
Developing sustainable production systems is ultimately a local challenge, requiring that researchers and farmers tailor new options to specific environments. To help them do this more efficiently, CIAT scientists act locally, while thinking globally. Through strategic research and farmer participatory studies at representative sites, they identify basic principles that can guide the development of improved production systems and help predict whether or not they will be sustainable under different conditions.

From Bottom Up and Top Down

Declining soil fertility, growing pest pressures, and other problems of marginal lands are warning signs that the intricate fabric of these agroecosystems is quickly unraveling. At CIAT we encourage collective action to reverse the pattern of destruction through a dual approach that moves from the bottom up and the top down.

At the grass roots level, our scientists study the geographical, social, economic, and political factors that shape resource management. This research provides clues as to what kinds of technologies and incentives could prompt farmers to change their current practices. On the basis of such analysis, we are developing strategies for community management of natural resources in hillside agroecosystems, to cite one example.

In conjunction with this work, Center scientists are developing GIS tools that deliver a wealth of complex land use information in forms that are relatively easy to use and understand. Some of these products are being designed to give local communities and institutions a quantitative basis for their decisions about resource management. Others help influential people at national and higher levels to study resource issues and appraise the options for government decision makers.



Our target agroecosystems

In Latin America our research on natural resource management is organized largely on the basis of three fragile agroecosystems: hillsides, forest margins, and savannas.

Hillsides—In Central America and the Andean zone, hillside areas support an estimated 10 million rural poor, many of whom depend heavily on beans, cassava, and livestock. Over half of the region's 95 million hectares of hillside land are undergoing rapid soil erosion. In addition to reducing crop productivity, this damage leads to siltation and contamination of rivers.

Forest margins—The vast Amazonian rain forests are being cleared at an alarming rate,

resulting in the permanent loss of biodiversity, among other effects. Shifting cultivation by small-scale farmers has been estimated to account for about a third of the deforestation. Cassava, rice, and tropical forages figure importantly in the predominant production systems of this agroecosystem.

Savannas—The South American savannas occupy more than 250 million hectares, mostly in Brazil but also in Bolivia, Colombia, and Venezuela. Sizable areas of this environment are sown to grass pastures and annual crops, such as rice. A potentially important food basket for the world, the savannas are also a fragile and precious natural resource, lying in the basin of major American rivers.

Fragile environments in Africa and Asia—Much of the germplasm we conserve and improve in Latin America as well as the research tools we employ there are relevant to similar environments on other continents. This is particularly true of the midaltitude and highland areas of central and eastern Africa as well as the uplands of Southeast Asia. CIAT scientists are addressing key resource management issues in those environments in connection with research on beans, cassava, and tropical forages.

INSTITUTIONAL LINKS

Doing Research Together

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

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

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

Our Project Portfolio

CIAT's research is conducted through 16 projects, which provide a mechanism for integrating research within the Center and for organizing cooperation with our partners. Brief profiles of the projects are available upon request.

Our Staff

The Center employs a total of more than 600 staff. About 70 of these are internationally recruited researchers from more than 20 countries. Some of our scientists are outposted to Brazil, Guatemala, Honduras, Kenya, Malawi, Nicaragua, the Philippines, Tanzania, Thailand, and Uganda.

The CGIAR

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

Our 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.

Australia
- Australian Agency for International Development (AusAid)
- Australian Centre for International Agricultural Research (ACIAR)

Belgium
- General Administration for Cooperation in Development (AGCD)

Canada
- Canadian International Development Agency (CIDA)
- International Development Research Centre (IDRC)

Colombia
- Colombian Institute for the Development of Science and Technology "Francisco José de Caldas" (COLCIENCIAS)
- Fund for Agricultural Development (FUNDAGRO)
- Ministry of Agriculture and Rural Development
- National Livestock Fund (FEDEGAN)
- National Program for the Transfer of Agricultural Technology (PRONATTA)
- Nestlé de Colombia S.A.

Common Fund for Commodities (CFC)

Denmark
- Danish International Development Assistance (DANIDA)

European Union (EU)
- European Commission

France
- Center for International Cooperation in Agricultural Research for Development (CIRAD)
- French Institute of Scientific Research for Development and Cooperation (ORSTOM)
- Ministry of Foreign Affairs

Inter-American Development Bank (IDB)

International Fund for Agricultural Development (IFAD)

Germany
- Federal Ministry for Scientific Cooperation and Development (BMZ)
- German Agency for Technical Cooperation (GTZ)

Japan
- Ministry of Foreign Affairs
- Nippon Foundation

Netherlands
- Directorate General for International Cooperation (DGIS)

Norway
- Royal Ministry of Foreign Affairs

Spain
- Ministry of Agriculture

Sweden
- Swedish International Development Agency (SIDA)

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

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

United Nations Development Programme (UNDP)

United Nations Environment Programme (UNEP)

United States of America
- Ford Foundation
- Kellogg Foundation
- Rockefeller Foundation
- United States Agency for International Development (USAID)
- United States Department of Agriculture (USDA)

World Bank

SEEKING SYNERGY

The vicious circle of poverty and natural resource degradation is a powerful force that sharply limits life's possibilities for millions of people now and ultimately threatens the welfare of everyone, rich and poor alike.

To break the circle requires a force of equal strength that will give rise to new and sustainable patterns of crop and land management. These must satisfy human needs, restore dignity to rural life, and create respect for the natural resources on which all life depends. At CIAT we believe that such a force can come only from the synergy that individuals and institutions generate when they apply their diverse talents in unison to a common cause.

That is why we invite you to join us in finding "solutions that cross frontiers."

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OUR MISSION

What To contribute to the alleviation of hunger and poverty

Where in tropical developing countries

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

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