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Pathways to Eco-Efficient Agriculture

CIAT Annual Report
2011

CIAT 45
Centro Internacional de Agricultura Tropical
International Center for Tropical Agriculture

A Remarkable Record of Science for Change
Since 1967

Pathways to Eco-Efficient Agriculture

Message from the Board Chair and Director General

Wider Spheres of Collaboration

Signing a new agreement for collaborative research (left to right): Juan Camilo Restrepo, Colombian Minister of Agriculture; Ruben Echeverría, CIAT Director General; Juan Manuel Santos, President of Colombia; and Juan Lucas Restrepo, Director, Colombian Corporation of Agricultural Research.

As part of a larger effort to renew CIAT's eco-regional role and strengthen its global presence, we focused strongly during 2011 on widening the Center's multiple spheres of scientific collaboration. These encompass our strategic relationship with the Center's host country, Colombia; our longstanding presence in several regions of the developing world; and our significant contribution to the global research portfolio of the CGIAR.

New partnership models, taking shape on the eve of CIAT's 45th anniversary, will better enable our Center to build on past gains and set the stage for future development impacts.

A Unique Global Contribution

Roughly 90% of CIAT's research is now aligned with the current CGIAR agenda, which provides a broad global framework for our work and integrates it with that of other international centers. CIAT plays an active role in 11 of the CGIAR Research Programs, serving as lead center for the Climate Change, Agriculture and Food Security (CCAFS) Program.

Officially launched in late 2010, CCAFS quickly gained momentum in 2011 and is already producing strategic research results (see pages 22-23). In just 6 months, it completed a baseline survey of more than 5,000 rural households, involving 30 national partners and 6 international centers. In addition, CCAFS worked with a consortium of more than 15 organizations to ensure a significant place for agriculture in international climate change negotiations.

CIAT's involvement in this and 10 other CGIAR programs reflects our unequivocal commitment to collective action as well as the unique character of our individual contribution. CIAT pursues an integrated global approach to research on tropical agriculture, which blends a sharp focus on agricultural biodiversity with the cross-cutting themes of tropical soils and policy analysis.

New Partnership Models in Colombia

In all of the regions where CIAT works, we prepared the ground this year for new research to help realize the potential of tropical agriculture for sustainable growth. With partners in Colombia, for example, we set in motion two new collaborative models.

One of these involves a strategic alliance uniting CIAT with the country's Ministry of Agriculture and Rural Development and the Colombian Corporation of Agricultural Research (CORPOICA). A full year of joint research on key crops and production systems in the Orinoquia region, supported by an innovative program of knowledge sharing, established the foundations for a longer term endeavor starting in 2012. It aims to put the agricultural development of this vast region on a competitive and sustainable basis.

The second collaborative model centers on a science park referred to as Parque Biopacífico, which unites CIAT, CORPOICA, the Colombian Institute of Agriculture (ICA), and the National University of Colombia, with support from the University of Valle (see page 12). Together, these organizations have nearly 300 scientists working in an area that is strategically important for Colombia's agriculture. Officially established in a ceremony attended by Colombian president Juan Manuel Santos, the park is a novel public-private sector initiative, which will focus on making agriculture more competitive.

A Strong Regional Presence

New partnerships in CIAT's host country serve as an anchor for the Center's wider agenda of eco-regional research in Latin America and the Caribbean. This research is organized around strategies that seek to integrate crop improvement with enhanced natural resource management. To consolidate a new strategy for Central America, CIAT directors met in Costa Rica with the ministers of agriculture from six countries and are following up on this initial exchange during 2012.

CIAT took important steps in other regions as well to widen the sphere of its research collaboration. One involved our research on tropical soils, which is mostly concentrated in sub-Saharan Africa but also has a Latin American presence. Under new leadership, we will build on 10 years of pioneering achievement by integrating the work of our soils network into CGIAR programs that deal with key natural resources and agroecosystems.

Another regional network that CIAT supports – the Pan-Africa Bean Research Alliance (PABRA) – embarked on a major effort to assess the impact of improved technology on food security and poverty at the household level. Just in the last 6 months of 2011, PABRA member countries released 17 new varieties, and about a half million farmers adopted improved seed and cropping practices.

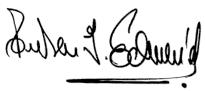
Meanwhile, in Southeast Asia, a new agreement with the Chinese Academy of Tropical Agricultural Sciences (CATAS) will strengthen our joint research on cassava and tropical forages. CIAT's new regional hub in Hanoi with the Vietnam Academy of Agricultural Sciences (VAAS) will facilitate our work with one of the region's strongest national agricultural research systems.

A Vision of Eco-Efficiency

In all of its collaborative spheres, CIAT's research is guided by a vision of eco-efficiency (see pages 4-5). Achieving more economically and ecologically prudent resource use in tropical agriculture has become a matter of the utmost importance in the face of climate change together with growing resource scarcity and the rapid rise in demand for farm products.

In 2011, CIAT researchers and several partners embarked on the development of a publication that spells out options and requirements for making our vision of eco-efficiency into a reality. The book will be published and widely promoted during 2012 in conjunction with events marking CIAT's 45th anniversary. We invite you to read in the sections that follow how research can make agriculture more eco-efficient, creating large benefits for people and the environment.

Juan Lucas Restrepo
Chair, Board of Trustees
(2010-2011)



Ruben G. Echeverría
Director General

From Vision to Reality

An aerial view of rice production near Vergara, in eastern Uruguay.

From the Neolithic Revolution to the Green Revolution, farmers have always sought to use their land, labor, and other resources more efficiently. But in recent years, this abiding concern has become especially urgent and worrisome. Farming communities and whole societies have awakened to the huge costs of over-using chemical inputs and mining earth's resources unsustainably to raise agricultural productivity in response to rapidly growing demand.

Under mounting pressure, tropical agriculture has thus arrived at a defining moment in its history. Either it can be allowed to fall short of human needs while continuing along its current unsustainable course. Or it can rise to the challenges of climate change, resource scarcity, and deteriorating food security by rapidly pursuing multiple pathways to eco-efficiency.

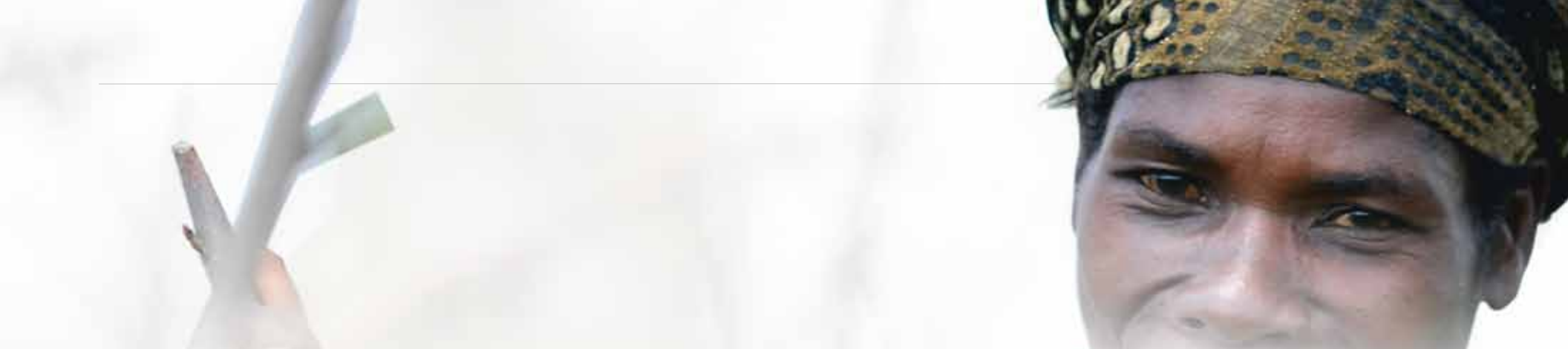
Pathways to Eco-Efficient Agriculture

Convinced that eco-efficiency can serve usefully as a guiding principle for research, CIAT decided several years ago to incorporate this concept into its mission. The challenge now for our organization and others is to translate the vision of eco-efficiency into reality. To foster debate and action, CIAT embarked on the development of a new publication series, whose inaugural volume, to be published in 2012, documents specific options for achieving a more eco-efficient agriculture.

The publication's authors agree that there is no single magic formula for achieving this end. They view the eco-efficiency concept rather as a practical tool that can help us better understand emerging challenges for agriculture, analyze technological and policy options, and weigh difficult tradeoffs.

To provide a broad framework for these tasks, the new publication charts six distinct but complementary pathways:

1. Large-scale adoption of better crop varieties and management practices, based on sound agronomic advice
2. Increased investment in best practices that offer large enough gains to compensate farmers for greater risks
3. Reduced investment in inputs that are being over-used
4. More efficient use of all resources to obtain greater returns at lower cost
5. Introduction of technologies that permit quantum leaps in agricultural productivity
6. Protection against future losses in productive capacity



Some of these pathways are already well traveled. Pioneering farmers and agricultural researchers continue to explore others, as described in this annual report.

The Origins of Eco-Efficiency

The World Business Council for Sustainable Development first used the term "eco-efficiency" in its 1992 publication, *Changing Course*. It defined the term as "creating more goods and services, with ever less use of resources, waste, and pollution." The 1992 United Nations Conference on Environment and Development (UNCED), held in Rio de Janeiro, Brazil, endorsed this concept, calling on private industry to embrace Agenda 21 – the conference's action plan for achieving sustainable development.

Some years later, agricultural experts took up the eco-efficiency banner as well. CIAT researchers have joined them, stressing that eco-efficient agriculture improves livelihoods by raising productivity and minimizing negative environmental impacts through more economically and ecologically prudent use of resources.

To provide guidance and inspiration for these efforts, the new eco-efficiency publication from CIAT documents recent advances in research on key production systems and crops. Among the diverse systems covered are the rice-wheat rotation of South Asia's Indo-Gangetic Plain and the cassava-based systems of Central Africa's Great Lakes Region. The chapters on crops cover those undergoing genetic improvement at CIAT plus fruits and vegetables.

Achieving Eco-Efficiency: How and for Whom?

Achieving eco-efficiency in agriculture requires, in addition to new technologies, a profound shift in our development vision at every level – from farmers' fields to the corridors of political power. This must involve revised policies, reformed institutions, and renewed investment, which make it attractive and feasible for rural people to adopt eco-efficient crops and production practices.

In recent years, many novel tools and concepts have emerged that can help, including product life-cycle analysis, green value chains, and carbon footprint measurement. Putting those options to better use is largely a matter of capacity development. In this arena as well, many new approaches show promise, such as participatory research methods and dynamic knowledge sharing techniques.

Skillful capacity building will be especially necessary for ensuring that new pathways to eco-efficient agriculture do not bypass smallholder farmers. This should also help create gender-sensitive options, which provide an exit from the absurd dichotomy between women's huge burden of responsibility for food production and their limited access to all types of resources.

Eco-Efficiency for a Better World

In response to the multiple crises besetting agriculture in recent years, the sector has received renewed support – but not enough. Agriculture must receive serious attention in international climate change negotiations, and its importance must be clearly recognized in the sustainable development agenda, which world leaders will revisit at Rio+20 to be held in Brazil during June 2012.

If both these steps are taken in 2012, then perhaps the year will see – not the end of this troubled world, as popular prophecies would have it – but the start of a better one, in which eco-efficient agriculture helps reconcile human aspirations with Nature's immutable laws.

1 Adopting Better Technologies More Widely

Climbing Beans: Rwanda's Upward Spiral ✓

Rwandan farmer Jean Damascene Bizimana, with one of his plots of improved climbing beans.

Despite the rain and mist blowing through his farm in Gicumbi District, northern Rwanda, 48-year-old Jean Damascene Bizimana is beaming as he shows visitors his climbing beans, throwing out his arm as if introducing a star performer. Jean Damascene is one of many thousands of farmers in Rwanda who have switched from the more traditional bush beans to improved climbing beans.

"When I see the bean pods looking like this – at this time of the season – I know it is money in my pocket!" he says, with a big, infectious grin. "These beans give hope to the farmer."

And it is easy to see the appeal. The bush bean plot adjacent to his climbers is as good as finished – stricken by disease and dilapidated by heavy rain. There are hardly any leaves left, and few plants have healthy seed pods. By comparison, the plot of climbers is so dense it seems almost impenetrable.

Climbing to the Challenge

Climbing beans make a lot of sense in Rwanda, which is fast running out of land. Already there are 11 million people squeezed into a country half the size of Costa Rica, and by 2100 that number is expected to leap to more than 40 million. Rarely has the need for eco-efficient solutions to sustainably boost food production been so pressing.

By virtue of growing upwards, climbing beans can produce up to three times more food on the same area of land than bush beans. They also enjoy two growing seasons per year; in some regions, three. While both types of beans are crucial sources of protein, some of the improved climbers also offer greater resistance to diseases of the leaves and roots, while others have been bred to contain higher levels of iron. After many years of research, 15 improved varieties were officially released in Rwanda during 2010.

For Jean Damascene, the impact was almost instantaneous. With the money he earned from climbing beans, he bought and constructed a tank to collect rainwater from his roof. The following year he bought cows, using the manure as compost and for fuelling a newly installed biogas generator. The generator, in turn, powers a light bulb in his home, enabling his 15-year-old daughter, Igirimbazi, to do her homework. She tells us that since the light was installed, she has moved from 15th position in the class to 4th.

A Collaborative Effort

Much of the climbing bean seed originally came from CIAT's headquarters in Colombia and was distributed via the Pan-Africa Bean Research Alliance (PABRA), which is supported by the Canadian International Development Agency (CIDA) and Swiss Agency for Development and Cooperation (SDC). Scientists at the Rwanda Agriculture Board (RAB) then enhanced the suitability of climbing bean varieties to the country's many ecosystems and to the demands of farmers through conventional breeding.

The work of HarvestPlus, a joint initiative coordinated by the International Food Policy Research Institute (IFPRI) and CIAT to develop biofortified varieties, complements the Rwandan government's drive to tackle rural malnutrition, especially in women and children. HarvestPlus is funded by the Bill & Melinda Gates Foundation, among other donors.

Other key partners in the work on climbing beans are the Alliance for a Green Revolution in Africa (AGRA), Association for Strengthening Agricultural Research in Eastern and Central Africa (ASARECA), and Dry Grain Pulses Collaborative Research Support Program, which is funded by the US Agency for International Development (USAID).

A Major Bean Player

The work has now transformed beans from a subsistence crop to a cash crop in Rwanda. The country now produces more beans than it can consume and exports the surplus to its neighbors. It even supplies the new varieties to scientists in other Central and East African countries for their own bean improvement programs.

There is still great potential to reach even more farmers in Rwanda, with new options for staking under evaluation. Climbing beans need stakes to wrap themselves around as they grow, but the ideal staking material – bamboo cane – is not readily available to many farmers. Alternatives include the planting of multipurpose trees to provide stakes and the use of strings suspended from wooden frames. Ongoing work to adapt climbers to warmer conditions at lower altitudes could help buffer the effects of climate change and potentially make the beans suitable for millions more farmers in Africa.

Olive Nakure has invested in a sewing machine with the extra money she has earned from improved climbing beans.

From Sowing to Sewing

In Gikore village in northern Rwanda, 28-year-old Olive Nakure is sitting at a large sewing machine in front of her house, concentrating hard. The hill behind her is covered in climbing beans.

She won't go back to bush beans, she says, shaking her head and smiling at the suggestion. She used to plant 5 kilograms of bush bean seed and harvest around 100 kilograms, but the same amount of climbing bean seed brings a harvest weighing 250 kilograms. "There's just no comparison," she says.

With the support of a local women's organization, she bought the sewing machine with the money she earned from selling her surplus beans. Now she makes sweaters, selling the majority to local schools. She has made around 500 in the last year.

Cultivating a Culture of Impact Assessment

A formal impact assessment is underway to establish the full extent of improved climbing bean adoption across Rwanda, with preliminary results due later in 2012. This study forms part of a major effort to assess the impact of improved technology on food security and poverty at the household level in sub-Saharan Africa. Conducted jointly with several CGIAR centers and universities, the research will apply diverse methods for both macro- and micro-level analysis in 10 countries, with in-depth analysis taking place in Uganda and Rwanda.

A thriving climbing bean plot in Gikore village, northern Rwanda.

Another initiative will carry out a new assessment of cassava impacts in Southeast Asia, focusing on four countries, with in-depth analysis being conducted in Thailand and Vietnam. New analysis is also underway to determine the impact of improved rice varieties and management practices in Latin America.

Further topics that are ripe for impact assessment include an approach referred to as integrated soil fertility management and innovative partnerships, such as the Pan-Africa Bean Research Alliance (PABRA) and African Network for Soil Biology and Fertility (AfNet).

In support of such initiatives, CIAT's impact assessment team has undertaken an ambitious 3-year program to build analytical capacity within the Center and beyond through training, seminars, workshops, and joint development of working papers. Building ties with top-ranked universities has proved particularly helpful for boosting CIAT's analytical capacity. Recent CGIAR reforms have also opened new windows of opportunity for collaborative impact assessment, particularly within the research programs on rice and climate change.

Recent CGIAR reforms have opened new windows of opportunity for collaborative impact assessment.

2 Investing More to Fine-Tune Farming

Soil Solutions at Farmers' Fingertips

A farmer in Siaya County, Kenya, tries out the new E-Farm text messaging service.

Early 2011 marked the halfway point for development of the African Soil Information Service (AfSIS), which is supported with a grant from the Bill & Melinda Gates Foundation and by the Alliance for a Green Revolution in Africa (AGRA).

The ambitious 4-year project, led from Nairobi by CIAT scientists, aims to produce a highly detailed digital map of soils in sub-Saharan Africa. It is part of an effort to sustainably boost crop yields by helping farmers, agronomists, and policymakers tackle the region's chronic soil health crisis.

Africa and Beyond

By analyzing thousands of soil samples in 42 African countries and linking this to the use of satellite imagery, AfSIS scientists expect to be able to make precise, site-specific recommendations to farmers in relation to fertilizer application, crop suitability, and agronomic practices. By early 2011, 15,000 soil samples had been analyzed, and 42 continent-wide "sentinel sites" established.

Analysis from sentinel sites confirms the widely recognized need for greater investment in work to retain and replenish soil phosphorus, nitrogen, and potassium. AfSIS studies have also revealed that the problem of soil acidity – a major cause of crop stunting – occurs only in very specific areas, suggesting that farmers could greatly benefit from targeted soil liming campaigns and the use of farmyard manure.

At the global scale, the work of AfSIS will feed into similar work being undertaken by GlobalSoilMap.net, a project aimed at digitally mapping all the world's soils. It is expected that the work of AfSIS and the wider efforts of GlobalSoilMap.net will revolutionize the delivery of soil information and contribute importantly to efforts to tackle food insecurity and the impact of climate change on agriculture.

E-Farm for Eco-Efficiency

Already the information is being used to help farmers with decisions that are crucial for making food production more eco-efficient. Field guides have been published and disseminated to about 300 farmers on a pilot basis. In western Kenya, some 1,600 smallholder maize producers have become the first to try out a new mobile phone service – E-Farm – launched in collaboration with two private telecom companies.

Participating farmers receive regular farming tips by text message (SMS) at a cost of US$0.125 for each message. Proceeds are shared between the service providers and internet phone companies. The messages – sent jointly by AfSIS and the district agricultural officer – contain tailor-made recommendations for fertilizer use and crop management. These are based on the results of AfSIS soil analysis and information from the national soils database and recent crop research.

AfSIS hopes to extend the service to more than 50,000 farmers in Kenya and to include a broader range of staple food crops (e.g., maize, common bean, soybean, potato, sorghum, and coffee) by the end of the project in late 2012.

3 Reversing Excessive Input Use

Overcoming Barriers to Passion Fruit Exports

New research demonstrating that Colombia's most widely grown passion fruit species are entirely free of quarantine insect pests could open the way for thousands of Colombia's smallholder farmers to increase fruit exports under the US-Colombia Free Trade Agreement approved in 2011 by the US Congress.

Question Mark over a Quarantine

Currently, Colombian passion fruits are subject to rigorous quarantines applied by the Animal and Plant Health Inspection Service (APHIS) of the US Department of Agriculture to prevent the introduction of foreign pests. Fruit flies classified by scientists as members of the family Tephritidae – including the dreaded Mediterranean fruit fly – are among the world's most damaging insect pests, causing billions of dollars in losses on a wide variety of agricultural products.

"US trade quarantines pose a significant barrier to Colombian exports of fresh passion fruit," said Kris Wyckhuys, an entomologist at CIAT and lead author of the new study. "The ban is based on the mere suspicion that Med fly affects these species in Colombia, stemming from reports of infestation in other South American countries."

In a meticulous field study of fruit flies on passion fruits – published in the journal *Crop Protection* – Wyckhuys and his co-authors detected no harmful species on more than 15,000 samples of passion fruit gathered from 231 farms over a 2-year period from all of Colombia's main production areas.

This work formed part of a project addressing passion fruit constraints, which was financed by the Colombian government and conducted by Jorge Tadeo Lozano University in collaboration with the Colombian Corporation of Agricultural Research (CORPOICA) and Colombian Institute of Agriculture (ICA). The new results on fruit flies help inform an evaluation being carried out by ICA with APHIS of any risks that may be involved with trade in Colombian passion fruits.

A Self-Imposed Barrier

Better knowledge about fruit pests is also critical for reducing indiscriminate, calendar-based use of agrochemicals to control pests and diseases, according to Alonso González, who leads CIAT's research on tropical fruits.

In addition to raising farmers' production costs, he explained, excessive applications eliminate beneficial insect species, including pollinating insects, thus reducing fruit production. The practice further gives rise to high levels of pesticide residues in harvested fruit, which are dangerous to producers and consumers while also representing a self-imposed barrier to exports.

Colombia's exports of fresh passion fruit have increased in value from about US$1.3 million in 2000 to just over $4.4 million currently. The country ships fresh produce primarily to the European Union, while exporting only processed passion fruit, mainly as juice, to the USA. The steady rise in international demand for purple, sweet, and yellow passion fruits has made them a key focus of Colombia's agricultural development in recent years. These crops show particular promise for creating rural employment and raising rural incomes.

Yet, in recent years, Colombia's fruit sector has shown signs of losing its competitive edge. This has resulted from farmers' limited access to irrigation and slow uptake of improved technologies, including knowledge-based strategies for managing pests. Widespread adoption of such strategies could go a long way toward making the country's passion fruit production more eco-efficient and more successful in international markets.

Passion fruit harvested from a trial plot at CIAT headquarters in Colombia.

Sharpening Colombia's Competitive Edge

Colombia's search for ways to make its agriculture more competitive led in 2011 to the creation of a new model for partnership in research and innovation for development. Referred to as Parque Biopacífico, the model unites in new ways four institutions that have worked together for decades: CIAT, the Colombian Corporation of Agricultural Research (CORPOICA), the Colombian Institute of Agriculture (ICA), and the Palmira Campus of the National University of Colombia, with support from the University of Valle. They are joining forces with the private sector and local government to create institutional synergies and apply new knowledge to the development challenges of Colombia's Pacific region, while also creating benefits for the entire country.

"This will be the country's biggest science park, with great potential to attract investment," said Colombian president Juan Manuel Santos during a ceremony held in December 2011 for the Park's establishment.

Encompassing an area of 1,000 hectares and involving more than 300 agricultural researchers, the Park serves as a center of excellence and innovation while providing a collaborative framework for the institutions that make up the Park or are associated with it.

"The Park will provide an international reference point for crop genetic improvement and for the development of innovations that add value to raw materials of biological origin and contribute to environmental sustainability," said Juan Francisco Miranda, the Park's director.

With an initial budget of more than US$800,000 – provided by local governments, the Palmira Chamber of Commerce, and other partners – the Park will develop a portfolio of services and define a shared agenda of innovation and development as well as a program for capacity strengthening and a strategy for promotion and communications. The Park's work agenda will center initially on strengthening Colombia's competitive edge in the production of fruits and vegetables in hillside areas of the Pacific region.

4 Using All Resources More Wisely

Climate Change Mitigation and Much More ✓

Tired of watching from the sidelines of international climate negotiations, scientists from CIAT and partner organizations are proposing a "paradigm shift," which could turn agriculture from a neglected climate problem into a potent solution. The researchers argue that improved tropical forages for livestock may offer the single most effective means to mitigate climate change in agriculture, while also sustainably boosting production of meat and milk as well as crops.

Eco-Efficiency par Excellence

Sown forages include an extraordinary variety of herbaceous and woody plants, mostly selected from undomesticated grass and legume species. Grown as perennial pastures or in combination with crops, forages provide feed for livestock while performing other functions as well, such as improving soil quality and reducing greenhouse gas emissions.

A chapter in CIAT's new publication on eco-efficient agriculture presents the case for mitigating climate change through various uses of forages. It explains how these plants can boost positive outputs from livestock systems, including more milk and meat, and at the same time reduce negative outputs – such as emissions of nitrous oxide, carbon dioxide, and methane – by using water, fertilizer, and other resources more efficiently.

In developing this argument, the authors underline the great extent and importance of the livestock sector. Livestock rearing uses 30% of the earth's ice-free land surface and 70% of all agricultural land, including large areas that are not suitable for cropping. The sector accounts for 40% of the total value of global agricultural output and provides livelihoods for nearly 1 billion people.

Field workers tend to an experimental *Brachiaria* plot at CIAT headquarters.

Some *Brachiaria* grasses show a remarkable ability to reduce nitrous oxide emissions.

With adequate management, the potential of sown forages to capture carbon is second only to that of forests.

Mitigation Pathways

Livestock are also estimated to be responsible for about half of agriculture's total greenhouse gas emissions. But forages can offset these emissions through diverse mitigation pathways.

One option is to exploit the remarkable ability of improved pastures, either alone or in combination with crops, to sequester carbon while restoring degraded marginal lands. In contrast with food crops, many forages grow well on such lands, providing the soil with a permanent protective cover and recuperating its productive capacity through the addition of organic matter and, in the case of legumes, biological nitrogen fixation. With adequate management, the potential of sown forages to capture carbon is second only to that of forests.

Another pathway involves harnessing the power of tropical forages, specifically *Brachiaria* species, to reduce nitrification and improve nitrogen-use efficiency in crop production. Nitrification is the microbial process responsible for both nitrous oxide emissions and contamination of water with nitrates. In a process called "biological nitrification inhibition" (BNI), *Brachiaria* grasses can suppress this activity by releasing a substance from their roots.

Much additional work is needed to realize the potential of these and other pathways. For example, scientists must devise simpler ways to monitor the real contribution of forages to carbon sequestration and BNI. This work must begin now if agriculture is to move from the sidelines to the center of climate change mitigation.

Grassroots Action

Field research at CIAT headquarters leaves no room for doubt about the ability of *Brachiaria* grasses to substantially reduce emissions of nitrous oxide, a greenhouse gas 300 times more potent than carbon dioxide. In experimental plots planted to *B. humidicola*, emissions were more than 90% less than in plots of soybean, which is good at fixing nitrogen from the atmosphere but has little capacity to lower gas emissions by inhibiting nitrification.

Now the challenge is to find practical means of putting this special ability of *Brachiaria* to work on a large scale. Rotations of annual crops like maize with *Brachiaria* pastures are one option being tested for inhibiting emissions of nitrous oxide from nitrogen fertilizer applied to the crop. To raise the potential of this technique, CIAT scientists, working with the Japan International Research Center for Agricultural Sciences (JIRCAS), will use molecular markers for the BNI trait to accelerate the improvement of climate-smart *Brachiaria* grass.

5 Achieving Quantum Leaps in Production

A Roadmap for Raising Rice Yields

With global rice demand expected to rise by more than 25% over the next 2 decades or so, finding a better way to raise the crop's genetic capability to produce grain is a matter of urgency.

Concerted Global Efforts

Responsibility for achieving this end rests heavily on the shoulders of a CGIAR Research Program called the Global Rice Science Partnership (GRiSP). Convinced of the need for a more coordinated global approach, scientists from GRiSP's international partners gathered in 2011 for a special workshop held at CIAT headquarters to set out a roadmap toward higher rice yield potential.

Participants acknowledged the importance of research aimed at ramping up photosynthesis in rice, which, if successful, could deliver a quantum leap in yield potential. But they also agreed on the need to complement this effort by applying several "safe-bet" rice breeding approaches on a global scale.

"Assembling these different approaches into a concerted global rice breeding effort represents a big step toward achieving gains in yield potential," said Achim Dobermann, deputy director general for research at the International Rice Research Institute (IRRI).

Safe Bets for Steady Progress

One approach involves the creation of a more yield-efficient plant type through "pyramiding" of genes associated with plant traits that are known to be associated with higher yields, based on extensive knowledge of rice physiology. Another option centers on hybrid rice development, pioneered by Chinese scientists, which has resulted in impressive yield increases of 15 to 20%.

Participants in the GRiSP Yield Potential Workshop visit experimental rice plots at CIAT headquarters.

Scientists also aim to take advantage of more powerful tools from molecular biology and vast amounts of new information from the fields of crop genomics and phenomics. Among other benefits, scientists will be better able to exploit genes from wild plants related to rice that control traits associated with higher grain yields. To gain a better understanding of the combinations of traits most likely to raise yields, scientists will soon begin using simulation modeling for analysis of such traits in "virtual plants."

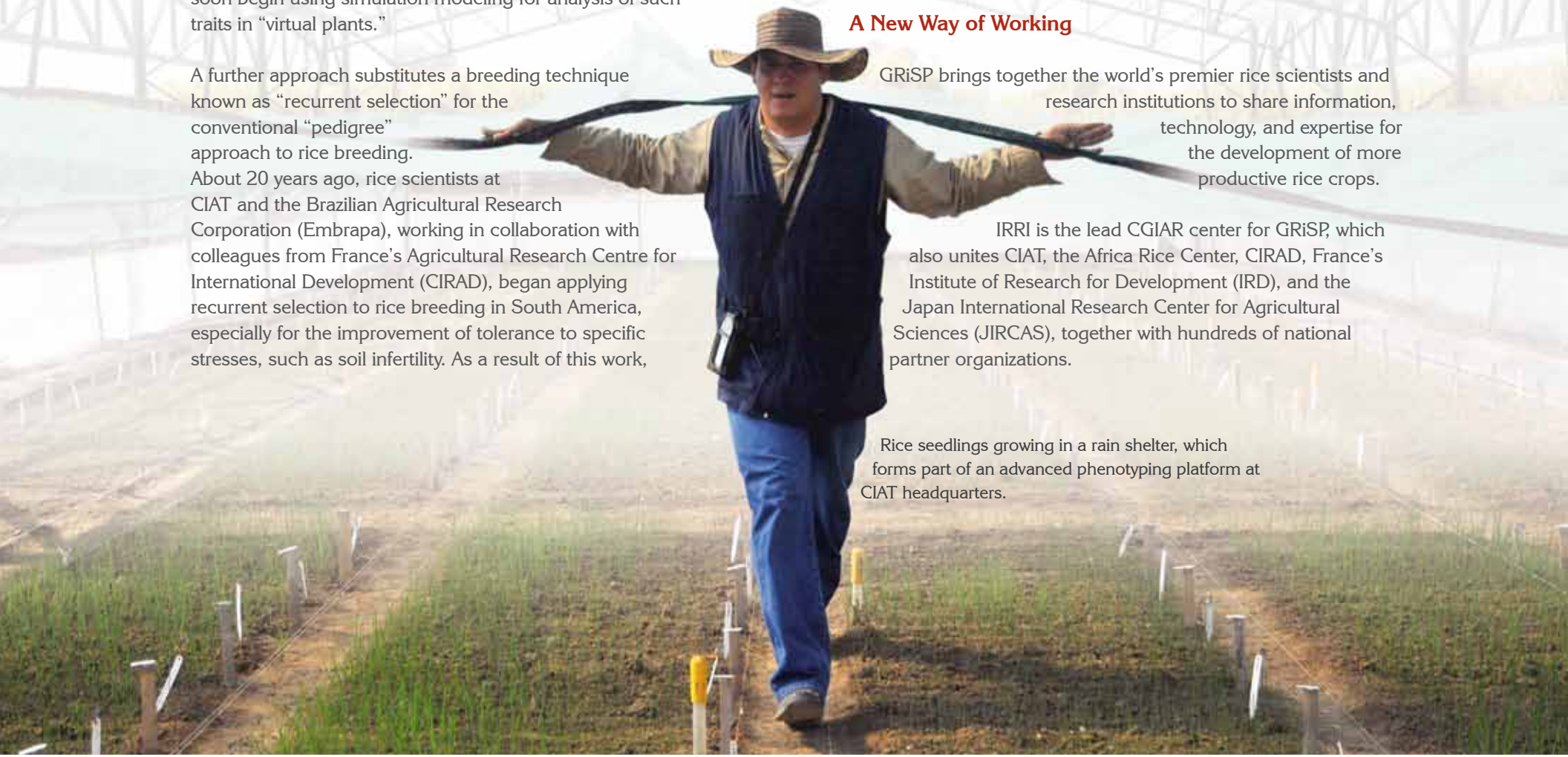
A further approach substitutes a breeding technique known as "recurrent selection" for the conventional "pedigree" approach to rice breeding. About 20 years ago, rice scientists at CIAT and the Brazilian Agricultural Research Corporation (Embrapa), working in collaboration with colleagues from France's Agricultural Research Centre for International Development (CIRAD), began applying recurrent selection to rice breeding in South America, especially for the improvement of tolerance to specific stresses, such as soil infertility. As a result of this work, national programs in seven countries have released nine improved rice varieties, and more are in the pipeline.

"The rice breeding community has a unique opportunity," said Joe Tohme, director of CIAT's Agrobiodiversity Research Area, "to embrace new tools and new collaboration in order to make major progress."

A New Way of Working

GRiSP brings together the world's premier rice scientists and research institutions to share information, technology, and expertise for the development of more productive rice crops.

IRRI is the lead CGIAR center for GRiSP, which also unites CIAT, the Africa Rice Center, CIRAD, France's Institute of Research for Development (IRD), and the Japan International Research Center for Agricultural Sciences (JIRCAS), together with hundreds of national partner organizations.



Rice seedlings growing in a rain shelter, which forms part of an advanced phenotyping platform at CIAT headquarters.

Food Production Transformed in Drought-Prone Nicaragua

All of his neighbors have dusty, unproductive land. But Víctor Beltrán has a field of maize over 5 feet high and another of sorghum swaying in the breeze. In the distance, a farm worker is preparing an area for planting beans. In the 60 years he has been here, Beltrán has never seen his farm like this – for very good reasons.

Just Add Water

Each year in Nicaragua, a punishing dry season makes the rivers run dry and crops fail. But during the country's equally intense rainy season, when there is plenty of water, the skies are so dark there is barely enough sunlight to grow food. The country's many subsistence farmers have no option than to plant when there is water and accept the poor yields that result. No one plants during the dry season – except Beltrán.

A year ago, he volunteered to be part of a pilot project that takes the concept of water harvesting to a new level. Rather than simply collecting rainwater in buckets or tanks, the project makes use of the region's hilly topography in the construction of whole reservoirs to collect and store rainwater.

Two steep-sided, interlocking hills that mark the boundary of Beltrán's land provide a perfect natural catchment area for excess rain during the wet season. A bulldozer, used to build a sturdy dam, compacted the earth on the reservoir floor to provide a natural seal.

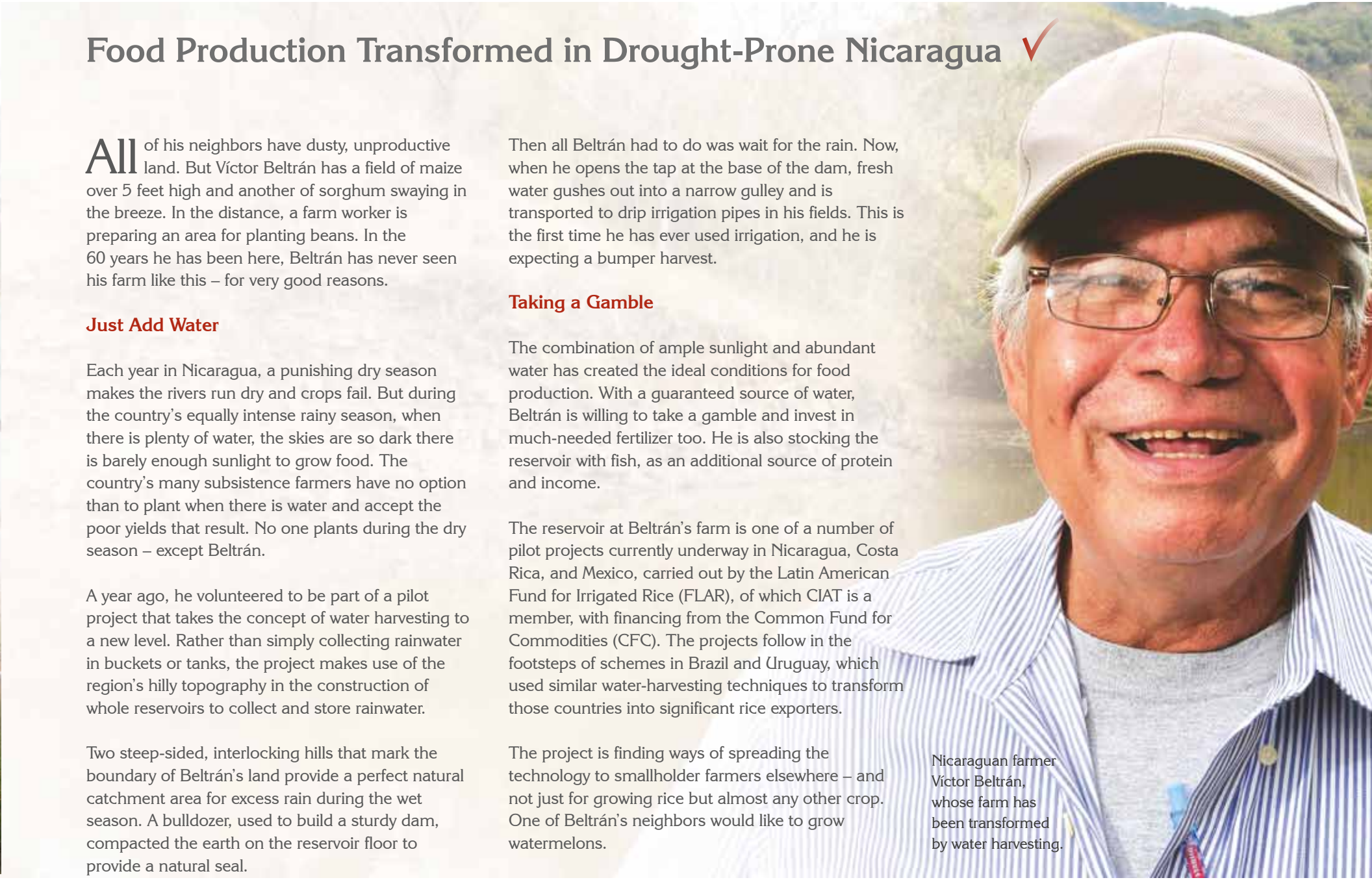
Then all Beltrán had to do was wait for the rain. Now, when he opens the tap at the base of the dam, fresh water gushes out into a narrow gulley and is transported to drip irrigation pipes in his fields. This is the first time he has ever used irrigation, and he is expecting a bumper harvest.

Taking a Gamble

The combination of ample sunlight and abundant water has created the ideal conditions for food production. With a guaranteed source of water, Beltrán is willing to take a gamble and invest in much-needed fertilizer too. He is also stocking the reservoir with fish, as an additional source of protein and income.

The reservoir at Beltrán's farm is one of a number of pilot projects currently underway in Nicaragua, Costa Rica, and Mexico, carried out by the Latin American Fund for Irrigated Rice (FLAR), of which CIAT is a member, with financing from the Common Fund for Commodities (CFC). The projects follow in the footsteps of schemes in Brazil and Uruguay, which used similar water-harvesting techniques to transform those countries into significant rice exporters.

The project is finding ways of spreading the technology to smallholder farmers elsewhere – and not just for growing rice but almost any other crop. One of Beltrán's neighbors would like to grow watermelons.



Nicaraguan farmer Víctor Beltrán, whose farm has been transformed by water harvesting.

6 Guarding against Future Production Losses

A Perfect Storm for Cassava?

Severe infestations of whitefly on cassava.

A hard-hitting CIAT report has helped raise the alarm for cassava producers, describing much of global production as precarious and at risk of being toppled by a perfect storm of pests and diseases. Published during 2011 in the journal *Food Security*, the study identified hotspots around the cassava-producing world where conditions are right for outbreaks of some of the crop's most formidable enemies: whitefly, green mite, cassava mosaic disease, and cassava brown streak disease.

Pinpointing Hotspots

Cassava is the third most important food crop in the tropics after rice and maize, and is consumed daily by up to 1 billion people, many of them in sub-Saharan Africa. Prized for its ability to thrive in harsh conditions, cassava produces its carbohydrate-rich roots in poor soils, even in times of drought. Cassava production for industrial uses is also a crucial source of income for hundreds of thousands of smallholder farmers in Asia and is growing rapidly both there and in other regions.

By using a technique known as "ecological niche modeling," CIAT scientists were able to conduct a detailed global risk assessment for cassava in relation to the four key pests and diseases. They compared cassava producing areas where these threats are already present with areas that have similar environmental conditions but where specific pest and disease pressure is either absent or low.

The researchers found that conditions are right for combined outbreaks of all four pests and diseases in some of the world's major cassava producing zones: Africa's Rift Valley region, much of Southeast Asia, southern India, Mato Grosso state in Brazil, and northern South America.

Risks without Borders

The report attributes the rapid spread of cassava pests and diseases in large part to the method by which the crop is propagated, with new plants grown from stakes – stem cuttings taken from older plants. As well as helping transfer infections from one generation of cassava crops to the next, the stakes are often transported very large distances – sometimes across international borders – enabling the spread of pests and diseases far beyond their geographic centers of origin.

"In an age of global travel, local risks to cassava production are now global risks – all it takes is one

contaminated stake and a pest or disease could jump an entire continent and establish itself very quickly," said Tony Bellotti, CIAT entomologist and one of the study's authors. It was funded by HarvestChoice, an initiative of the University of Minnesota and the International Food Policy Research Institute (IFPRI).

The alarming results of the CIAT cassava study highlight the need for renewed emphasis on research into plant hosts, viruses, and disease vectors as well as their natural enemies. Knowledge from such research will be critical for devising integrated pest and disease management strategies at the regional, landscape, and local levels. This task is becoming particularly urgent as climate change further alters the shifting pest and disease dynamics.

CIAT scientist Tin Maung Aye examines cassava crops in northeastern Thailand, which have been affected by a combination of pest and disease outbreaks.

Outbreaks on the Rise in Southeast Asia

At a time when Southeast Asia's cassava industries are strong, with high demand, better prices, and expanding markets for sale and processing, the potential for smallholder cassava production to help reduce poverty is greater than ever.

But the risk of severe pest and disease outbreaks is also on the rise. The sudden emergence of the cassava mealybug in Thailand during 2008 illustrated how vulnerable the crop can be. The outbreak cut overall production in the country by 20-25% the following year, with some areas suffering losses of more than 50%.

During 2009-2010, scientists at CIAT and the Nigeria-based International Institute of Tropical Agriculture (IITA) worked together with the Thai Department of Agriculture (DOA), Department of Agricultural Extension (DOAE), and The Thai Tapioca Development Institute (TTDI) to diagnose the problem and identify a biological control agent.

Mass rearing and release of the parasitoid wasp *Anagyrus lopezi* continued in Thailand during 2011, and it appears that the mealybug is now under control there, although there have been outbreaks in Cambodia and, to a lesser extent, Burma and Laos. There are now concerns over a number of other pests and diseases of cassava, including mites, a "witches' broom" disease, and bacterial blight.

Through a new 4-year project supported by the European Union, with funds managed by the International Fund for Agricultural Development (IFAD), CIAT will help establish effective monitoring of pests and diseases, roll out known control measures, and undertake applied research on less well-known pests and diseases to develop possible responses. The project includes capacity building and method development, both for identification and control of pests and diseases. This work will complement that of Thai scientists contributing to a project with the Food and Agriculture Organization (FAO) of the United Nations, which deals specifically with cassava pink mealybug.

Climate Change and Cash Crops

Climate change not only threatens the production of staple food crops but could also affect important cash crops grown by smallholder farmers – like cocoa and tea.

The cocoa plantations of Ghana and Côte d'Ivoire and tea plantations of East Africa support well over 1 million smallholders. Research released by CIAT climate scientists in 2011 revealed that a temperature rise of more than two degrees Celsius – expected in both regions by 2050 – will significantly reduce the suitability of growing conditions for both crops.

Chocolate Meltdown in West Africa

The cocoa study found that suitability could start declining as soon as 2030, with warmer conditions causing the heat-sensitive cocoa trees to struggle to produce pods. By 2050, a rise of 2.3 degrees Celsius could drastically affect production in some of the region's major cocoa-producing areas.

While many smallholder cocoa farmers already use larger shade trees to help keep their cocoa trees cool, the study made a series of additional recommendations to buffer the effects of rising temperatures. These included suggestions for alternative cash and food crops to help spread the risk of one crop failing as well as measures to minimize the threat of bushfires during the dry season.

Crop scientists will also need to move fast to develop hardier cocoa crops capable of tolerating warmer, drier conditions, the study noted. Renewed research into suitable irrigation systems will also be needed together with the development of government-level policies to help cocoa farmers and the industry as a whole prepare and adapt.

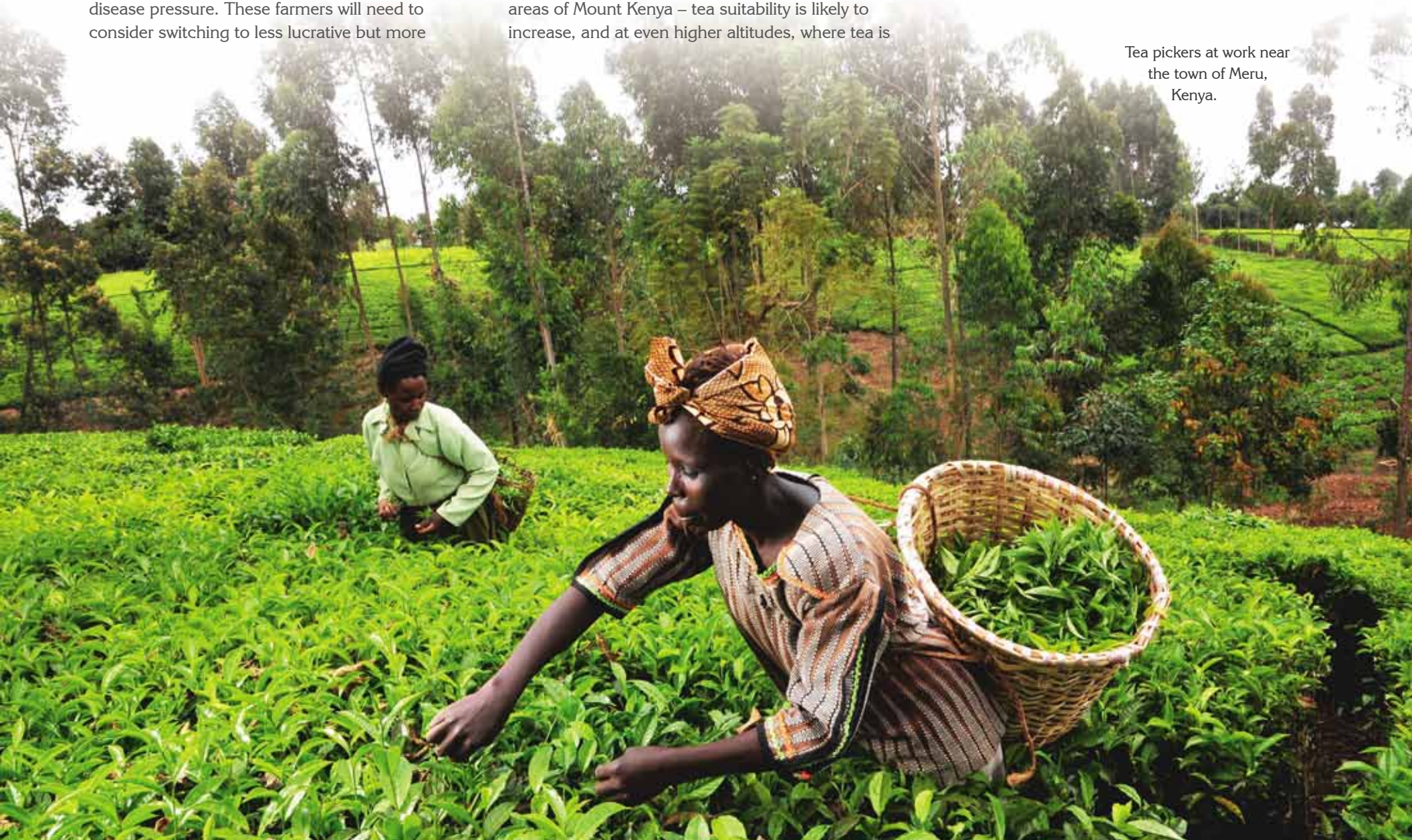
The results of the cocoa study will assist decision makers in the Cocoa Livelihoods Project of the multi-stakeholder World Cocoa Foundation, a public-private partnership that aims to help improve cocoa production and farmer incomes in West Africa. This partnership is funded by the Bill & Melinda Gates Foundation and 15 chocolate companies.

Trouble Brewing in East Africa

In East Africa, two separate studies on tea found that temperature rises of a similar order will reduce suitability in Kenya and Uganda, affecting tea producers and those involved in processing the leaves – a major source of rural employment in both countries.

According to the studies, the optimum tea producing zones would shift approximately 500 meters uphill by 2050. Farmers at lower elevations are likely to face a decline in tea production and quality, and a rise in pest and disease pressure. These farmers will need to consider switching to less lucrative but more suitable crops. Others will be able to continue producing tea but will need to adopt new farming practices and plant hardier tea varieties.

But in some regions – particularly the mid-altitude areas of Mount Kenya – tea suitability is likely to increase, and at even higher altitudes, where tea is not currently grown, production will also become more favorable. But the reports recommend against the clearing of forests and protected areas to establish tea plantations.



Tea pickers at work near the town of Meru, Kenya.

Climate Change, Agriculture and Food Security

Off to a Running Start in a Race against Time

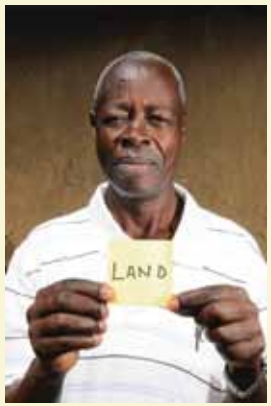
The CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS) addresses one of the most serious threats to the livelihoods of smallholder farmers of our time. In 2011, CCAFS completed its first full year as a CGIAR Research Program, with CIAT as its lead center. Here are some of the highlights.

- A **report on climate change "hotspots"** was published in June, identifying areas that are food insecure and highly vulnerable to the impacts of climate change. The report found that by 2050, South Asia (including almost all of India), sub-Saharan Africa, and parts of Latin America will face shorter growing seasons, significantly affecting the production of staple food crops and forages for livestock. This analysis was carried out by scientists from the International Livestock Research Institute (ILRI) and coordinated by CCAFS. bit.ly/climatehotspots

- Several **comprehensive peer-reviewed studies** into the likely effects of climate change on key staple crops (including potatoes, beans, bananas, and cassava) were published in October, including recommendations for developing climate-resilient varieties, with emphasis on the crucial role of biotechnology in accelerating the process. bit.ly/journalsbooks

- **Baseline surveys on food security and climate adaptation** – covering more than 5,000 households, 250 villages, and 12 countries in East and West Africa as well as South Asia – were carried out in 2011. In addition to basic socio-economic data, the surveys gathered information on how agricultural communities have so far responded to climate-related challenges. This information will help researchers identify effective strategies and practices already in place, which could be replicated elsewhere. The survey sites will be revisited several times during the 10-year life of the program to allow researchers to assess the impact of CCAFS work and plan community-led trials of agricultural technologies. bit.ly/baselinesurveys

- **Community adaptation costing workshops** in East and West Africa helped pioneer a new approach to assessing rural communities' "adaptive capacity" – that is, their collective ability to confront and overcome what they regard as their most pressing challenges. For the purposes of the workshops, these challenges did not necessarily have to be climate change-related. Even so, the process of community decision making and coordinated action is crucial and transferable for the purposes of climate change adaptation. Further workshops – part of a joint initiative of CCAFS and Oxford University's Environmental Change Institute – will take place in Southeast Asia during 2012. bit.ly/SROIKenya



Kenyan farmer Manasse Juma.

- Launched in October, the **climate change Adaptation and Mitigation Knowledge Network (AMKN)** brings together climate, agriculture, and socio-economic research onto an easily searchable online map. Developed as a key output of the CIAT-led research theme Adaptation to Future Climate, the continually updated database includes photos and videos from research sites, and acts as an information service for practitioners, donors, and policy makers interested in food security and climate change and how work at priority sites is progressing. www.amkn.org

- **Agriculture and Rural Development Day (ARDD)**, coordinated by CCAFS in collaboration with about 15 other organizations, including the International Fund for Agricultural Development (IFAD) and The World Bank, was held in parallel with the 17th Conference of the Parties (COP17) to the United Nations Framework Convention on Climate Change (UNFCCC), in Durban, South Africa, during December. ARDD – the third event of its kind – focused on galvanizing international support for "climate-smart" agriculture. It was attended by around 500 people and supported a strong political push to launch a new work program on agricultural climate change adaptation and mitigation under the UNFCCC's Subsidiary Body for Scientific and Technological Advice (SBSTA). This ongoing effort will continue throughout 2012, with key policy fora including the United Nations Conference on Sustainable Development, or Rio+20, in June and the UNFCCC's COP18 in Qatar at the end of the year. www.agricultureday.org

Tina Joemat-Pettersson, South Africa's Minister of Agriculture, Forestry, and Fisheries.

- Released in the run-up to ARDD was a **landmark set of recommendations** on Achieving Food Security in the Face of Climate Change from the Commission on Sustainable Agriculture and Climate Change, which consists of 13 leading agricultural experts from around the world. The Commission, which was set up by CCAFS, formulated seven specific recommendations on how to improve food security in the face of challenges such as climate change, population growth, food price volatility, and malnutrition. On this basis, the Commission urges immediate, coordinated action to make fundamental changes in the global food system. bit.ly/ccafscommission

Traveling in Time with Climate Analogues

A glimpse of the future can be worrisome but also empowering. Based on global climate models, a new online tool called Climate Analogues enables scientists to compare predicted future climates for specific locations with places where those conditions exist at present.

With this new knowledge, scientists and others can begin to see what the challenges and opportunities might be. For example, maize growers in Southern Africa can see that their climate in 2030 will be comparable to that in parts of Argentina today. They can then make decisions about how to adapt in good time and identify cultural or technological barriers to adaptation. Climate Analogues can thus serve as an entry point for the international exchange of agricultural knowledge. bit.ly/analogues

In 2011, 50 scientists in India and Nepal were trained in how to use the software. Further training will take place in CCAFS regions during 2012.

CIAT Financial Highlights

Though 2011 presented CIAT's scientific and support staff with significant challenges, their efforts and commitment made this a fifth consecutive year of financial health.

Financial Results for 2011

Of particular significance was our progress this year toward integrating the CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS) – which was approved at the end of 2010 – into CIAT's financial and administrative systems. One consequence is that total revenues and gains as well as total expenditures for 2010 and 2011 are not directly comparable.

CIAT and the CGIAR Consortium signed the Performance Implementation Agreement for CCAFS in July 2011. In parallel with this, 18 Participant Performance Agreements (PPAs) were developed for 14 CGIAR partner Centers and 4 participating universities; all of these agreements were signed in October and November. In September, it was agreed that the lead center for each CGIAR Research Program will fully recognize all funds it receives for this program from the CGIAR Fund.

CIAT received the first funds for CCAFS – US$12.6 million – from the CGIAR Fund in early August and immediately disbursed them to partners. To help CCAFS get underway, CIAT disbursed $3 million from its own reserves to CCAFS partners and recovered this amount in the first half of December upon receiving a second Fund disbursement of $23.6 million, to be followed by the final installment of $4.4 million early in 2012. In 2011, CIAT disbursed a total of $30.8 million CCAFS funds to partners. CIAT's expenditures of restricted project funds, including those from CGIAR Challenge Programs, increased by $1 million to $42.8 million.

For the first time, the Center achieved full cost recovery for both direct and indirect costs. This is a significant milestone, since prior to 2007 less than 50% of such costs were charged.

After 45 years of operations, the renovation of CIAT's infrastructure has become a matter of urgency. We have made progress with aboveground facilities and must now undertake work on belowground infrastructure, which is much more expensive. Nevertheless, we allocated almost 80% of the limited capital funds to the research area, not counting vehicle and computer funds, which are replenished from cost recovery.

CIAT Statement of Financial Position
December 31, 2011 and 2010
(US$ in thousands)

	2011	2010
Current assets	50,966	32,196
Non-current assets	24,653	22,726
Total assets	**75,619**	**54,922**
Current liabilities	53,575	34,988
Non-current liabilities	2,230	1,552
Total liabilities	**55,805**	**36,540**
Undesignated net assets	10,282	9,169
Designated net assets	9,512	9,213
Temporary net assets	20	-
Total net assets	**19,814**	**18,382**
Total liabilities and net assets	**75,619**	**54,922**

CIAT's operating surplus this year was $1.4 million – in line with expectations despite unforeseen operational and personnel expenses as well as pension provisions for Colombian local staff. Net assets, excluding capital invested in fixed assets, increased by just under $1 million to $13.5 million.

CIAT Statement of Activity
December 31, 2011 and 2010
(US$ in thousands)

	2011	2010
Grants	85,280	56,100
Other revenues and gains	2,765	6,058
Total revenues and gains	**88,045**	**62,158**
Program-related expenses	86,895	54,957
Management and general expenses	6,171	5,128
Other losses and expenses	1,713	870
Subtotal expenses and losses	**94,779**	**60,955**
Indirect cost recovery	(8,146)	(4,914)
Total expenses and losses	**86,633**	**56,041**
Net surplus	**1,412**	**6,117**
Operating expenses by natural classification		
Personnel costs	28,738	27,142
CGIAR Research Program – CGIAR center partnership costs	27,380	-
Non-CGIAR center partnership costs	11,748	12,713
Supplies and services	20,242	15,135
Operational travel	4,502	4,107
Depreciation of fixed assets	2,169	1,858
Indirect cost recovery	(8,146)	(4,914)
Total operating expenses, net	**86,633**	**56,041**
Days of reserves	**86**	**84**

Days of operating reserves increased by 2 days from the 2010 level to 86 days in 2011, close to the new minimum requirement for CGIAR centers.

Financial Outlook for 2012

As stated in *CIAT Annual Report 2010*, the financial stability mechanism implemented by the CGIAR Consortium in 2011 helped significantly to facilitate financial management in the centers during the transition period in which CGIAR Research Programs are being finalized and launched. With these programs in place during 2012 and beyond, CIAT and other centers must strive for maximum accuracy in budgeting for research activities.

CIAT's Board of Trustees approved a 2012 budget of $94.6 million, of which $37.2 million are CCAFS partner funds. We conservatively assume that in 2012 the total CCAFS budget will be at about the same level as in 2011, with just over $42 million from the CGIAR Fund. However, the original budget for CCAFS, as approved by the CGIAR Consortium and Fund in the signed Performance Implementation Agreement, amounts to $56 million.

CIAT's net surplus is budgeted at $1.2 million, which should add 5 or 6 days to our total operating reserve days. We expect the Colombian currency to further strengthen by more than 3%. CIAT has taken early measures in the first half of 2012 to hedge some administrative expenses above the budget rate.

Donor Support

The research achievements described in this report were made possible by the multi-donor CGIAR Fund (www.cgiarfund.org) as well as by grants from the organizations listed below, some of which are also Fund donors. CIAT received funding as well through the CGIAR Challenge Programs – Generation, HarvestPlus, Sub-Saharan Africa, and Water and Food.

As the Center marks its 45th anniversary in 2012, we express our gratitude to all of the donors that have supported our successful efforts to reduce hunger and poverty through agricultural research for development in the tropics.

African Wildlife Foundation (AWF), Kenya
Alliance for a Green Revolution in Africa (AGRA), Kenya
Associates in Rural Development (ARD), USA
Association for Strengthening Agricultural Research in Eastern and Central Africa (ASARECA)
Australian Centre for International Agricultural Research (ACIAR)
Austrian Development Agency (ADA)
Belgian Development Cooperation (DGDC)
Bill & Melinda Gates Foundation (BMGF), USA
Brazilian Agricultural Research Corporation (Embrapa)
Cafédirect Producers' Foundation (CPF), UK
Canadian International Development Agency (CIDA)
CARE International in Nicaragua
Catholic Relief Services (CRS), USA
CGIAR Program on Climate Change, Agriculture and Food Security, hosted by the Department of Agriculture and Ecology, Faculty of Life Sciences, University of Copenhagen, Denmark
Citizens Network for Foreign Affairs (CNFA), USA
Colombia
- Additional Investment for Sustainable Alternative Development (MIDAS)
- Administrative Department of Science, Technology and Innovation (Colciencias)
- Chamber of Commerce of Palmira
- Colombian Agricultural Company, Ltd. & JSC (COACOL)
- Conservation International (CI)
- Corn Products Andina
- Governor's Office of the Department of Nariño
- Governor's Office of the Department of Valle del Cauca
- Mayagüez S.A.
- Ministry of Agriculture and Rural Development (MADR)
- National Federation of Oil Palm Growers (Fedepalma)
- National Federation of Rice Growers (Fedearroz)
- National Fund for the Promotion of Horticultural and Fruit Production (FNFH)
- National University of Colombia (UN)
- Natural Heritage, Trust Fund for Biodiversity and Protected Areas
- Palmar del Oriente, Palm-Oil Company
- Paper Manufacturing Company PLC (PROPAL)
- Regional Autonomous Corporation of Cundinamarca (CAR)
- United Nations Development Programme (PNUD-Colombia)
- University of Valle (Univalle)

Common Fund for Commodities (CFC), The Netherlands
Department for International Development (DfID), UK
Dow AgroSciences, USA
European Union (EU)
Federal Ministry for Economic Cooperation and Development and German Agency for International Cooperation (BMZ-GIZ), Germany
Food and Agriculture Organization of the United Nations (FAO), Italy

CGIAR
Science for a food secure future

CIAT 45
Centro Internacional de Agricultura Tropical
International Center for Tropical Agriculture
A Remarkable Record of Science for Change
Since 1967

Ford Foundation, USA
Forum for Agricultural Research in Africa (FARA), Ghana
Foundation for the Technological, Agricultural, and Forestry Development of Nicaragua (FUNICA)
French Agricultural Research Centre for International Development (CIRAD)
Global Biodiversity Information Facility (GBIF), Denmark
Global Crop Diversity Trust (GCDT), Italy
Global Environment Facility (GEF), USA
Government of Iran
Government of Peru
Green Mountain Coffee Roasters (GMCR), USA
Institute of Research for Development (IRD), France
Inter-American Institute for Cooperation on Agriculture (IICA), Costa Rica
International Fund for Agricultural Development (IFAD), Italy
International Organization for Migration (IOM), Switzerland
Iowa State University (ISU), USA
Japan International Research Center for Agricultural Sciences (JIRCAS)
Koppert Biological Systems, The Netherlands
Lutheran World Relief (LWR), USA
National Starch and Chemical Company (National Starch), USA
National University of Engineering (UNI), Nicaragua
Organization of American States (OAS), USA
Organization of the Petroleum Exporting Countries (OPEC), Austria
Oxfam International (Oxfam), UK
Pan American Health Organization (PAHO), USA
Panama Institute of Agricultural Research (IDIAP)
People's Republic of China
Pioneer Hi-Bred International, Inc. (PIONEER), USA
Rainforest Alliance, USA
Regional Fund for Agricultural Technology (FONTAGRO), USA
RiceTec, Inc., USA
Rutgers University, New Brunswick, USA
Sustainable Food Laboratory (SFL), USA
Swedish International Development Cooperation Agency (SIDA)
Swiss Agency for Development and Cooperation (SDC)
Swiss Centre for International Agriculture (ZIL)
Syngenta Foundation for Sustainable Agriculture (SFSA), Switzerland
Technical Centre for Agricultural and Rural Cooperation (CTA), The Netherlands
The Global Forum on Agricultural Research (GFAR), Italy
The Kilimo Trust
The McKnight Foundation, USA
The Nature Conservancy (TNC), USA
The Nippon Foundation, Japan
The Thai Tapioca Development Institute (TTDI)
The World Bank, USA
United Nations Environment Programme (UNEP), USA
United States Agency for International Development (USAID)
University of California-Davis (UC-Davis), USA
Wageningen University and Research Centre, The Netherlands
World Vision, USA
Yale University, USA

Member of the CGIAR Consortium

Scientific Publications

Complete lists of scientific publications in 2011 and previous years as well as other information resources are available at:
www.ciat.cgiar.org/AboutUs/Library/Pages/Library.aspx

Articles and other information resources are among the primary means by which CIAT shares the results of collaborative research. Following is a selection from the total of 219 items published by Center scientists with partners in 2011; more than half of the total appeared in international refereed journals. The articles listed here represent the full breadth of Center research; most are already being cited in the literature, reflecting the relevance and high quality of our science.

Agrobiodiversity

Asplen, M.K.; Wyckhuys, K.A.G.; Heimpel, G.E. 2011. Parasitism of autumnal morphs of the soybean aphid (Hemiptera: Aphididae) by *Binodoxys communis* (Hymenoptera: Braconidae) on buckthorn. Annals of the Entomological Society of America 104(5):935-944.

Blair, M.W.; Astudillo, C.; Rengifo, J.; Beebe, S.E.; Graham, R. 2011. QTL analyses for seed iron and zinc concentrations in an intra-genepool population of Andean common beans (*Phaseolus vulgaris* L.). Theoretical and Applied Genetics 121(6):1059-1070.

Outstanding Research Publication Award

In 2011, the recipient of this CIAT internal award was the journal article listed below, which records progress toward more effective use of genetic diversity to improve rice for key traits, such as drought tolerance:

Garavito, A.; Guyot, R.; Lozano, J.; Gavory, F.; Samain, S.; Panaud, O.; Tohme, J.; Ghesquière, A.; Lorieux, M. 2010. A genetic model for the female sterility barrier between Asian and African cultivated rice species. Genetics 185(4):1425-1440.

Bouis, H.E.; Hotz, C.; McClafferty, B.; Meenakshi, J.V.; Pfeiffer, W.H.; Deckelbaum, R.J. 2011. Biofortification: a new tool to reduce micronutrient malnutrition. Food and Nutrition Bulletin 32, Suppl. 1:31S-40S.

Butare, L.; Rao, I.; Lepoivre, P.; Polanía, J.; Cajiao V., C.H.; Cuasquer, J.B.; Beebe, S.E. 2011. New genetic sources of resistance in the genus *Phaseolus* to individual and combined aluminium toxicity and progressive soil drying stresses. Euphytica 181(3):385-404.

Dedicova, B.; Nilsson, O.; Egertsdotter, U.; Panis, B.; Lynch, P. 2011. Effect of cryopreservation on growth of different elite embryogenic cell lines of Norway spruce (*Picea abies* (L.) Karst.). Acta Horticulturae 908:203-206.

Guyot, R.; Garavito, A.; Gavory, F.; Samain, S.; Tohme, J.; Ghesquière, A.; Lorieux, M. 2011. Patterns of sequence divergence and evolution of the S_1 orthologous regions between Asian and African cultivated rice species. PLoS ONE 6(3):e17726.

McClean, P.E.; Burridge, J.; Beebe, S.E.; Rao, I.M.; Porch, T.G. 2011. Crop improvement in the era of climate change: an integrated, multi-disciplinary approach for common bean (*Phaseolus vulgaris*). Plant Function & Evolutionary Biology 38(12):927-933.

Pérez, E.; Gibert, O.; Rolland-Sabaté, A.; Jiménez, Y.; Sánchez, T.; Giraldo, A.; Pontoire, B.; Guilois, S.; Lahon, M.-C.; Reynes, M.; Dufour, D. 2011. Physicochemical, functional, and macromolecular properties of waxy yam starches discovered from "Mapuey" (*Dioscorea trifida*) genotypes in the Venezuelan Amazon. Journal of Agricultural and Food Chemistry 59(1):263-273.

Pérez-Almeida, I.; Torres, E.; Angulo, L.; Acevedo, M. 2011. Genetic diversity among Venezuelan rice cultivars based on parentage coefficient estimation and analysis using microsatellite molecular markers (SSR). Interciencia 36(7):545-551.

Rengifo, J.A.; García, J.G.; Rodríguez, J.F.; Wyckhuys, K.A.G. 2011. Host status of purple passionfruit for the Mediterranean fruit fly (Diptera: Tephritidae). Florida Entomologist 94(1):91-96.

Sofi, P.A.; Zargar, M.Y.; Debouck, D.; Graner, A. 2011. Evaluation of common bean (*Phaseolus vulgaris* L) germplasm under temperate conditions of Kashmir valley. Journal of Phytology 3(8):47-52.

Soule, M.; Porter, L.; Medina, J.; Santana, G.P.; Blair, M.W.; Miklas, P.N. 2011. Comparative QTL map for white mold resistance in common bean, and characterization of partial resistance in dry bean lines VA19 and I9365-31. Crop Science 51(1):123-139.

Wang, C.; Lentini, Z.; Tabares, E.; Quintero, M.; Ceballos, H.; Dedicova, B.; Sautter, C.; Olaya, C.; Zhang, P. 2011. Microsporogenesis and pollen formation in cassava. Biologia Plantarum 55(3):469-478.

Wyckhuys, K.A.G.; López A., F.; García, J.; Jiménez, J. 2011. Host exploitation and contest behavior in a generalist parasitoid partially reflect quality of distinct host species. Biocontrol Science and Technology 21(7/8):953-968.

Tropical Soils

Ayuke, F.O.; Pulleman, M.M.; Vanlauwe, B.; Goede, R.G.M. de; Six, J.; Csuzdi, C.; Brussaard, L. 2011. Agricultural management affects earthworm and termite diversity across humid to semi-arid tropical zones. Agriculture Ecosystems & Environment 140(1/2):148-154.

Brhane T., G.; Tamene, L.; Vlek, P.L.G. 2011. A participatory soil quality assessment in Northern Ethiopia's Mai-Negus catchment. Catena 86:1-13.

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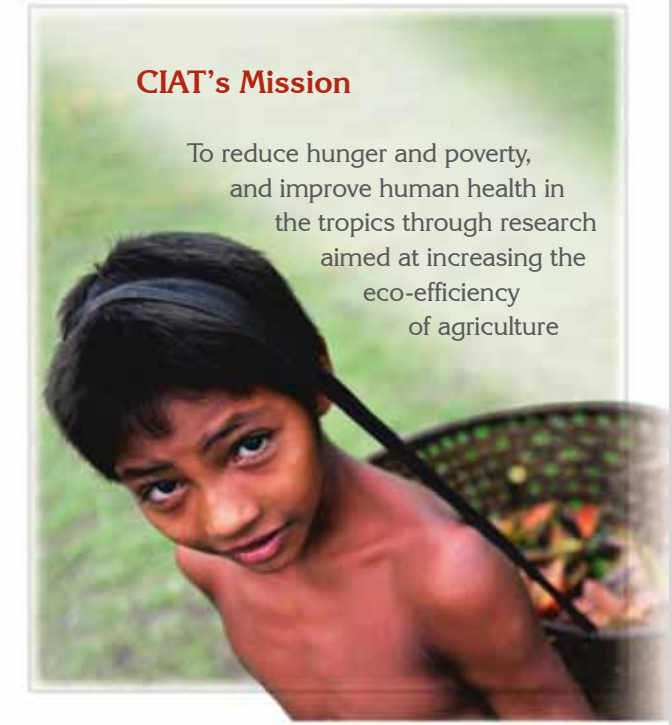
CIAT Today

The International Center for Tropical Agriculture (CIAT), working in collaboration with hundreds of partners across the developing world, is dedicated to developing technologies, innovative methods, and new knowledge that better enable farmers, mainly smallholders, to improve their crop production, incomes, and management of natural resources.

Since no single organization can address the whole of tropical agriculture, CIAT complements the efforts of its numerous partners by focusing strategically on selected crops and research areas. As a member of the CGIAR Consortium, CIAT has global responsibility for the improvement of beans, cassava, and tropical forages – crops that have historically been neglected in research despite their vital importance for food and nutrition security. For Latin America and the Caribbean, we conduct research on rice and tropical fruits as well. All of our work on agricultural biodiversity employs advanced biotechnology to discover useful knowledge and accelerate crop improvement.

CIAT also conducts research on two major issues that cut across tropical crops and production niches: (1) sustainable management of tropical soils and (2) decisions and policies that are critical for coping with challenges such as climate change and environmental degradation.



About CGIAR

CGIAR is a global research partnership that unites organizations engaged in research for sustainable development. CGIAR research is dedicated to reducing rural poverty, increasing food security, improving human health and nutrition, and ensuring more sustainable management of natural resources. It is carried out by the 15 centers who are members of the CGIAR Consortium in close collaboration with hundreds of partner organizations, including national and regional research institutes, civil society organizations, academia, and the private sector.
www.cgiar.org

CGIAR
Science for a food secure future

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CIAT management is pleased to announce that in 2011 Wanda Collins was named as the Center's new Board Chair. She succeeds Juan Lucas Restrepo, who continues on the Board as Executive Director of the Colombian Corporation of Agricultural Research. We are extremely grateful to Juan Lucas for his past and ongoing service to CIAT. Geoffrey Hawtin was named to take Wanda's place as the new Vice Chair.

We welcome Ruth Oniang'o, who joined the Board as of 1 January 2012, and express our thanks to Fina Opio and Luis Fernando Vieira, who completed their terms as Board members.

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CIAT Board at its November 2011 meeting (left to right): Geoffrey Hawtin, María Fernanda Reyes (Board Secretary), Luis Fernando Vieira, Miguel Eduardo Sarmiento, Ruth Oniang'o, Wanda Collins, Anthony Cavalieri, Ruben Echeverría, Juan Camilo Restrepo, Graham Joscelyne, Fina Opio, Moisés Wasserman, Lisa Schipper, and Juan Lucas Restrepo.

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A Glimpse of Eco-Efficient Agriculture

Some people used to call Maurice Kwadha a madman. Once, he was physically attacked while collecting discarded milk packets at his local market, by someone who thought he had lost his mind. But Maurice had a plan, and his farm in Kenya's Nyando Basin is thriving at a time when many smallholders in East Africa are struggling to produce food sustainably.

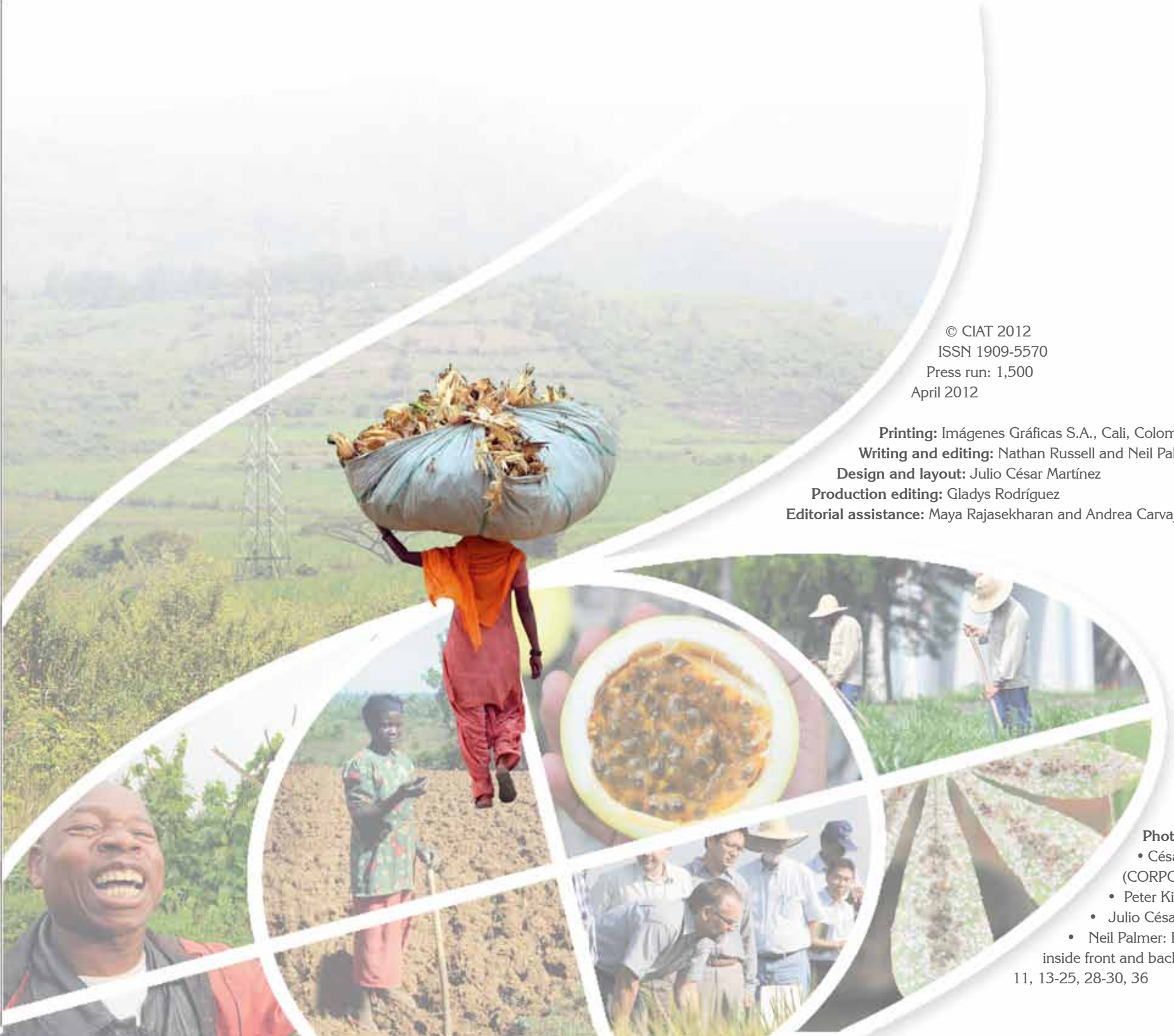
Maize and Napier fodder grass grow next to rows of banana and papaya trees; several alleys of multi-purpose border trees help to stabilize and replenish the soil, providing shade and fodder, and eventually fuelwood and building material. Maurice uses leaf mulch to nourish his fruit trees; further up he has a small area for onion, sweet potato, and tomato.

Maurice's burgeoning tree nursery is by far his most profitable enterprise, despite being less than a quarter of the size of his crop land. He has around 20,000 seedlings – some for his own farm but most for sale. Many are growing in the discarded plastic packets used for milk, the same ones that caused Maurice to attract the wrong kind of attention as he collected them at his local market.

The money from his tree nursery enabled Maurice to buy a water-harvesting tank, a water pump, and a television. It also helped him to send one of his children to school and another to college. Maurice's farm is working proof that, with a bit of lateral thinking, smallholders can boost food production, increase resilience to climate change, and develop profitable businesses.

"What matters is the way you utilize your farm," he says.

Maurice Kwadha, with a diagram of his small farm in Kenya's Nyando Basin.



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