CIAT
International Center for Tropical Agriculture
Since 1967 / Science to cultivate change

Stewardship Report

Achieving Food Security and Rural Prosperity across the Tropics

CIAT's Partnership with BILL & MELINDA GATES *foundation*

Innovative and sustainable solutions through agricultural research for development

CIAT's Global Vision

Innovation and empowerment in agriculture

Nearly 1 billion people are affected by severe hunger and poverty globally. Many are farmers who rely on small plots of land for their food and livelihoods. They struggle with unproductive soil, plant diseases and pests, climate variability, and weak policies and markets. The need to strengthen the fight against hunger and poverty, especially in the tropics, is more urgent than ever.

CIAT remains as optimistic about helping farming families overcome obstacles to sustainable productivity growth as it did when the Center opened its doors in 1967. The Center has decades of experience in diverse research areas, which enable us to bring a broad systems perspective to our mission to reduce hunger and poverty, and improve human nutrition. At the core of CIAT's mission is the concept of eco-efficiency. This means we promote competitive and profitable food production for economic empowerment of the world's poor, while reducing agriculture's environmental footprint and preserving agrobiodiversity.

Crop improvement is a key leverage point for bringing about those aims. CIAT conducts research globally on cassava, common bean, and tropical forages, as well as on rice in Latin America and the Caribbean. Critical for reducing hunger, these crops also offer wide scope for strengthening farmers' market orientation and raising rural incomes. Our researchers work in two other areas that cut across all tropical crops and environments – soils and pro-poor policies.

Through research on soil management and land restoration, the Center opens new pathways toward sustainable intensification of crop production, while improving the ecosystem services on which rural communities depend.

> ***"When I try to imagine the future, I'm optimistic because I see women demanding information and opportunities."***
> ***– Melinda Gates***

CIAT's Decision and Policy Analysis (DAPA) research area harnesses the power of information to influence actions concerning climate change adaptation and mitigation, sustainable ecosystem management, and linking farmers to markets. Recognizing the significant and overlooked role of women in agriculture, CIAT's growing team of gender specialists strives to ensure our programs are gender aware and transformative.

The Center has a proven record of delivering results that address the local realities and challenges facing smallholders, as well as a solid reputation for integrity, innovation, and transparency. Aware that greater impact is achieved through effective collaboration, we take pride in our strong and growing partnerships with other research organizations, NGOs, governments, the private sector, donors, and other CGIAR centers around the world.

In Partnership with the Gates Foundation

A new era of opportunity for agricultural research

Farming is critical to three-quarters of the world's poor but receives very little attention. We share the Foundation's belief that every life has equal value, which is why CIAT is dedicated to reducing hunger and poverty over the long term.

The power of investing in agriculture is clear: when farmers can grow more food and earn more income, they can achieve self-sufficiency and lead better lives. Increased income and improved nutrition produce ripple effects – allowing farmers to send their children to school, provide for their health, and invest in the future.

The Foundation's strategic investments in CIAT and CGIAR – a global research partnership for a food-secure future – over the years have contributed significantly to our shared aims. BMGF is committed to agricultural development and continues to be instrumental in prioritizing innovation in the sector and encouraging others to do the same. Grand Challenges Explorations, for example, rewards unorthodox thinking to overcome persistent bottlenecks in creating new tools for the developing world.

We realize there is no single silver bullet to tackling the challenges farmers face. That's why CIAT has a comprehensive strategy to produce tangible outcomes from agricultural research, which entail smarter use of resources and translate into valuable impacts, like higher incomes and improved child nutrition. Our researchers toil around the clock to boost agricultural productivity and enhance the nutritional quality of staple crops, make smallholder agriculture more competitive and market oriented, and ensure farming is both environmentally sustainable and climate smart.

We are grateful to the Bill & Melinda Gates Foundation for their steadfast commitment to CIAT's innovative research for development. We look forward to strengthening our partnership to accelerate the fight against hunger, malnutrition, and poverty in the tropics.

Science for agricultural revolution

CIAT scientists and partners deliver new technology, methods, and knowledge that help farmers respond to their current and future needs. The Center cultivates change through major advances in science reinforced by improved public policies and agricultural markets. At CIAT we're proud of our ability to generate cost-effective, equitable solutions to poverty and food insecurity, which can be scaled up to deliver lasting impact.

Headquartered in Colombia, CIAT has regional offices in Nairobi, Kenya, and Hanoi, Vietnam, with a network of scientists conducting high-quality research throughout Latin America and the Caribbean, sub-Saharan Africa, and Asia. Our global team assesses opportunities to achieve food security and responds with unique approaches designed to preserve agrobiodiversity, enhance soil fertility and land management, support good governance, promote equity, and lift smallholder farmers out of poverty.

Impact of the Gates Foundation's Investments

Optimism for the impatient

An estimated 250 million children are vitamin A deficient and approximately to 500,000 go blind every year. A lack of the vitamin also puts children and pregnant women at risk of diseases and even death from common infections like measles.

These startling facts led CIAT and partners to fast-track improvement in the nutritional value of cassava. Beta-carotene – the orange pigment used by the body to make vitamin A – was boosted fourfold from 5 micrograms to about 20. Normally the cassava breeding cycle takes around 8 years but scientists devised a "rapid-cycling" method to achieve record fast results in just 3 years.

Vitamin A biofortification has the potential to benefit 70 million people in developing countries who consume 500 calories of cassava every day, but the BMGF-funded research has implications beyond boosting beta-carotene content in the crop. By unraveling a bit more of the mystery surrounding the genetic makeup of the crop, scientists are exploring rapid breeding for other important traits.

Better crops, better nutrition

Imagine: micronutrients-rich varieties of staple food crops that can be grown in a wide range of environments, nutritious seed that can be saved, shared, and grown by even the poorest farmers year after year, and healthier harvests that can provide nutrients directly to those who need them most.

HarvestPlus, jointly coordinated by CIAT and the International Food Policy Research Institute (IFPRI), leads a global effort to make this a reality by breeding and disseminating micronutrient-rich staple food crops to reduce hidden hunger – caused by a lack of micronutrients. In line with the Foundation's vision of a world where all children

have the nutrition they need for a healthy start to life, BMGF has generously supported HarvestPlus since 2005.

Through HarvestPlus, over 1.5 million farm families have been reached with Orange-Fleshed Sweet Potato, Vitamin A Cassava, Iron Bean, Vitamin A Maize, Iron Pearl Millet, Zinc Rice, and Zinc Wheat. Now the program is focusing on scaling up and out. To achieve the program's ambitious goal of reaching 100 million people with biofortified crops by 2018 and a billion people by 2030, collaboration will be key.

> ***"We can help poor farmers sustainably increase their productivity so they can feed themselves and their families. By doing so, they will contribute to global food security. But that will happen only if we prioritize agricultural innovation." – Bill Gates***

Improved cassava: Full speed ahead

There has been steady progress in cassava breeding in the past 30 years. But when presented with a shortcut, why take the long way around?

CIAT is devising a plan to reach more farmers, more quickly, and with cassava varieties that better meet their production, processing, and market needs. By exploiting several advantages of the use of homozygous lines in breeding, scientists can increase the rate of genetic gain in cassava.

Researchers are developing robust protocols for the inventive process so that other breeding programs in Africa, Asia, and Latin America can take advantage of this "double-haploid" method to obtain inbred lines in just one year, compared with the 7–10 years it takes for successive self-pollinations. Phase II of the project, funded by BMGF, is helping achieve further gains in eco-efficient agriculture.

Quenching the thirst for drought-tolerant grain legumes

Six hundred million of the world's poor depend on legume crops for food and fodder. Legumes yield high-value grain that is priced 2–3 times higher than cereals and can be processed locally to create a wide-range of food products, while the stem and leaves, as well as the residue that remains after oil extraction, are valued as high-protein livestock feed.

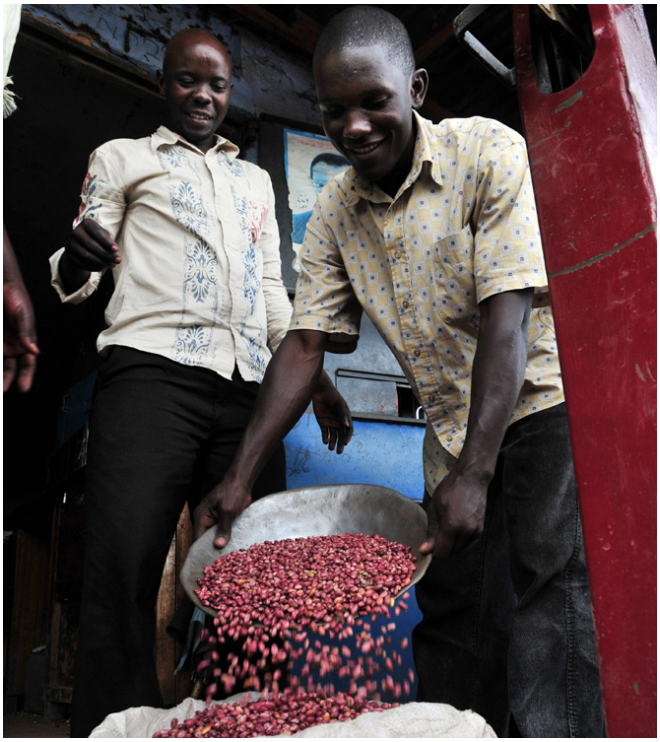
But farmers are facing shorter, less reliable growing seasons, especially in Africa, due to drought, heat, and other susceptibilities to climate change. The International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), CIAT, and partners are working to enhance the productivity of six important grain legumes – chickpea, common bean, cowpea, groundnut, pigeonpea, and soybean – by at least 20% in drought-prone areas of sub-Saharan Africa and South Asia through the availability and adoption of improved crop varieties and associated crop management practices.

Grand Challenges Explorations: One bold idea, that's all it takes

The Bill & Melinda Gates Foundation's Grand Challenges Explorations initiative was launched in 2008 to encourage scientists worldwide to think outside the box. CIAT is proud to unite with revolutionary thinkers at BMGF to find solutions to humanity's grand challenges.

CIAT proudly leads the following projects:

- GCE 1: Endophytic biological control for cassava and beans *(2014–2017)*
- GCE 2: Engineering selective autophagy for virus elimination in cassava *(2014–2017)*
- GCE 3: Less is more: The 5Q approach *(2014–2015)*
- GCE 4: Synthetic seeds for clonal propagation of disease-free cassava *(2012–2013)*



Fungi: Friend of cassava and beans, foe of pests and diseases (GCE 1)

Scientists at CIAT and the U.S. Department of Agriculture have a new secret weapon to enhance the resilience of beans and cassava to pest attacks. They have teamed up with fungus to fight bean weevil and cassava mealybug.

The "endophytic biological control for cassava and beans" project hopes to prove that the commercially available *Beauveria bassiana* fungus can be transferred into bean and cassava crops to boost the plants' natural defenses against them. The study has the potential to achieve a major leap forward in the biological control of pests. Plus, farmers would only need to use a minute amount in order to achieve field-wide resistance, potentially reducing costs and labor.

Attacking the root of the problem (GCE 2)

Some refer to cassava as the "Rambo root," for its ability to thrive in tough conditions such as higher temperatures and drought. But cassava has one enduring weakness: its vulnerability to pests and diseases, which can cripple farmers' production.

Two of the most severe cassava viruses are cassava mosaic disease (CMD) and cassava frogskin disease (CFSD). CMD, a curse to food security, produces mosaic, mottling, misshapen, and twisted leaflets and stunting in the root. Underground, CFSD causes thin roots that accumulate little or no starch, but on the surface the stems and leaves generally show no noticeable disease symptoms so farmers don't realize the plants have been damaged until harvest.

CIAT scientists are working to combat these debilitating diseases by exploiting a plant survival mechanism, called autophagy, to seek and destroy hostile viruses. By developing a self-defense protein that is programmed to recognize invading viruses and escort them to the autophagy system, cassava can be enabled to resist devastating attacks from some of its most damaging pathogens.

Less is more: The 5Q approach (CGE 3)

Sometimes less is more. CIAT is testing a new, remarkably simple method to improve customer service in development. The approach allows for continuous feedback from project stakeholders to make immediate use of the results to adjust priorities and adapt project implementation if need be. The 5 questions are modified throughout the

project cycle and depend on previous answers, but always address changes in awareness, behavior, access, and use of information.

The methodology is being tested in Northern Tanzania as part of a project aimed to increase food security and farming system resilience through wide-scale adoption of climate-smart agricultural practices and technologies. 5Q's timely feedback loop has the potential to change the face of monitoring and evaluation in development programs, with major benefits coming more quickly to farmers.

Taking innovation beyond the lab (GCE 4)

Cassava's vulnerability to pests and diseases is due in part to the way the crop is propagated – usually by the planting of stem cuttings – which can facilitate the spread and buildup of pests and diseases from season to season. In 2012, CIAT scientists began to propagate cassava using synthetic seeds produced from clean, healthy plants to help farmers break the pest and disease cycle.

The seeds are artificially induced *in vitro*, from the plants' growing points – called meristems – by treating them with synthetic hormones to make them produce "somatic embryos." These are exact genetic replicas of the parents, and have the ability to generate whole plants. The seeds are given a synthetic protective coating, mimicking a normal seed cask, for ease of storage and transportation.

Two years later, the results of the "Synthetic seeds for clonal propagation of disease-free cassava" project are so promising that two CIAT scientists involved in the project attended the Xcelerator Training Program in Seattle to address the complexities of implementing the new technology in the developing world for broad impact.

Bill & Melinda Gates Foundation-funded projects

Project Name	CIAT Leader(s)	Period	US$ (in '000)
Double haploid breeding for cassava enhancement	Clair Hershey	2010–2017	4,989
Endophytic biological control for cassava and beans	Soroush Parsa	2014–2017	100
Engineering selective autophagy for virus elimination in cassava	Wilmer Jose Cuellar	2014–2017	100
Less is more: The 5Q approach	Anton Eitzinger	2014–2015	100
Epigenetic breeding in crops	Paul Chavarriaga	2013–2016	289
Genomic approaches to understanding resistance and virulence in the cereal-Striga interaction for targeted breeding of durable defence	Mathias Lorieux	2013–2016	232
Synthetic seeds for clonal propagation of disease-free cassava	Paul Chavarriaga	2012–2013	100
Institutionalization of quality assurance mechanism and dissemination of top quality commercial products to increase crop yields and improve food security of smallholder farmers in sub-Saharan Africa	Deborah Bossio	2012–2013	178
Achieving sustainable Striga control for poor farmers in Africa	Rolf Sommer	2011–2015	60
Improving the livelihoods of smallholder farmers in drought-prone areas of sub-Saharan Africa and South Asia through enhanced grain legume production and productivity	Steve Beebe	2011–2014	3,580
Gene discovery in cassava for pest and disease resistance engagement	Luis Augusto Becerra Lopez Lavalle	2011–2012	37
Improving tropical legume productivity for marginal environments in sub-Saharan Africa	Steve Beebe	2010–2014	1,330
Predicting the impact of climate change on cocoa, cashews and cotton-growing regions in Ghana and Côte D'Ivoire	Peter Läderach	2010–2011	56
HarvestPlus Challenge Program	Joe Tohme	2005–2011	18,675
Repositioning participatory research and gender analysis in times of change	Patricia Laura Biermayr Jenzano	2010	140
A globally integrated African soil information service	Deborah Bossio	2008–2012	8,182
Evaluation and scaling up new chemical and biological commercial products for improving and sustaining crop yields in selected agro-ecological zones in sub-Saharan Africa	Joyce Jefwa	2008–2011	3,428

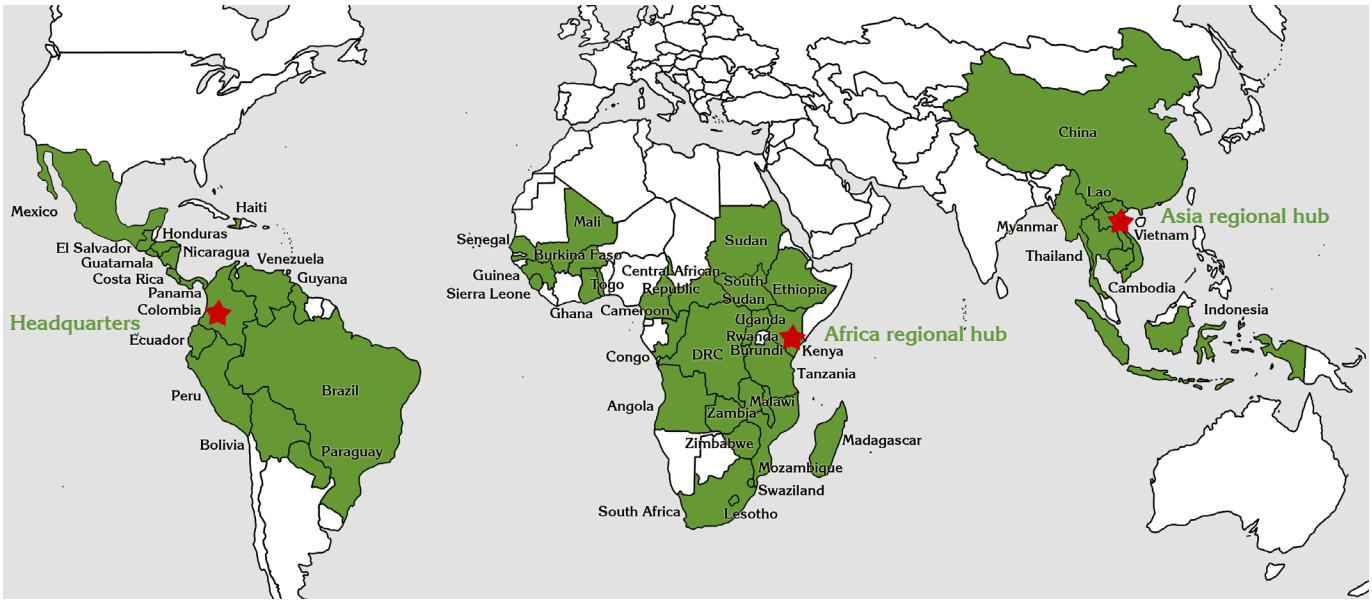
Promise to partners

Our innovative research is carried out with the highest integrity and transparency, according to an agenda that is socially and environmentally responsible. We monitor and evaluate the impacts of all our programs to bolster meaningful knowledge sharing and learning. CIAT's research and related endeavors are demand driven, harnessing creativity and integrating environmental sustainability, gender equality, and policy and institutional considerations into our activities.

Looking forward: developing joint visions

CIAT's work harnesses global expertise and partnerships that empower poor people to provide for their families and that shed light on new solutions to today's global challenges. In keeping with the Bill & Melinda Gates Foundation's efforts to help all people lead healthy, productive lives, CIAT is working to advance our mutual aims and ensure that investments in agricultural research lead to tangible, on-the-ground results.

The global reach of CIAT research



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Photos: Neil Palmer (CIAT)