



The Impacts of CIAT's Collaborative Research

The International Center for Tropical Agriculture (CIAT), working with hundreds of partners in developing countries, produces technologies and knowledge that better enable farmers, mainly smallholders, to enhance eco-efficiency in agriculture. This means we help make production more competitive and profitable as well as sustainable and resilient through economically and ecologically sound use of natural resources and purchased inputs.

In the 45 years since CIAT was established, its scientists have compiled an impressive record of achievement. In the interests

of accountability to donors and other stakeholders, they have also devoted considerable effort to economic analysis aimed at determining how much impact their work has generated.

The results of CIAT's impact analysis reside in more than 250 journal articles and other documents published since the 1970s. CIAT's output of such material has grown dramatically, starting with 9 publications in the Center's first decade and reaching almost 170 over the last decade.

In recent years, many of these publications (almost 40%) have

examined the impact of the crops for which CIAT is responsible within CGIAR. Nearly a third of the studies have reported on new tools and methods for impact assessment. The rest have focused on the impact of research dealing with climate change, soil fertility, crop biofortification, participatory research, and other topics.

This document reports some of the main impacts of CIAT's collaborative research, highlights key initiatives whose impacts have yet to be assessed, and describes several new studies and other efforts to strengthen capacity for economic analysis.

For the Record

The sections that follow summarize CIAT's main research achievements since the late 1990s, drawing on diverse publications and recently updated databases. Most of the gains reported here have resulted from

improved crop varieties, which have created considerable benefits for adopting rural households. Those impacts were initially documented through a major initiative begun by CGIAR in the late 1990s to assess the impact

of crop improvement across centers. It produced a wealth of convincing evidence that yield growth is a key driver of increased crop production in developing countries.

Common Bean

- By 1999, improved varieties of common bean were being planted to about 50% of the bean area in Latin America and the Caribbean (LAC) and almost 15% in sub-Saharan Africa, boosting yields by 0.1 to 0.9 tons per hectare.
- The gross annual value of the production increases resulting from variety adoption at that time was estimated at around US\$180 million for LAC and \$25 million for Africa,¹ with a cumulative value since 1970 of nearly \$1.1 billion (Johnson et al., 2003a). By the end of the last century, an estimated 2 million rural households had directly benefited from improved beans.
- According to a more recent study, the adoption of improved beans in Africa will generate net benefits worth nearly \$200 million against investments of \$16 million from 1986 to 2015, with an internal rate of return of 81%. Almost 5.3 million rural households have benefited from modern bean varieties over the last 17 years (Kalyebara et al., 2008; Renkow and Byerlee, 2010).
- The proportion of the total bean area planted to improved varieties containing genetic material from CIAT has doubled over the last decade, increasing to 30% (Alene et al., 2011).
- The adoption of improved bean varieties, many of them coming from CIAT, has reached 45% of the total bean area in Rwanda and 28% in Uganda, significantly improving the diets of adopting farm families (Larochele, 2012).



In sub-Saharan Africa, \$16 million invested in bean research has translated into significant benefits for more than **5.3 million** rural households

Upward Bound in Rwanda

One of the most exciting episodes in the story of bean research impact concerns the spread of improved climbing beans in Rwanda. In recent years, a growing number of the country's farmers have switched to "climbers" from the more traditional bush beans.

While both are excellent sources of protein and help to improve soil fertility through nitrogen fixation, climbing beans yield up to three times more – perfect for a country with limited land. Some of the improved varieties also offer greater resistance to bean diseases, while others contain more iron or zinc.

Many of the new climbing varieties originated in CIAT's work via the Pan-Africa Bean Research Alliance (PABRA). Further breeding work was undertaken by the Rwanda Agriculture Board (RAB) to enhance their suitability to the country's many ecosystems.



¹ The value of the production increases was derived by multiplying 1999 prices by the amount of the production increases resulting from adoption of improved bean varieties.

Cassava

- By the late 1990s, improved cassava varieties were being planted to about 7% of the total area in LAC, 18% in Africa,² and 23% in Asia, with yield increases ranging from 20 to 130%, depending on the region.
- The gross economic value generated by improved cassava was estimated at almost US\$440 million in 1998, with an internal rate of return in the range of 9 to 22% (Johnson et al., 2003b). An estimated 10 to 15 million rural households had benefited by the late 1990s.
- According to more recent estimates, the adoption of improved varieties resulting from CIAT research conducted in partnership with national scientists has reached nearly 90% in Thailand and Vietnam. The production increases resulting from higher yields have generated benefits worth almost \$12 billion over the last 20 years (Ebata, 2011).



In Thailand and Vietnam,
90%
adoption of improved cassava has generated gains worth
\$12 billion
over the last 2 decades

The Making of Asia's Cassava Boom

The impact of cassava research in Southeast Asia was made possible by extraordinary changes in the role of this starchy root. Having served the region for centuries as a secondary food crop, cassava became, from the 1970s on, a preferred raw material for the production of animal feed and of starch for a wide variety of industrial uses.

Researchers perceived in this transformation a huge opportunity for smallholder cassava farmers to raise their incomes by catering to diverse and expanding markets. The governments of Thailand, Vietnam, and China invested in cassava research and extension, taking advantage of CIAT training and its strategic work in the region on plant breeding and crop management. The private sector began to support cassava research as well because of its financial stake in maintaining a large and steady supply of cassava roots.

Responding to market stimulus, farmers have greatly expanded the cassava area – by more than a third across the region – and widely adopted improved cassava clones and agronomic practices, which have doubled yields, on average. The cash farmers are now pocketing creates benefits that are evident in small rural communities across the region.



² CIAT contributes importantly to cassava improvement in Africa through collaboration with its Nigeria-based sister center, the International Institute of Tropical Agriculture (IITA).

Tropical Forages

- In Latin America, superior *Brachiaria* grasses, many of them from CIAT, have been widely adopted and cover an area estimated at 25.4 million hectares, generating large economic benefits (Holmann, 2009).
- In the absence of data on the area sown to specific grasses developed by CIAT and others, assessing the economic impacts of resulting improvements in livestock production is complex. Nonetheless, estimates for several countries suggest that these impacts are huge. In Brazil, for example, they are believed to be as large as US\$4 billion, while in Colombia they are thought to exceed \$1 billion.
- Estimates for Central America suggest that *Brachiaria* adoption generated additional value of about \$1 billion in 1 year, with 80% of the gains accruing to the beef and 20% to the milk industries. The net present value resulting from *Brachiaria* adoption was estimated at \$1.7 billion over 14 years (Holmann et al., 2004).
- In Southeast Asia, improved tropical forages have been adopted widely since the start of promotion in 1995. Adoption is difficult to estimate with precision, however, since many government agencies and NGOs are involved. Even so, more than 15,000 smallholders are estimated to have adopted various forage species so far in CIAT project areas (Martin, 2010; Stür et al., 2005).
- Improved forages enable farmers in Southeast Asia to save labor and raise incomes by boosting the market value of livestock. Farmers feed forages to cattle, buffalo, pigs, goats, poultry, and fish and also sell fresh forage as well as seeds and cuttings for forage propagation to neighbors (Soem et al., 2009; Tan-Khanh et al., 2007; Stür et al., 2005).



Economic impact of superior forage grasses

Brazil	\$4 billion
Colombia	\$1 billion
Central America	\$1.7 billion



Faces behind the Figures

All of the 15,000 or more women and men who have adopted forages near CIAT project sites in Southeast Asia have a story to tell about how they are turning subsistence farming into a productive, market-oriented enterprise.

All of these people are exchanging labor-intensive practices like slash-and-burn agriculture for more sustainable farming systems, which are steadily improving their livelihoods.

In their stories, one factor – growing well-adapted forages on small areas of their farms – plays a critical role in the transition. Forages provide a high-quality feed source, which better enables farmers to take advantage of rising demand for livestock. Another key to success is the support of competent researchers and extension workers using participatory approaches to promote farmer innovation.

The stories of 17 farmers are told in a publication titled *Forages and farmers: Case studies from South-East Asia*, which is available online at this link:

<http://aciar.gov.au/publication/MN142>

Rice



In Latin America and the Caribbean, improved rice varieties produced benefits worth **\$860 million** over 3 decades

- Nearly 60% of all the improved rice varieties released in LAC are believed to contain germplasm developed by CIAT. According to the most recent studies (conducted in the late 1990s), these varieties have generated aggregated benefits worth US\$860 million for the period 1967–1995. Rice consumers are the main beneficiaries, receiving almost 60% of all the gains generated by adoption of improved varieties (Sanint and Wood, 1998).

Raising the Bar for Rice

The adoption of new semi-dwarf rice varieties, starting in the late 1960s, permitted an immediate and substantial increase in the yield of this key staple across Latin America and the Caribbean. But since then, rice yields have grown slowly in this region and elsewhere, even though disease resistance, grain quality, and other traits have been greatly improved.

Boosting rice production to feed a rapidly growing world population requires an urgent, coordinated global effort to raise the plant's yield potential.

Capacity Strengthening

- CIAT has contributed importantly to increasing the knowledge pool and strengthening the capacity of its many research partners.
- More than 13,000 professionals from Latin America, Africa, and Asia have benefited from training offered by the Center (CIAT, 2011).
- About half of these people have taken part in specialized courses or workshops, while about 35% have received individual training. The remainder did thesis research at CIAT for postgraduate degrees.

Anthony Ukom – One of the 13,000



I came to CIAT in 2012, with the aim of evaluating anti-oxidant potential in four varieties of yam, which I brought from my country, Nigeria. My study focused on a specific group of molecules, called flavonoids, which control antioxidant action in yam, conferring important health benefits.

As a result, I'm developing recommendations for yam preparation that avoid damage to its anti-oxidant capacity. CIAT scientists have helped me gain access to new knowledge that facilitates my work. Research and education are very important to any country, creating benefits for generations to come.

Unfinished Business

In addition to the impacts described earlier, CIAT has registered many other achievements, which are highly relevant to the Center's mission but have not yet been subjected to rigorous impact assessment.

Genetic resources



- One key challenge is to determine the global benefits of the CIAT genebank, which safeguards for humanity the world's largest collections of beans, cassava, and tropical forages, with a total of some 65,000 accessions. This material has contributed importantly to the development of improved crop varieties at CIAT. In addition, more than half a million samples have been distributed to national research programs, universities, and other partners in more than 100 countries.

Pest management and soil improvement



- Another good candidate for impact analysis is global research on integrated management of tropical whiteflies, which was led by CIAT with other CGIAR centers over a 15-year period. Together with many national partners, center researchers helped develop resistant crop varieties and improved practices for smallholder farmers, whose mixed cropping systems were being severely damaged by whiteflies and viruses transmitted by them. Researchers believe that millions of rural households benefited from this work but have not made exact estimates of its impact.
- An approach referred to as "integrated soil fertility management," or ISFM, is also ripe for thorough assessment. It seeks to intensify crop production sustainably through a combination of improved crop varieties with the application of both mineral fertilizers and organic inputs. The basic principles of ISFM have been widely accepted, and there are many cases demonstrating how they can be applied in diverse production systems.

Innovative partnerships

CIAT has shown consistent leadership over the years in forming and supporting inclusive networks and partnerships. The economic, social, and other impacts of this work are likely to be quite large and merit careful impact assessment.



- The Pan-Africa Bean Research Alliance (PABRA), for instance, has been instrumental in strengthening the capacity of national partners to engage in collaborative, problem-solving research.
- Other noteworthy cases are public-private partnerships, like the Latin American Fund for Irrigated Rice (FLAR) and CLAYUCA Corporation. FLAR, for example, in addition to accelerating the flow of improved varieties to farmers, has laid the foundations for a rice "agronomic revolution" in the region.



- A further case involves regional “learning alliances.” These integrate research at CIAT and in partner institutions on issues such as market linkages for smallholders with the work of large development agencies, which possess a tremendous capacity to promote technological and institutional change in rural areas. Through learning alliances with 25 such agencies in Central America, 33,000 rural families were able to develop agro-enterprises that boost rural incomes by bringing a wide variety of tropical products to market.

The Way Forward

According to a CGIAR report on measurement of center performance, CIAT is among the best in terms of “impact assessment culture” (Science Council, 2010, informal document).³ To strengthen its capacity in this area, the Center has assembled a strong multidisciplinary team of social scientists, and they are entering into strategic partnerships that improve the methods and procedures used to measure CIAT’s research impacts worldwide.

To further reinforce CIAT’s impact assessment culture, the team has developed a new strategy for monitoring and evaluation of outcomes and impacts, which consists of four pillars: (1) an outcome-monitoring model; (2) impact assessment studies; (3) ex-ante, foresight, and strategy analysis; and (4) awareness creation and capacity building. The Brazilian Agricultural Research Corporation (Embrapa) is contributing to the development of this strategy, focusing particularly on the use of Embrapa’s “social balance” concept for outcome monitoring (Embrapa, 2012).

According to the World Bank and others, at least 5% of all project funds should go to monitoring, evaluation, and impact assessment. CIAT has pledged to increase its investment in this work during the next few years, while also making adjustments in the Center’s database management policy.

Against this background, CIAT’s impact assessment team has embarked on several new initiatives, as described below.



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- The team is engaged in a major effort to assess the impact of improved bean technology on food security and poverty at the household level in sub-Saharan Africa, with in-depth analysis in Rwanda and Uganda. Forming part of the Diffusion and Impact of Improved Varieties in Africa (DIIVA) Project, this research is being conducted jointly with Virginia Tech, USA; the International Potato Center (CIP) and HarvestPlus; and RAB in Rwanda as well as Uganda’s National Agricultural Research Organisation (NARO). This is a clear example of how our association with advanced research institutes, CGIAR Centers and Research Programs, and national partners can enhance the quality of our impact assessment outputs.
- Another initiative will carry out a new assessment of cassava impacts in Southeast Asia, focusing on four countries. In all likelihood, this analysis will be expanded to include the impacts of tropical forages. For both crops, in-depth analysis will be conducted in Thailand and Vietnam.

³ The CGIAR performance indicator for impact assessment encompassed number and quality of publications, advances in methods, dissemination of results, workshops, and capacity enhancement.



Member of the CGIAR Consortium



CGIAR is a global agricultural research partnership for a food secure future. Its science is carried out by the 15 research centers of the CGIAR Consortium in collaboration with hundreds of partner organizations.

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- New analysis is also underway to determine the impact of improved rice varieties and management practices in LAC. Starting in Colombia, the research will also examine how the rice sector has been affected by government policies.
- In Central America, the CIAT team is working with a university partner to evaluate the benefits of improved bean, forage, and rice varieties.
- The team will also give special attention to evaluating the impacts of biofortified crop varieties for producers and consumers in LAC. A series of studies on this topic will be conducted in Brazil over the next few years, involving strong collaboration between Embrapa and CIAT under the coordination of HarvestPlus.

In support of these 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.

The recent start of a project with the CGIAR Standing Panel on Impact Assessment (SPIA) will significantly boost and complement CIAT's efforts, creating new opportunities to use frontier methodologies for the analysis of the impacts of natural resource management and policy research.

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