



The Impacts of CIAT's Collaborative Research

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.

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 exponentially – at an annual rate of about 10% – starting with 9 publications in the Center's first decade and reaching a total of 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 the 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

This section summarizes CIAT's main research achievements since the late 1990s, drawing on diverse publications and recently updated databases containing CIAT's impact figures.

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 the 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 benefitted 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 benefitted 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% (Walker et al., 2011). In Africa alone, these varieties benefitted an additional 1 million rural households during 2010.



In sub-Saharan Africa
\$16 million invested in
bean research
translates into
benefits worth
\$200 million
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, thousands 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 diseases of the leaves and roots, 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.

Rwanda now produces more beans than it can consume and supplies improved varieties to other Central and East African countries for their own breeding programs. Further adapting climbers to thrive in warmer, lower altitudes could help the work reach even more farmers and help buffer the effects of climate change.



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 benefitted 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).



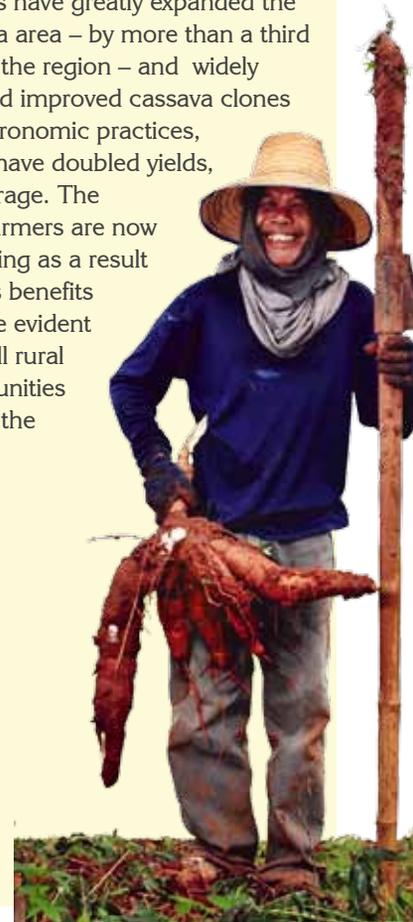
In Thailand and
Vietnam
90%
adoption of improved
cassava has
generated gains worth
\$12 billion
over the last
2 decades

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 as a result 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. This is one of the challenges to be addressed by a CGIAR research program called the Global Rice Science Partnership or GRiSP.

By pursuing a broad portfolio of genetic approaches on a global scale, scientists hope to deliver incremental gains in rice production, comparable to those achieved for maize in developing countries since the 1970s.

Capacity Strengthening



- CIAT has contributed importantly to increasing the knowledge pool and strengthening the capacity of its many research partners. More than 12,000 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.

One of the 12,000

Edgar Alfonso Rodríguez is among the thousands of young professionals who have benefited from CIAT's important contribution to strengthening national research capacity. He is working on his Ph.D. in soil and water management under the joint supervision of Elena Velásquez, a soil science professor at the Palmira campus of Colombia's National University, and her husband, Patrick Lavelle, a soil ecologist at CIAT.

Edgar's thesis research, which he is conducting as part of a strategic alliance between CIAT and the Colombian government, addresses the fundamental issue of how to compare different land uses in terms of their eco-efficiency. Having embraced this principle several years ago, CIAT is now seeking ways to put it into

practice. Edgar is helping develop eco-efficiency indicators, which take into account soil chemical and physical properties and macro-fauna composition as well as the social and economic conditions of people working the land.

Both of Edgar's parents are teachers, and he plans to follow in their footsteps to become a university professor. As such, he expects to continue his research, preferably in collaboration with CIAT, while sharing with future generations of science students his newfound passion for making Colombia's agriculture more eco-efficient.

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.

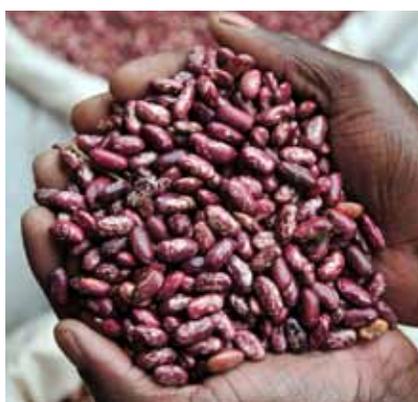
Pest management and soil improvement



- 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.
- The African Network for Soil Biology and Fertility (AfNet) has been similarly successful in promoting the adoption of participatory and gender-sensitive approaches for adaptive research and technology testing. AfNet is also vital for putting to use new aids for decision making, such as the

Africa Soil Information Service (AfsIS), which covers 18.1 million square kilometers.



- Other noteworthy cases are public-private partnerships, like the Latin American Fund for Irrigated Rice (FLAR) and the Latin American and Caribbean Consortium to Support Cassava Research and Development (CLAYUCA). 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 agroenterprises that boost rural incomes by bringing a wide variety of tropical products to market.

Other lines of research that offer major opportunities for achieving and demonstrating impact involve crop biofortification, climate change and agriculture, and linking farmers to markets.

The Way Forward

According to a recent CGIAR report on measurement of center performance, CIAT is among the best in terms of “impact assessment culture” (Science Council, 2010, informal document).³ With the aim of further strengthening its capacity for impact assessment, the Center has assembled a multidisciplinary team of social scientists with diverse backgrounds, covering such areas as natural resource economics, climate change impact and mitigation, bio-economy, and policy analysis.

According to the World Bank and other development institutions, at least 5% of all project funds should go to monitoring, evaluation, and impact assessment. CIAT plans to increase its investment in this work within the next few years, while also making adjustments in the Center’s database management policy aimed at streamlining analysis.

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

- 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. This research, conducted jointly with several CGIAR centers and universities, will apply diverse methods for both macro- and micro-level analysis in 10 countries, with in-depth analysis taking place in Uganda and Rwanda.
- Another initiative will carry out a new assessment of cassava impacts in Southeast Asia, focusing on four countries. In all likelihood, this analysis

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



According to a recent CGIAR report on center performance, CIAT is among the best in terms of “impact assessment culture”



The International Center for Tropical Agriculture (CIAT) is one among 15 members of the CGIAR Consortium of International Agricultural Research Centers. The CGIAR is a global partnership that unites organizations engaged in research for sustainable development with funders, including governments, foundations, and international and regional organizations. CGIAR research – conducted in close collaboration with hundreds of partner organizations – aims to reduce poverty and hunger, improve human health and nutrition, and enhance ecosystem resilience.

For more information:

Robert Andrade

Impact Assessment Officer

r.s.andrade@cgiar.org

will be expanded to include the impacts of tropical forages. For both crops, in-depth analysis will be conducted in Thailand and Vietnam.

- 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.

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.

Recent CGIAR reforms have also opened new windows of opportunity for collaborative impact assessment, particularly within the research programs on rice and climate change. Such collaboration is critical for expanding impact assessment to include timely issues such as climate change mitigation, policy and trend analysis, and bio-economic modeling.

References

- CIAT (Centro Internacional de Agricultura Tropical). 2011. Capacity strengthening. Cali, Colombia.
- Ebata, A. 2011. Economic impact assessment for cassava in Asia. Centro Internacional de Agricultura Tropical (CIAT), Cali, Colombia.
- Holmann, F. 2009. Impact of the adoption of *Brachiaria* grasses in selected countries of Latin America. Centro Internacional de Agricultura Tropical (CIAT), Cali, Colombia.
- Holmann, F.; Rivas, L.; Argel, P.; Pérez, E. 2004. Impact of the adoption of *Brachiaria* grasses: Central America and Mexico. *Livestock Research for Rural Development* 16(12):1-13.
- Johnson, N.L.; Pachico, D.; Wortmann, C.S. 2003a. The impact of CIAT's genetic improvement research on beans. In: Evenson, R.E.; Gollin, D. (eds.). *Crop variety improvement and its effect on productivity: the impact of international agricultural research*. CABI Publishing, Cambridge, USA. p. 257-274.
- Johnson, N.L.; Manyong, V.M.; Dixon, A.G.O.; Pachico, D. 2003b. The impact of IARC genetic improvement programmes on cassava. In: Evenson, R.E.; Gollin, D. (eds.). *Crop variety improvement and its effect on productivity: the impact of international agricultural research*. CABI Publishing, Cambridge, USA. p. 337-355.
- Kalyebara, R.; Andima, D.; Roger, K.; Buruchara, R. 2008. Improved bean varieties and cultivation practices in Eastern-Central Africa: economic and social benefits. Centro Internacional de Agricultura Tropical (CIAT), Cali, Colombia.
- Martin, G. 2010. ACIAR investment in research on forages in Indonesia. ACIAR Impact Assessment Series Report No. 65. Australian Centre for International Agricultural Research (ACIAR), Canberra. 59 p.
- Renkow, M.; Byerlee, D. 2010. The impacts of CGIAR research: a review of recent evidence. *Food Policy* 35(5):391-401.
- Sanint, L.; Wood, S. 1998. Impacto de la investigación del arroz en Latinoamérica y el Caribe durante las tres últimas décadas. Instituto Interamericano de Cooperación para la Agricultura (IICA); Banco Interamericano de Desarrollo (BID); Instituto Internacional de Investigación sobre Políticas Alimentarias (IFPRI), San José, Costa Rica. 24 p. (Priorización de la investigación agropecuaria en América Latina y el Caribe no. 3).
- Soem, D.; Boupha, T.; Stür, W.; Seng, M. 2009. The impact of adoption of forage fodder banks on labor use for feeding cattle in Prey Chhor District, Kampong Cham Province, Cambodia. International Center for Tropical Agriculture (CIAT), Vientiane, Lao PDR. 1 p.
- Stür, W.; Connell, J.; Phengsavanh, P.; Khanh, T.T. 2005. Unlocking the potential of smallholder livestock production - using managed forages as an entry point. International Center for Tropical Agriculture (CIAT), Vientiane, Lao PDR. 1 p.
- Tan-Khanh, T.; Stür, W.; Van Ha, N.; Duncan, A. 2007. Profitable smallholder beef production in Vietnam. Forages - enabling system change and powering partnerships. International Center for Tropical Agriculture (CIAT), Vientiane, Lao PDR. 1 p.
- Walker, T.; Alene, A.; Andrade, R.; Diagne, A.; Labarta, R.; Groot, H.; Jaleta, M.; Muthoni, R.; Ndjunga, J.; Simtowe, F.; Yigezu, Y. 2011. Measuring the effectiveness of agricultural R&D in sub-Saharan Africa from the perspectives of varietal output adoption: initial results from the DIVA project. Conference paper presented at ASTI-FARA, Accra, Ghana.