Improving Rural Livelihoods:

CIAT's Medium-Term Plan 2008-2010

Submitted to the Science Council of the CGIAR

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CIAT Medium-Term Plan

Context And Program Discussion

During 2007 CIAT is moving forward with a major reorganization of its research program with a view to sharpening focus and enhancing integration. CIAT has moved from 11 projects and one systemwide program (Participatory Research and Gender Analysis (PRGA)) to 6 projects and the PRGA. Following recommendations from the three research Center Commissioned External Review in 2006, CIAT is implementing its projects through a product line approach and within the framework of two broad Research for Development Challenges (RDCs): People & Agroecosystems and Sharing the Benefits of Agrobiodiversity. Research Leaders have been appointed for each of the RDCs. People & Agroecosystems research encompasses two projects: Markets, Institutions and Livelihoods, and the Integrated Soil Fertility Management Project of the Tropical Soils Biology Institute (TSBF) of CIAT. The Sharing the Benefits of Agrobiodiversity RDC includes projects to improve the productivity of beans, cassava, rice, and tropical forages.

In additional to these organizational changes, due to constraints in unrestricted resources and the need to stabilize and rebuild reserves, 10 internationally recruited staff (IRS) positions (nine of which were scientific) and 65 nationally recruited staff positions (38 of which were scientific) were eliminated. The most visible reductions in investment occur in rice research (Table 2) where reliance is being placed on partnerships with the member funded public-private partnership FLAR (Latin American Fund for Irrigated Rice); with CIRAD on rain fed rice; and with the Generation CP and IRRI within the CGIAR. Substantial reductions in unrestricted resources were also made in forages research although these are masked by anticipated increases in restricted funding in Table 2. Before these cuts, the unrestricted investment (though not the total investment) in forages research was disproportionately large compared to investment in beans and cassava. Furthermore, two IRS positions were eliminated in the socio-economics area, but this nonetheless remains CIAT's largest scientific competency in terms of IRS. One position was eliminated in plant pathology and this work was distributed among the three remaining pathologists.

Overall these organizational, financial, and programmatic changes remain broadly consistent with CIAT Strategic Plan 2001-2010. Nevertheless, the evolution of CIAT's research program and the changing context in the operating environment in general and in the CGIAR in particular suggests that CIAT will in the near future re-examine the Strategic Plan with a view to updating and reformulating the strategic vision of the center. This is expected to occur after the 6th External Program and Management Review of CIAT and the subsequent interaction with the Science Council, the CGIAR ExComm, and the Annual General Meeting of the CGIAR.

Figure 1

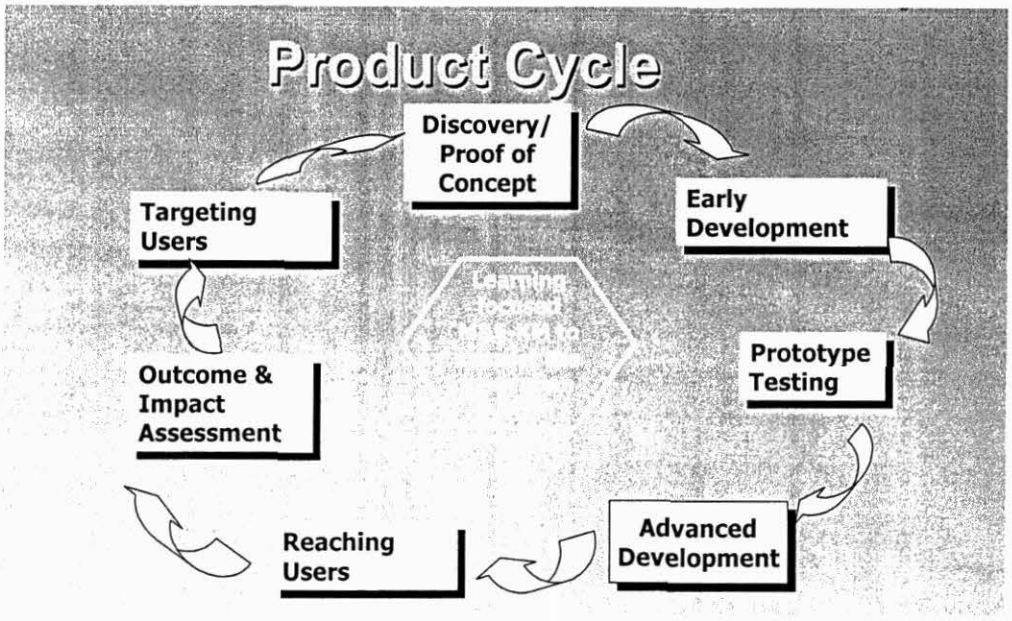

Figure 2

Framework for Product Development

Product: Beans with Improved Micronutrient Concentration

Target Region: Eastern & Southern Africa

Cycle Phase	Targeting Users	Proof of Concept	Early Development	Prototype Testing	Advanced Development	Reaching Users	Outcome & Impact Assessment
Partners		NARS Kya, Uga, DRC, Rwa	*NARS, Eth, Kya,* UGA, DRC, Rwa, Tnz, Zam, Mwi		NARS Eth, Kya, UGA, DRC, Rwa, Tnz, Zam, Mwi	NARS Eth, Kya, Uga, DRC, Rwa, Tnz, Zam, Mwi, NGOs	
Platform	GIS, SocioEc	GR, Pheno.	Brdg/ Pheno/ MAS	SocioEcon Agronomy, Systems	Brdg	Develop/ Partners	SocioEcon, GIS
Target Dates				2008	2010	2011	2016

As noted in the previous EPMR, CIAT has moved forward with the development of the product concept as an organizing principle for its research. Figure 1 shows the phases of the product cycle while Figure 2 shows how the product development framework is intended to focus CIAT research on specific product outputs for specific target regions/groups. The framework also stipulates the timeframe for the milestones for each

phase in the product development as well as the scientific competencies and partnerships needed at each stage. Therefore, the framework makes explicit how partnerships contribute all stages of CIAT research and how different scientific disciplines are integrated into the development process for a given product. This framework corresponds neatly to the log frames of the CGIAR MTPs with products corresponding to outputs; the users and partners in both cases being made explicit; output targets being defined temporally; and outcomes and impact taken into account.

Specific changes in the research of each of the projects can be found in the project descriptions.

In terms of major partnership developments, CIAT remains strongly engaged in the four existing Challenge Programs (CPs) and looks forward with particular interest to participation in the forthcoming Challenge Programs on linking farmers to markets; climate change; and high value products. All of these issues have been for many years subjects of concern and research at CIAT so that participation in these CPs is fully consistent with CIAT longstanding research agenda. In 2007 CIAT has been working especially closely with IITA and other partners on joint efforts to enhance cassava research in Africa in dialogue with the Bill and Melinda Gates Foundation, while TSBF-CIAT has been in a similar dialogue on a strategy for soils research in Africa. Likewise, CIAT has been part of two consortia, one through the Generation CP, the other in partnership with ICRISAT and IITA, on grain legumes in Africa. Finally, IRRI, WARDA and CIAT are working together on an initiative for rice research in Africa.

FINANCIAL HIGHLIGHTS

FINANCIAL OUTCOMES FOR 2006

OVERALL REVENUE AND EXPENDITURES

Compared with 2005, total revenue decreased by 8% in 2006, from US$41.5 million to $38.0 million, and total expenditures decreased 1% from US$42.4 million to US$41.9 million; the figure includes reorganization phase-out costs of $2.8 million in 2006. Changes in total revenue and expenditures are due mainly to a low restricted project implementation during 2006, with net restricted revenue decreasing by 15%. In contrast, unrestricted contributions increased 7% in 2006 while unrestricted expenditures increase 20%. The increase in unrestricted expenditures is due principally to a revaluation of the Colombian peso, the expenditures incurred under the defaulted EC contribution and the reorganization phase-out costs. These movements in unrestricted income and expenditures resulted in a deficit of US$3.9 million for 2006. Consequently the net reserves decreased to $1.8 million at the end of 2006.

Compared with the estimates reported in the MTP submitted in June 2006, actual 2006 revenue was 13% lower than projected, $38.0 million compared to a projected $43.7 million. Expenditures were 9% lower than estimated, declining to US$41.9 million, versus the projected $45.9 million. Hence, CIAT finished 2006 with a deficit of $3.9 million compared with a projected deficit of $2.2 million. As explained above the decreases in both revenue and expenditures projections were largely caused by a slightly lower rate in implementing restricted projects.

The top three donors in 2006 were CIDA, USAID and The World Bank, while in 2005 they were CIDA, USAID and DFID.

EXPENDITURE ANALYSIS

Project expenditures: After the restructuring that took place ion 2007, CIAT moved to product lines.

The 14 existing macro-projects have been replaced by 8 Product Lines disbursed between the two RDCs. Sharing the Benefits of Agro-biodiversity Program expenditure was US$22.2, or 8 percent lower compared with the US$24.2 million projected in June 2006. People and Agro-Ecosystems expenditure was US$20.5 million, 3 percent lower compared with the US$21.2 million projected.

The old SB-2 Project has been incorporated among the SBA-1, SBA-2, SBA-3, SBA-4 and PA-1 Product Lines. IP-6, PE-1, BP-2, SN-1 and SN-3 projects are now part of the PA-1. PE-2 also known as TSBF is now PA-2. The SSA component implemented by CIAT is now reported under the PA-1 and the PRGA and Harvest Plus CP maintain their categories as independent projects. This report includes the HarvestPlus funds

implemented by CIAT, however the project descriptions and log frames are reported separately by IFPRI and CIAT in the HarvestPlus MTP report.

Expenditures by Priorities: Following Science Council instructions, beginning 2006 research projects are reported according CGIAR priorities. Main priorities for CIAT program for 2006 were: Conservation of staples crops 19 percent; Integrated land and water management 16 percent; Genetic improvement of yields of food staples, Genetic improvement against abiotic stresses, Genetic improvement of nutritional quality and Rural institutions 7 percent; Markets for the poor and Intensification 6 percent. 10 priorities have less than 5 percent and 5 are not priority for CIAT.

Expenditures by Undertaking, Activities and Sectors: Increasing productivity represented 45 percent, Saving Biodiversity 21 percent, Protecting the Environment 18 percent, Strengthening NARS 13 percent, and Improving Policy 3 percent.

Expenditures by region: From the regional perspective compared to 2005, expenditures in Latin America and the Caribbean remained stable at 46 percent, Sub-Saharan Africa increased from 35 to 37 percent, Asia decreased from 18 to 16 percent and Central and West Asia and North Africa (CWANA) remained stable at 1 percent.

Expenditures by object: Excluding reorganization phase-out costs of US$2.8 million, personnel costs amounted to 49 percent in 2006. Supplies and services increased from 25 percent in 2005 to 27 percent in 2006. Travel expenditures increased from 8 percent to 9 percent and the depreciation cost amounted to 4 percent. The Collaboration/Partnership Cost category, which shows the expenditures implemented by CIAT partners, represented 11 percent in 2006 compared with 14 percent in 2005. Personnel costs decreased by 8 percent in absolute terms, from US$20.6 million in 2005 to US$19.1 million in 2006 as product of the reorganization process started in 2006. Reductions in staff costs were lower than planned due to the effect of the revaluation of the Colombian peso against the US dollar during the past year.

FINANCIAL INDICATORS

Short-term solvency (liquidity). This indicator expressed as expenditures requirements in days, decreased from 61 days in 2005 to 36 days in 2006.

Long-term financial stability (adequacy of reserves). Expressed as CIAT expenditures requirements in days, this indicator also decreased from 47 days in 2005 to 18 days in 2006.

The updated business plan approved by BOT, as explained below, projects annual surpluses from 2007 to 2009. It depicts a progressive improvement in these indicators to finally meet the CGIAR target at the end of 2009.

FINANCIAL DEVELOPMENTS IN 2007

As a consequence of the high deficits generated in 2005 and 2006 plus the CCER recommendations, the BOT instructed Management to reorganize CIAT's agenda and to make drastic unrestricted cost reductions. Strategic cuts approved for 2007 implied a reduction of 10 International Recruited Staff and at least 65 National Recruited Staff positions. Additionally, 5 IRS staff time and 30 NRS time positions are being moved from unrestricted to restricted projects as part of the full cost budgeting process. The strategic cuts and the full cost budgeting process that moved several staff from unrestricted to restricted will represent savings by US$4.7 million. The separation of the above mentioned staff will cost US$2.5 million, which will be partially covered with the special contribution from the World Bank.

New estimates for 2007 put revenue at $45.4 million, and expenditures at $44.0, including the phase out cost of $ 2.5 million explained above, plus $0.5 million corresponding to 2 IRS and 12 NRS positions cut during the 2006 reorganization that will leave CIAT in 2007. This gives a net surplus of $1.4 million for 2007, which, added to a $1 million planned unspent core capital reserve, will increase the reserves level to $4.2 million. This number is still well below of the CGIAR target, but constitutes the starting point in CIAT's financial recovery.

Compared with 2006, unrestricted funding will decrease by 3 percent, mainly due to the reductions from Usaid, Norway, Netherlands and Japan, partially compensated by the World Bank especial contribution and some exchange rate gains by the devaluation of the US dollar against the euro and other donor currencies. Restricted funding and expenditures are planned to increase 30 percent in 2007. The majority of these increases correspond to the EC contribution projected for 2007 at the level of 150 percent of the funds not received in 2006 and funds going to collaborators and operations in the regions.

PROGRAM EXPENDITURES 2007

Expenditures by Priorities: insignificant changes are expected in 2007 in relation to 2006. Conservation of staple crops represents 20 percent, Integrated land and water management 15 percent, Rural institutions 8 percent, Markets for the poor and Genetic improvement of nutritional quality 7 percent, Genetic improvement of yields of food staples, Genetic improvement against abiotic stresses and Intensification 6. 10 priorities have less than 5 percent and 5 are not priority for CIAT. A new macro project (EPI) that houses exploratory, partnerships and institutional capacity building activities outside the current research priorities, has also been created. EPI initiatives represent 16 percent of research expenditures (around $2,4 million).

Expenditures by Undertaking, Activities and Sectors: Increasing productivity represents 45 percent, Saving Biodiversity 21 percent, Protecting the Environment 18 percent, Strengthening NARS 13 percent and Improving Policy 3 percent.

Expenditures by region: Compared with 2006 expenditures in Latin America and the Caribbean decrease from 46 percent to 45 percent in 2007. Sub-Saharan Africa increases from 37 percent to 38 percent. Expenditures in Asia and Central and West Asia and North Africa (CWANA) remain constant at 16 and 1 percent respectively.

Expenditures by object: Excluding the reorganization phase-out costs, Overall personnel decreases from 49 percent in 2006 to 44 percent in 2007 as an effect of the cut implemented. Supplies and services decrease to 23 percent. Collaboration/Partnerships Costs increase to 19 percent. Travel expenditures represent to 9 percent and depreciation costs 5 percent.

FINANCIAL PROJECTIONS FOR 2008—2010

As with previous submissions, the MTP projection for the following 3 years is extrapolated on the basis of the current year. However, structural changes are expected to be fully implemented in 2007. Consequently, no additional cuts or phase-out costs are planned for the next years.

The following table summarizes the financial projections for the 4 years of the MTP :

CIAT BUSINESS PLAN 2007 - 2010

	2007	2008	2009	2010
Total Income	45.400	42.680	42.680	42.680
Total Expenditures	44.040	40.510	40.860	41.220
Surplus / (Deficit)	1.360	2.170	1.820	1.460
Net Reserves at the end of the year	**4.180**	**6.350**	**8.170**	**9.630**
Reserves indicator	39 days	60 days	77 days	90 days

Project Descriptions and

Log Frames for 2008-2010

CIAT Markets, Institutions and Livelihoods Product Lines PA-1

Narrative Project Description

Rationale for the MTP Project and Changes.

Rationale:

This Product Line aims to deliver innovations (mostly in the form of approaches, methods, tools and policy options) that contribute to improving the effectiveness of agricultural research and development and the uptake of research results by small scale farmers – and especially the poor that include many female farmers -- in Africa, Asia and Latin America.

Product development in CIAT typically comprises a sequence of needs assessment for product targeting and design, product development, integrating products into systems, reaching reaching the intended end users with the product and assessing impact. To become a successful product line, the expectation is that this sequence needs to be repeated in a cyclical, rather than linear, manner. Each cycle also needs to incorporate a learning component that builds on the past and facilitates adjustments that lead subsequently to enhanced impact over as short a time as possible. In the commodity or soils-based product lines, this implies the acquisition and application of socio-economic (including market) knowledge at the start of the cycle and again in its later stages. One of the key functions of PA1is to serve as CIAT's repository for the core competencies necessary to support successful targeting, systems integration, reaching end users and impact assessment – with inputs contributing directly through teamwork with biophysical scientists to the delivery of the outputs of CIAT's other product lines. Those outputs are not repeated in the MTP for PA1.

Many of the outputs expected from PA1 also constitute IPGs in their own right, with applicability to demands outside CIAT. Sometimes, indeed, these IPGs can be better developed in situations and with partners outside CIAT before being brought back into CIAT for further application. The opportunities presented to increase greatly CIAT's reach and contributions to poverty alleviation are the justification for concentrating these core competencies. In response to the CCER recommendations of 2006, CIAT has further consolidated its project portfolio, and refocused the research in some areas now within PA1 to produce more IPGs. The former projects from MTP 2007-2009 that are now consolidated and refocused within PA1 were:

- Tropical fruits
- Crop and agroecosystem health management
- Rural agroenterprise development
- Participatory research approaches
- Spatial and economic analysis for decision and policy support in agriculture and the environment

At the same time, CIAT has been obliged to reduce its core research budget – especially in non-commodity research areas. All three factors – consolidation of the project

portfolio, refocusing of the research agenda and reductions in core budget -- have led to significant changes in the outputs planned in the previous MTP, and to a complete reworking of output targets.

PA1 on *Markets, Institutions and Livelihoods* aims to address several aspects of the System Priorities 3, 4 and 5, by addressing key research questions around systems approaches ("where to do what?"), organizational models and learning approaches.

Output 1. Institutional arrangements for increasing impacts
The CGIAR's emerging framework for SP 5C – *Improving rural institutions and their governance* – recognizes that SP areas 1 to 4 cannot be achieved without strengthening the organizational capacities of farmer organizations (including women's producer organizations) and rural service providers. Better understanding is needed of how the roles of organizations in the rural R&D sector are changing, how they function best in different settings, and the most effective approaches to strengthening their capacities for innovation, resilience and to support rural people to break people out of the poverty trap. In this way, the CGIAR will also be better placed to facilitate or even help to organize the right partnerships, at national, regional and international scales.

We will build on research by CIAT's former Project on *Participatory research approaches*, which carried out some of its work at the level of farmer groups, by elevating this research to the institutional level. Our long-standing research collaboration with CAPRi on social capital issues in Africa will also provide a basis on which to build. A dominant lens that we will continue to use in assessments will be the effectiveness of approaches, methods and institutional arrangements as promoters of pro-poor interventions and change. Lessons will be drawn for strengthening the participation and influence of the poor in land and water management institutions and with service providers. Methods for improving the targeting and reach of agricultural research institutions will be examined, as well as how the poor can better contribute to the agenda of the formal research sector and lead some types of experimentation. The relevance, accountability and impacts of multi-stakeholder agricultural innovation platforms (partnerships between farmer/civil society organizations, and private and public sectors) will be examined in a range of settings.

Methods for tracking change, improving learning and assessing livelihood impacts for these purposes will be compared. Some aspects of this research agenda was formerly located under the Project *Spatial and Economic Analysis for Decision and Policy Support*. Recognizing the close relationship between this area and SP areas 5B and 5D, research towards this Output will be closely linked with that in Outputs 2 and 5. Doing this will facilitate understanding of the institutional aspects of smallholder participation in market chains and in developing the potential of payment for environmental services generated from agriculture to both improve the environment and rural livelihoods.

Output 2. Market value chain management practices
Smallholder farmers, almost everywhere seeking to generate income from increased productivity, have new opportunities as a result of growing demand from domestic urban

populations, or from new or more accessible export and niche markets. Opportunities can be in existing staple crops, or in high value commodities; the emphasis varies by region, with IFPRI studies indicating that many more of Africa's resource-poor farmers will benefit from a main focus on the former, while the economic benefits of the latter are more promising in Latin American countries. However, opportunities need to be assessed in the context of changing market needs, expected impact on farms and rural enterprises of the poor, and both market and non-market failure.

Market access is key to widescale poverty alleviation and has the potential to improve rural livelihoods. However, it is different for domestic and export markets; for supermarket chains, and niche versus traditional export commodities. Many factors determine the bargaining power of smallholders, including the quantity, quality and competitiveness of their supply, and the confidence in their reliability held by those further along the value chain. Wholesalers, processors, transporters, retailers and consumers manage by their own criteria. A key research question is how to build and sustain customer support for products that promote development. To effectively answer this question, it is important to take a cue from simple businesses that work very well.

Improved conceptual and empirical understanding of how impact occurs is used to design more effective and equitable market-oriented R&D interventions. This responds directly to SP 5B. Discrete products will include protocols for diagnosis and selecting germplasm, and tools for assessing benefits, costs and risks of targeted staple and high value crops, improved knowledge management and an understanding of the mechanisms that govern effective product supply chains. New varieties of beans, cassava and rice will offer opportunities as model staple crops that also respond to market requirements. Mechanisms to link farm enterprises into the agri-food chain in a more equitable manner will be identified and validated with development partners, private sector buyers and state organizations in Latin America and Asia. General spatial analysis tools, as well as Canasta and Homologue tools, will be adapted to a range of crops, with concepts being expanded to Africa.

Sustainable supply chains linking smallholders and key corporate buyers will be catalyzed, evaluated for equity, gender and environmental effects, and appropriate lessons outscaled through links with business partners, development and donor agencies in Africa, Asia and Latin America. A guide to improved knowledge management and innovation in agri-chains for linking smallholder farmers into higher value markets will be developed and validated.

This research agenda integrates some work formerly located under the Project *Spatial and Economic Analysis for Decision and Policy Support* with the former *Rural Agroenterprise Development* Project, so as to enable more holistic research across value chains.

Output 3. High value commodities

The purpose of this output is to produce IPGs related to high value crops that reduce inequality between resource poor and resource rich farmers. Approaches, tools and

technologies for improving the competitiveness of smallholder producers of high value commodities including tropical fruits will be developed. Our strategy will be to contribute to transferable knowledge, tools & methods, for site specific, pro poor development, and to promote the lessons more widely in the tropics. The research challenges include those of a traditional nature such as adaptability, adoptability, and selection while maintaining genetic diversity. But new challenges are also involved: in information management and communication; agronomic and financial risk management; business skills development; perishable product nature and traceability; and product functional qualities. Many of the supply chain issues being addressed in Output 2 will be important here, and these two outputs will be closely linked.

Using naranjillo, Andean blackberry and avocado as model high-value fruit crops, methods for participatory selection of elite clones of high value perennial fruit species will be designed and evaluated; product development will then proceed to methods for their mass propagation. By 2010 we expect to have completed assessments of elite clones for disease resistance. We will promote and support with local partners and particularly farmer associations, on a pilot learning basis, the development of rural nurseries for these fruit crops. This research will relate directly to SP area 3A, and represents a continuation of the research agenda of the former *Tropical Fruits* Project.

Crop selection criteria were developed for model crops. These include (a) the opportunity to impact positively on natural resource management, (b) contribute to the reduction of the inequity between resource poor and rich, (c) permit the generation of IPGs, (d) enhance internal integration, (e) market demand and participation in the product development is clearly expressed by the industry, (f) CIAT and partners have a comparative advantage and few or no alternative providers are available, and (g) clear opportunities for fund raising exist. Given the dynamics of higher value crop markets, new model crops are likely to be considered on a regular basis.

Drawing also on the experience of the former project on *Spatial and Economic Analysis for Decision and Policy Support,* we will extend this research to the agricultural intensification agenda of SP 4D. Methodology and tools will be developed to target higher value products to environmental niches, and evaluated with a range of crops in Latin America. Protocols for screening and selecting medicinal plants will developed, published and applied initially in LAC. Databases for accessions and performance of high market value, underutilized crops and tropical fruit species will be established and made widely accessible as aids to intensification at local and niche level for a range of environments.

Output 4. Product and environmental quality through IPDM

This output corresponds with the agenda of the former *Crop and agroecosystem health management* project. The scope however is reduced by the transfer to the commodity product lines of work on disease resistance breeding, and by staff cuts.

The focus will be on the development of technologies for better product and environmental quality through management of diseases and pests, applied in three areas.

Firstly, disease management components and strategies will be developed for tropical fruits, particularly the model crops of naranjilla, Andean blackberry and avocado targeted by Output 3 above – and in close collaboration with work on that output. Fruit product quality will be vital in the commercialization of these crops, for which inorganic pesticide use is generally unacceptable. This research is also directly related to SP area 3A.

Secondly, and based on previous research by CIAT in Latin America, a biological pesticide suitable for Africa will be evaluated in Africa – work that would offer potential to strengthen scientifically the approaches to local biopesticides often followed at present by development agencies in Africa.

Thirdly, and in response to an increasingly common production constraint in cool moist highland areas suffering overexploitation and depleted soil fertility, a method under development to quantify one plant pathogenic soil-borne species of Pythium species will be validated in Africa, initially for beans, and the method adapted to evaluate disease management strategies. Both the above sets of research output targets respond to SP area 4D, by enabling additional intensification without aggravating environmental degradation.

Output 5. Innovations for adaptation to change and vulnerability
As a general purpose, we aim to make available policy guidelines, tools, and innovations for adaptation and resilience of agricultural systems to situations of risk, high stress and vulnerability. This is a new output area for this MTP period, and responds to SP 4D for intensification in marginal environments. On the one hand, it responds to the global challenge of adaptation to climate change; on another, it aims to respond to the expensive and critical Sub-Saharan Africa regional challenges of soil degradation and of the incentives and processes needed if farmers are to invest in their restoration.

Agricultural implications of current climatic variability will be estimated, and planning support provided for adaptation by small farmers and their R&D service providers to future climate change. Discrete products will include improved understanding of the natural and biological resource that provides the link to climate change, and guidelines that improve smallholder farmers' adaptive behavior in the face of climate variability that is associated with longer term climate changes.

As contributions to the research agenda of PA2 under TSBF and in collaboration with the Institute, we aim to improve understanding of the environmental, social and market dynamics of soil degradation and recovery. Better tools are needed for the identification of effective development policies and associated investments that support the implementation of profitable and resilient land uses that enhance both welfare and environmental benefits. Protocols will be developed for evaluating how and under what circumstances farmer linkages to markets affect investments in NRM, positively or negatively. Research is focused in southern, central and eastern Africa.

An extension of this integrated approach to soil fertility will be to determine, from comparative studies and action research, the approaches and best practices that enable

farming systems and landscapes to recover from acute stress – whether caused by drought or other forms of emergency. This latter work is currently defined as one of four flagship research themes of the Alliance for Agricultural Research in Eastern and Southern Africa (AARESA).

Description of Impact Pathways (IP)

Many of the outputs from PA1 are knowledge-intensive innovations in the form of methods, tools and good practice guides. Most are targeted globally or at least across two regions, with application to development often depending upon subsequent local adaptation, translation, etc. While many of these outputs will be published internationally, a large proportion of the potential users in the development community will not be reached directly by this means. Awareness of new and existing outputs will be raised through web-based and targeted email alerts, the widely disseminated CIAT-in-Africa Highlights series, and relevant externally published newsletters (international, regional and national) and partner communications. Targeted and systematic monitoring will be needed from PA1 to ensure that IPs are functioning as expected, and to design adjustments as may be necessary.

The IP for biopesticides from Output area No 4 is distinct. This output will continue to rely in part upon agreements with the private sector, for example within Colombia and Latin American countries, for commercialization. At least in the initial stages of the planned expansion of this research to Africa, reliance will be placed upon links with NGOs and larger national and sub-regional farmer organizations for promotion and capacity building that leads to community-level processing and small scale enterprise development.

Research Approach to Develop International Public Goods (IPG)

Outputs from PA1 that are knowledge-intensive innovations (methods, tools, good practice guides, and so on) are derived from lessons learned systematically across environmental, socio-economic and geographical situations. Outputs need to be robust enough to be targeted subsequently at global and/or very broadly regional levels. Good practice guides (and similar outputs) published internationally constitute our main IPGs, but relatively few are likely to be directly applied in creating impacts; they need adaptation locally by users (rural service providers, business development), and in some cases by PA1 to produce more specific and accessible regionally valid public goods.

Some outputs related to tropical fruits and IPDM (within Outputs Nos 3 and 4) are biophysical in nature. Many of these IPGs will be handled in a similar manner to those of the SBA RDC. Research on the three model tropical fruit species also is designed to produce, as IPGs, knowledge-intensive lessons that are intended to assist others (donors, policy makers, rural development institutions, NARS) to develop and commercialize other relatively neglected tropical fruit species.

Elaboration of Partners' Roles

Research partners in strategically selected benchmark locations or agroecological situations will usually be actively involved in collaborative research for targeting,

participatory technology development, monitoring and impact assessment. In some cases they may be leading this work – at least at local level and whenever possible at regional level too, on the principle of subsidiarity; in that event, CIAT's role would be to coordinate that work so as to arrive at conclusions at the higher level.

CIAT has also found multi-institutional learning alliances, preferably with selected partners having regional reach, to be an effective mechanism for generating much of the knowledge-intensive IPG output of PA1 across environments and situations. One particularly large multi-country learning alliance around agroenterprise development and natural resource management is led by Catholic Relief Services (CRS), whose local partners become the local implementers and/or experimenters; CRS global and regional staff work with CIAT in deriving the IPG lessons that are converted to publications and best practice guides. In the case of the Sub Saharan Africa Challenge Program (SSA CP), a series of multi-institutional R&D partnerships serving as innovation platforms at local level provide the primary level of learning in each participating country, with proof of concept of the CP's hypotheses being derived by CIAT, IITA, FARA and other leading institutions at supra-regional level.

Widespread testing, verification, adaptation or application of an approach or tool also may need support to capacity building with local partners such as NGOs and CBOs. In some cases CIAT finds itself needing to initiate or catalyze capacity strengthening, while seeking (or developing the capacity of) a suitable local or regional partner to take over and lead that role. This decentralized approach may also be, in certain situations, a faster approach to learning and deriving of robust IPGs across situations than if CIAT were to attempt to manage all case studies directly. Our usual practice is to try and focus our direct research involvement to a limited number of primary partners, in the interests of quality of research, while encouraging a process of wider evaluation, learning and feedback subsequently.

Project Funding:

Budgeting 2006-2010

Year	2006 (actual)	2007 (estimated)	2008 (proposal)	2009 (plan)	2010 (plan)
US Dollars (millions)	12.065	13.205	11.993	12.105	12.220

CIAT MARKETS, INSTITUTIONS AND LIVELIHOODS PRODUCT LINES PA-1 (2008-2010)

Targets	Output	Intended User	Outcome	Impact
OUTPUT 1	Institutional arrangements and mechanisms for targeting, increasing and evaluating impacts	Agricultural and environmental research organizations, development and environmental organizations, civil society groups, policy makers at regional, national and local scales	Greater incorporation of the interests of the poor in the design and implementation of R&D projects	R&D investments have larger impacts, of which a larger share goes to the poorest beneficiaries
Output Targets 2008	A method for tracking change, improving learning, accountability, relevance and impacts of agricultural innovation systems tested in at least two countries in Africa and Asia	Complex R4D research programs and projects, eg. CPWF, SSA CP, PABRA, EULACIAS Project (led by Wageningen Uni), KS Project, Cambio Andino Project; ERI projects in Eastern and Southern Africa with NARES; civil society organizations; formal and informal farmers' organizations; rural service providers (extension services; NGOs, agro-processors, agro-dealers, financial institutions	Institutions responsible for complex R4D research projects and programs use these methods to monitor, evaluate and strengthen the networks that they build and foster	More efficient use of research-for-development funds to foster innovation; higher quality 'learning selection' in projects and programs using the tools; improved relevance and impacts of agricultural innovations systems through better expression of user-demands; improved and sustainable livelihoods through faster and more equitable innovation processes
	A set of good practices derived from Colombia and Kenya for strengthening the participation of the poor in land and water management institutions	R&D organizations working for pro-poor land and water management in tropical watersheds	Poor are empowered in land and water management and their interests are reflected in rules and policies	Empowerment of the poor; more equitable management of land and water resources

Targets	Output	Intended User	Outcome	Impact
	Two studies published assessing levels and dimensions of social capital and approaches that are critical for promoting pro-poor market linkages, farmer experimentation, social inclusion, and investment in natural resource management in Eastern Africa	ERI projects in Eastern and Southern Africa: NARES; Civil society organizations; Formal and informal farmers' organizations; Rural service providers (extension services; NGOs, agro-processors, agro-dealers, financial institutions	Increased efficiency and number of actors including vulnerable/ disadvantaged farmers participating in the resource to consumption chain	Empowerment of formal and informal farmers' organizations and faster development and adaptation of more appropriate technologies leading to improved sustainable livelihoods, especially for the rural poor
Output Targets 2009	Lessons for strengthening and weaving effective networks for influence and pro-poor impact put into use in at least one R4D program	Complex R4D research programs and projects, eg. CPWF, SSA CP, PABRA, EULACIAS Project, KS-in-Research Project, Cambio Andino Project; ERI project collaborators in Eastern and Southern Africa	Complex R4D research projects and programs use network methods developed to monitor, evaluate and strengthen the networks that they build and foster	More efficient use of research-for-development funds to foster innovation; higher quality 'learning selection' in projects and programs using the tools; improved relevance and impacts of agricultural innovations systems through better expression of user-demands (see above)
	Methodological framework for testing and evaluating innovation platforms (multi-stakeholder partnerships between private-public-CSOs) and other forms of partnerships for facilitating small holder participation in high value market chains	National agriculture research and extension systems; civil society organizations; decentralized local Governments and local institutions; rural service providers	Increased capacities of organizations / institutions to develop and promote integrated agro-enterprise development solutions for wealth creation	Effective multi-stakeholder partnerships with skills in innovative approaches for linking farmers to markets, improved performance of the research for development, better delivery of quality services, accelerated uptake of agricultural innovations and feedback to research and development priorities

Targets	Output	Intended User	Outcome	Impact
Output Targets 2010	An assessment of the potential of payment for environmental services generated from agriculture to both improve the environment and rural livelihoods	Agricultural extension, Organizations working on pro-poor development, conservation organizations, managers of downstream water systems (irrigation and potable water)	Where appropriate, farmers will receive additional incentives to adopt soil and water conserving practices	Upland agriculture is more productive and sustainable and downstream water supplies are improved
OUTPUT 2	Diagnostic, targeting and information tools that improve market value chain management for the economic and environmental benefit of smallholder farmers and the poor	Policy-makers (public, private & donor), farmer organizations, NGO's, researchers in CIAT and partner organizations	Improved conceptual and empirical understanding of how impact occurs is used to design more effective research and development interventions	R&D efforts lead to more effective, equitable and sustainable development in the tropics
Output Targets 2008	Three sets of frameworks, methodology and tools to target staple crops and higher value products to environmental and socioeconomic niches developed and tested for at least 15 crops (General spatial analysis tools, as well as CIAT's Canasta and Homologue software tools, adapted to a range of crops; concepts expanded to Africa)	Policy-makers (public, private & donor), NGO's, researchers in CIAT and partner organizations, farmer organizations	Tools developed by CIAT are used for the identification of environmental niches that support the implementation of supply chains of staple crops and differentiated high value crops.	More effective locating and targeting of germplasm in response to environmental and market conditions leads to higher welfare and environmental benefits

Targets	Output	Intended User	Outcome	Impact
	Three improved supply chain governance prototypes – organizational forms, contractual arrangements and information management – to link farm enterprises into the agri-food chain in a more equitable manner identified and validated with development partners, private sector buyers and state organizations in LAC and Asia	Policy-makers (public, private & donor), NGO's, farmer organizations, researchers in CIAT and partner organizations	Improved market linkages achieved among supply chain actors based on comparative advantages, improved access to information and stronger relationships	Rural populations benefit from sustainable and equitable market links that generate demand for products, value adding opportunities and on and off farm employment
Output Targets 2009	At least three analytical frameworks, methodology and tools for assessing the benefits, costs and risks of targeted staple and high value crops applied to research and development projects on key production constraints (drought, pests, diseases) , GMOs (as required in CBD, for LAC countries)	Policy-makers (public, private & donor), farmer organizations, NGO's, researchers in CIAT and partner organizations	Tools are used for identification of genetic resources that are deployed to support agricultural development.	More effective locating and targeting of germplasm leads to higher welfare and environmental benefits

Targets	Output	Intended User	Outcome	Impact
	One guide to improved knowledge management and innovation in agri-chains for linking smallholder farmers into higher value markets developed and validated with development partners, private sector buyers and state organizations in LAC and Asia	Policy-makers (public, private & donor), NGO's, farmer organizations, researchers in CIAT and partner organizations	Supply chain actors learn to innovate collaboratively, communicate in a transparent fashion and take advantage of differentiated product niches in national and international markets with targeted state support	Increased participation of smallholders in dynamic markets leads to income and employment gains in rural communities.
Output Targets 2010	Use of spatial analysis to develop a protocol for screening and selecting germplasm developed, published and applied for 15 staple crops (globally), 5 high value crops (globally) and 4 GMOs (in LAC)	Policy-makers (public, private & donor), farmer organizations, NGO's, researchers in CIAT and partner organizations	Method is widely adopted to establish high value product supply chains for medicinal plants.	More effective locating and targeting of germplasm leads to higher welfare and environmental benefits
	At least five sustainable supply chains linking smallholders and key corporate buyers developed, evaluated for equity and environmental effects and outscaled through links with business partners, development and donor agencies in Africa, LAC and Asia	Policy-makers (public, private & donor), NGO's, farmer organizations, researchers in CIAT and partner organizations	Equitable business arrangements investigated, adapted and mainstreamed by strategic private sector partners and outscaled to other businesses as 'good practice'	More inclusive supply chain models in place in Africa, LAC and Asia that permit smallholder market participation in an equitable, sustainable and dynamic fashion contributing to rural livelihoods
OUTPUT 3	Approaches, tools and technologies for improving the	Scientists and research managers; development	Decision-makers gain better understanding of high value	R&D efforts more effectively and systematically targeted.

Targets	Output	Intended User	Outcome	Impact
	competitiveness of smallholder producers of high value commodities including tropical fruits	planners and practitioners; producer associations; policymakers; donors	crop systems and performance, and thereby take informed decisions on resource allocations	Increased productivity of high value, readily-marketed products
Output Targets 2008	A methodology for participatory selection of elite clones of high value perennial fruit species implemented (based on model crops of naranjilla, Andean blackberry and avocado)	Research and development agencies, farmer organizations	Farmer associations and members engaged in evaluating agronomic characteristics of pre-selected elite clones	More decentralized and participatory evaluation of germplasm leads to increases in welfare and environmental benefits
	A methodology and two prediction models to target higher value products to environmental niches developed and tested with at least 5 crops in LAC	Decision makers in farmer associations, NGOs, and GOs	Tools are used for identification of genetic resources deployed to support agricultural development	More effective locating and targeting of germplasm leads to higher welfare and environmental benefits
Output Targets 2009	A methodology for mass propagation of elite clones of naranjilla, Andean blackberry and avocado established	National research agencies	Propagation methods adapted to individual species (or clones) of local interest	Wider and more rapid adoption and impact of preferred clones
	A protocol for screening and selecting medicinal plants developed, published and tested in at least 3 supply chains in LAC	Decision makers in producer associations, NGOs, and GOs	Method is widely adopted to establish high value product supply chains for medicinal plants	More effective targeting of germplasm leads to higher welfare and environmental benefits

Targets	Output	Intended User	Outcome	Impact
Output Targets 2010	Assessment of elite clones of naranjilla, Andean blackberry and avocado for disease resistance completed. Rural nurseries of naranjilla and Andean Blackberry established by at least 10 farmer associations	Smallholder farmers, local nurseries, national agricultural R&D agencies	Producers have access to planting material with known resistance characteristics	Rural nurseries become viable businesses
	One database for accessions and performance of at least 4 high market value, underutilized crops and/or tropical fruit species established	National agricultural and environmental NGOs and GOs. Researchers internal and external to CIAT.	Identification of environmental niches based on established databases that support the implementation of high value crop supply chains	More effective targeting of germplasm leads to higher welfare and environmental benefits
OUTPUT 4	Technologies for better product and environmental quality through management of diseases and pests	National research and development agencies; and farmer associations in Latin America and Africa	Cost-effective and environmentally friendly practices and tools promoted by national R&D agencies and in use	Increased rural income through increased yield, higher market values and reduced production costs
Output Targets 2008	A biological pesticide suitable for Africa tested	NARI researchers in Africa	Cost-effective and environmentally friendly bio-pesticide option available to farmers in Africa	Increased and stabilized production

Targets	Output	Intended User	Outcome	Impact
	An assessment of the major pest and disease constraints for a model tropical fruit in selected countries in Latin America	Farmers and producers of biological inputs and planting material in LAC	Safe propagation of planting material; lixivium and other ecological practices applied in management of pest and diseases	Increased and stabilized production
Output Targets 2009	A method to quantify one pathogenic Pythium species validated and adapted to evaluate disease management strategies	NARI researchers in Africa	Efficient and integrated approaches in use for managing Pythium root rot	Increased and stabilized production
	Disease management components and strategies developed for the major pest and disease constraints identified for the model tropical fruit for Latin America	Farmers, researchers and private sector in LAC	Cost-effective and environmentally friendly bio-pesticides for different production systems implemented	Reduction of economic losses by tropical fruits growers in LAC
Output Targets 2010	Disease management strategies verified for the model fruit expanded for testing with farmers growing naranjilla, Andean blackberry and avocado under a range of conditions	Farmers, researchers and private sector in LAC	Cost-effective and environmentally friendly bio-pesticides for different fruit production systems implemented by farmers	Reduction of chemical use in orchards in LAC. Technologies available for Africa and Asia.

Targets	Output	Intended User	Outcome	Impact
OUTPUT 5	Policy guidelines, tools and innovations for adaptation to risk, high stress and vulnerability.	Policy-makers (public, private & donor), farmer organizations, NGO's, researchers in CIAT and partner organizations	Improved conceptual and empirical understanding of how policy enables effective research and development interventions	R&D efforts lead to effective, equitable and sustainable development in the tropics.
Output Targets 2008	Standard protocol to examine how farmer linkages to markets affect investments in NRM (currently in use in Malawi, Uganda, Zimbabwe, Mozambique)	Policy-makers (public, private & donor), NGOs, researchers in CIAT and partner organizations, farmer organizations	Tools developed are used for the identification of development policies and associated investments that support the implementation profitable and resilient land uses	Effective policies that account for environmental, social and market conditions thereby leading to enhanced welfare and environmental benefits
Output Targets 2009	Socio-economic and agronomic vulnerability and hotspots identified under current climate variability and future climate change (pilot sites identified)	Policy-makers (public, private & donor), farmer organizations, NGOs, researchers in CIAT and partner organizations	Tools developed are used for the identification of development policies and associated investments that support the implementation profitable and resilient land uses	Improved efficiency of development interventions in increasing the adaptive capacity of agricultural systems to climate variability and change
Output Targets 2010	A set of instruments (seasonal forecasting, insurance, policy), agricultural technologies and practices for coping and adapting to climate change identified and promoted in pilot sites	Policy-makers (public, private & donor), farmer organizations, NGOs, researchers in CIAT and partner organizations	Innovations contributing to enhanced resilience in agricultural systems to climate variability and change	Less vulnerability of rural communities, especially in marginal areas, to climate variability and change

CIAT TSBF INSTITUTE PRODUCT LINE PA-2: TROPICAL SOIL BIOLOGY & FERTILITY

NARRATIVE PROJECT DESCRIPTION

Rationale & Changes

Rationale:

Soil fertility degradation has been described as one of the major constraints to food security and income generation in developing countries. Despite proposals for a diversity of solutions and the investment of time and resources by a wide range of institutions it continues to prove to be a substantially pervasive problem. The rural poor are often trapped in a vicious poverty cycle between land degradation, fuelled by the lack of relevant knowledge or appropriate technologies to generate adequate income and opportunities to overcome land degradation. Intensification and diversification of agricultural production on smallholdings is required to meet the food, feed and income needs of the poor, and this cannot occur without investment in soil fertility. Investing in soil fertility management is necessary to help households mitigate many of the characteristics of poverty, for example by improving the quantity and quality of food, feed, income, and resilience of the productive capacity of the soil to climate and environmental change.

The integrated soil fertility management (ISFM*) is a set of soil fertility management practices combined with the knowledge on how to adapt these to local conditions, thereby maximizing fertilizer and organic resource use efficiency and agricultural (crop and livestock) productivity. These practices necessarily include appropriate fertilizer and organic input management in combination with the utilization of improved germplasm.* However, in order to reap the benefits from ISFM practices and technologies, the enabling environment such as input-output markets, institutions and policy must be in place. There is a strong emphasis in ISFM research on understanding and seeking to manage the processes that contribute to improvement in soil fertility. The emergence of this paradigm, very closely related to the wider concepts of integrated natural resource management (INRM), represents a significant step beyond the earlier, narrower, nutrient replenishment approach to soil fertility enhancement.

Research on natural resource management has been criticized for not addressing the real needs of rural people and hence has often been judged irrelevant as a result. In the march to generate solutions to farmers' problems, research has generated a wide variety of technologies, such as fertilizers, improved legume germplasm and crop rotations. ISFM arose because of the recognition that addressing the ***interactions*** between components (e.g., water, pests and soils) is as important as dealing with the components themselves. However, improving the natural resource base without addressing issues of marketing and income generation (e.g. the resource-to-consumption logic) seems sterile and is often the reason for a lack of adoption of improved agricultural technologies and other farming practices.

To address the soil fertility related issues and to contribute to sustainable land management in the tropics, the research for development portfolio of CIAT includes the Product Line entitled "Integrated soil fertility management in Africa" which is housed in

the Research for Development Challenge on "People and Agroecosystems". The goal of the project is to strengthen national and international capacity to manage tropical ecosystems sustainably for human well-being, with a particular focus on soil, biodiversity and primary production; to reduce hunger and poverty in the tropical areas of Africa through scientific research leading to new technology and knowledge; and to ensure environmental sustainability through research on the biology and fertility of tropical soils, targeted interventions, building scientific capability and contributions to agricultural policy formulation and development. The main objectives are: (1) to support the livelihoods of people reliant on agriculture by developing profitable, socially-just and resilient agricultural production systems based on Integrated Soil Fertility Management (ISFM); (2) to develop Sustainable Land Management (SLM) in tropical areas of Africa through reversing land degradation; and (3) to build the human and social capital of all TSBF-CIAT stakeholders for research and management on the sustainable use of tropical soils.

To achieve these objectives, the work is organized into five major outputs:

1. Biophysical and socioeconomic processes understood, principles, concepts and methods developed for protecting and improving the health and fertility of soils;
2. Economically viable and environmentally sound soil, water, and nutrient management practices developed and tested by applying and integrating knowledge of biophysical, socio-cultural and economic processes;
3. Partnerships and tools developed and capacity enhanced of all stakeholders for improving the health and fertility of soils;
4. Improved rural livelihoods through sustainable, profitable, diverse and intensive agricultural production systems;
5. Options for sustainable land management (SLM) for social profitability developed, with special emphasis on reversing land degradation.

Each of these outputs has specific output targets for each year to contribute towards output level outcomes and impacts. The outcomes and impacts are conceptualized using seven strategic pillars:

1. Improving fertilizer efficiency and developing soil and water management practices;
2. Improved germplasm as an entry point for managing soil fertility;
3. Managing the genetic resources of soil for enhanced productivity and plant health;
4. Understanding farm level social and cultural dynamics;
5. Linking farmers to markets, nutrition, and health;
6. NRM strategies to move from plot to landscape scales; and
7. Strengthening scientific and institutional capacity of partners for ISFM.

The project has a major focus on developing and extending technologies that support sustainable intensification of cropping systems, especially in the dry and moist savanna, hillside, and forest and forest margin agro-ecological zones (AEZs) in Africa. In these AEZs, poverty, population growth and a rising demand for food is driving expansion of cropped area into increasingly marginal lands and/or remnant forest zones. Under these circumstances, sustainable intensification of agriculture on already cultivated land

(instead of expanding the area under cultivation) represents the most promising solution to achieving food and income security and protecting against natural resource degradation.

Changes:
Reduced core support to CIAT by donors resulted in elimination of the ISFM program in Latin America in 2007. Because of this change, the output targets for 2008 and 2009 for the work in Latin America have been eliminated from the logframe.

One of the major recommendations of the CCER was for TSBF to improve linkages with the private sector to improve access to fertilizer and develop recommendations for its use that are of mutual benefit to all stakeholders involved. TSBF should become the lead institution for providing scientific information to the industry on realistic markets. These will incorporate: data on soils and cropping systems, optimal fertilizer formulations for balanced crop nutrition, details on fertilizer packaging and information provided to farmers, practical ISFM concepts, the decision support tools needed for their implementation, and socioeconomic research on needs for fertilizer marketing infrastructure, integration with local knowledge to enhance adoption, economic benefits for farmers, and societal costs as a whole.

Important aspects of this recommendation are being implemented. TSBF-CIAT is playing a key role in the implementation of the recommendations of the African Fertilizer Summit taking specific action to improve farmers' access to fertilizer, quality seeds, extension services, market information and soil nutrient testing and mapping to facilitate effective use of inorganic and organic fertilizers, while paying attention to the environment. New projects have been designed to:

a) Adapt profitable fertilizer technologies to farmers bio-physical and socio-economic environments;
b) Analyze current market opportunities and information systems and test alternative options to effectively link farmers to inputs, financial and outputs markets;
c) Strengthen capacity of farmers, researchers, extensions agents, agro-dealers, NGO's and local institutions on fertilizer use and village level market development;
d) Develop tools for scaling up and a framework for the extrapolation of results; and
e) Develop a major project on the role of fertilizer on the environment in SSA with GEF-UNEP.

TSBF-CIAT is already enhancing the access of farmers to fertilizers in many of its ongoing projects. An example is the soybean project (through a strategic alliance of all stakeholders including fertilizer dealers). With respect to the provision of scientific information to the fertilizer and other farm input industry and to complement the activities of biophysical scientists in generating and fine-tuning fertilizer recommendations in line with the socioeconomic and cultural realities of the smallholder farmers, TSBF-CIAT recently completed a study on farm and agro-inputs (including fertilizers) in 40 markets in Western Kenya and plans to carry out a similar study in

Uganda, Malawi and Tanzania in the near future. TSBF-CIAT is closely working with private sector dealing with fertilizers through strong NGOs such as Agricultural Market Development Trust (AGMARK), Citizens Network for Foreign Affairs (CNFA) and IFDC. That said, aspiring to the leading position as provider of market information to the fertilizer industry is not likely to be a feasible or desirable objective for TSBF.

CGIAR System Priorities:

CIAT's TSBF Institute (Product Line on Integrated Soil Fertility Management in Africa) is housed mainly under CGIAR System Priority Area 4: Promoting poverty alleviation and sustainable management of water, land, and forest resources. Majority of the efforts are dedicated to System Priority Area 4A: Promoting integrated land, water and forest management at landscape level. The project contributes to Specific goals 1 (To develop analytical methods and tools for the management of multiple use landscapes with a focus on sustainable productivity enhancement), 2 (To enhance the management of landscapes through changing stakeholder awareness and capacity for social-ecological planning at landscape and farm levels) and 5 (Creating multiple benefits and improved governance of environmental resources through the harmonization of inter-sectoral policies and institutions). Considerable efforts are also dedicated to System Priority Area 4D: Promoting sustainable agro-ecological intensification in low- and high-potential areas. The project contributes to Specific goals 1 (To improve understanding of degradation thresholds and irreversibility, and the conditions necessary for success in low productivity areas), 3 (To identify domains of potential adoption and improvement of technologies for improving soil productivity, preventing degradation and for rehabilitating degraded lands), 5 (To improve soil quality to sustain increases in productivity, stability, and environmental services through greater understanding of processes that govern soil quality and trends in soil quality in intensive systems), and 7 (To optimize productivity at high input use (e.g. labor, nutrients, pest control practices, water, seed, and feed) through understanding and managing spatial and temporal variation).

Impact pathways:

The 5 major outputs outlined above in the rationale section articulate the logical relationship of activities within the project logframe. ***Output 1*** (*Biophysical and socioeconomic processes understood, principles and concepts developed for protecting and improving the health and fertility of soils*) encompasses our research developing principles and concepts that transcend the classical boundaries of the biophysical sciences through integration with economics, sociology and anthropology. Local and scientific knowledge interact to develop integrated "hybrid" knowledge for soil fertility management, improved food security, and environmental protection. The intended users of the ISFM principles and concepts are CGIAR, ARIs, researchers from NARS and local universities, agricultural extension, NGOs, farmers associations and individual farmers, and regional consortia. These intended users are applying the principles, concepts and methods to improve technologies and systems understanding. The final impacts of this output are resilient production systems and sustainable agriculture based on improved soil health and fertility.

The process and integrated knowledge generated under Output 1 activities is therefore applied as sustainable soil fertility and land management practices, shaped by and responding to the socio-cultural and economic environment. Research activities from ***Output 2*** (*Economically viable and environmentally sound soil, water, and nutrient management practices developed and tested by applying and integrating knowledge of biophysical and socioeconomic processes*) address the social, economic, and gendered dynamics of local knowledge generation and exchange, the nature of the interface between research-extension, local community institutions/social networks, and evaluate the economic and environmental impacts of current or proposed practices. These activities provide general principles and methodologies for TSBF-CIAT and partners to enhance farmers' capacity for applying best principles for sustainable soil, water and land management practices.

At the center of the research-outcome-impact chain, ***Output 3*** (*Partnerships and tools developed and capacity enhanced of all stakeholders for improving the health and fertility of soils*) addresses the building of human and social capital of all TSBF-CIAT stakeholders for effective research and sustainable management of tropical soils. This is particularly necessary since managing soil fertility for improved livelihoods requires the integration of technical, social, economic and policy issues at multiple scales. To overcome this complexity, research and extension staffs need the capacity to generate and share information that will be relevant to other stakeholders working at different scales (i.e., policy makers, farmers).

Output 4 (*Improved rural livelihoods through sustainable, profitable, diverse and intensive agricultural production systems*) represents the application of human and social capital and networking and sound, socio-culturally and economically relevant biophysical principles for ISFM. The challenge of intensification and diversification of smallholder agricultural production is that meeting the food and income needs of the poor cannot occur without investment in natural resource management, especially soil fertility. Investment in improving soil fertility is not constrained by a lack of technical solutions *per se* but is more linked to socio-economic issues such as lack of access to information for improved decision making and for analyzing trade-offs and limited inputs (including credit and loans) and profitable markets.

The highest scale for our research-for-development activities is found within ***Output 5*** (*Options for sustainable land management (SLM) practices for social profitability developed, with special emphasis on reversing land degradation*). These activities are dedicated to applying the findings of all the previous outputs for restoring degraded agricultural lands to economic and ecological productivity, enhancing ecosystem health and improving livelihoods by generating technology, institutional, and policy innovations. Since soils play a central role for the provision of ecosystem services (e.g. regulation of water quality and quantity, carbon storage and control of net fluxes of greenhouse gases to the atmosphere), appropriate soil management at the landscape level should result in enhanced provision of environmental services.

The key assumptions for these 5 outputs are: security and political stability does not restrict access to target sites and continuation of on-going activities; poverty reduction strategies remain central to human development support and funding; TSBF-CIAT stakeholders remain engaged with TSBF-CIAT strategic priorities and/or TSBF-CIAT management continues to adapt and innovate in response to changing priorities; funding for research on globally-important issues continues; and linkages maintained among research and development organizations. The expected beneficiaries, target ecosystems and end users are principally small-scale crop-livestock farmers and extension workers, NGOs and NARES in tropical agroecosystems of Sub-Saharan Africa. The target ecoregions are East and Central African highlands (Kenya, Uganda, Ethiopia, Tanzania, Rwanda, DR Congo); Southern African savannas (Zimbabwe, Malawi, Mozambique, Zambia); West African region (Burkina Faso, Niger, Cote d'Ivoire, Nigeria, Benin, Togo, Mali, Senegal, Ghana).

International Public Goods (IPG):

The IPG of the TSBF Institute include:

- Improved knowledge on soil processes;
- Global inventory of below-ground biodiversity;
- Improved knowledge on nutrient and other resource flows;
- Improved knowledge on how different stakeholders use and manage landscapes;
- Tools and indicators to assess soil quality;
- Improved approaches and practices for managing soil, water and land resources;
- Innovative diversification options within farms;
- Decision support tools and models to analyze trade-offs among food productivity, ecosystem services and land conservation;
- Methods and tools for promoting effective collective action for improved soil fertility management and improved livelihoods;
- Novel forms of institutional innovations and policy options to reduce land degradation and to restore degraded lands.
- Three-tier-approach for sustainable crop and livestock enterprise promotion, linking farmers to market, and rural poverty reduction.

The Institute's comparative advantage is in conducting IPG research on ISFM in farming systems where soil degradation undermines local livelihoods and market opportunities. However, while TSBF-CIAT will focus primarily on strategic research, it is also ready to support technology dissemination and development activities with partners via regional networks and global projects. TSBF-CIAT will continue research on below-ground biodiversity as a means of beneficially managing soil biology, through the GEF-UNEP funded global project on below-ground biodiversity (BGBD) which has started its Phase II activities. Much of the applied research and dissemination of findings, as well as NARSs capacity building, will be done via the Institute's regional partner network — the African Network for Soil Biology and Fertility (AfNet). TSBF-CIAT also collaborates with the South Asian Regional Network (SARNet) on soil fertility research in that region.

Partners:

NARES: These are important local partners that contribute staff time and operational resources to all 5 outputs of the project. The staff time of NARES partners is indicated for each country. East and Central African highlands (Kenya-10, Uganda-4, Ethiopia-1, Tanzania-1, Rwanda-5, DR Congo-5); Southern African savannas (Zimbabwe-3, Malawi-1 Mozambique-1, Zambia-1); West African region (Burkina Faso-1, Niger-3, Cote d'Ivoire-2, Nigeria-2, Benin-1, Togo-1, Mali-1, Senegal-1, Ghana-2).

ARIs: These are important international partners that contribute mostly to strategic research in output 1 on biophysical and socioeconomic processes and output 2 on natural resource management strategies. These include CIMMYT-1, ILRI-1, CIP-1, IFDC-1 ICRAF-2, IITA-2, ICRISAT-2, IRD (France-1), CIRAD (France-2),JIRCAS (Japan-1).

Universities: These are local and international partners that participate mostly in co-supervision of students that work on ISFM related aspects. University of Nairobi (Kenya-2), Maseno University (Kenya-1), Makerere University (Uganda-2), Kenyatta University (Kenya-2), Zimbabwe (Zimbabwe-2), Sokoine (Tanzania-1), University of Ibadan (Nigeria-1), Universidade Federal de Lavras (Brazil-1), Universidade Regionale de Lavras-FURB (Brasil-1), INPA (Brasil-1), UFAM (Brasil-1), Universidade De Brasilia (Brasil-1), Jawaharlal Nehru University (India-1), University of Agricultural Sciences (India-1), Kumaon University (India-1), Sambalpur University (India-1), Universitas Lampung (Indonesia-1), Brawijaya University (Indonesia-1), Gadjah Mada University (Indonesia-1), Bogor Agricultural University (Indonesia-1), Université de Cocody (Cote d'Ivoire-1), Universite D'Adobo-Adame (Cote d'Ivoire-1), Universidade Veracruziana (Mexico-1), Instituto Polytecnico (Mexico-1, Ishikawa Prefectural University (Japan-1), Kyoto University (Kyoto-1), Leuven (Belgium-2), Paris (France-1), Bayreuth and Hohenheim (Germany-3), SLU (Sweden-3), Cornell (USA-2), Wisconsin-Madison (USA-1), U.C. Davis (USA-1), Ohio State (USA-1), Colorado State University (USA-1), East Anglia (UK-1), Queen Mary University (USA-1), Michigan State University (USA-1), Purdue University (USA-1), ITC (The Netherlands-1) University of Exeter (UK-1), Wageningen University and Research Centre (Netherlands-3), and KU-Leuven University (4).

Regional Consortia: These partners play a key role in building capacity in the regions for ISFM research and also for dissemination of tools and technologies to promote ISFM. These include AFNET for Sub-Saharan Africa and African Highlands Initiative for African highlands.

NGOs: These partners play a key role in dissemination of tools and technologies for ISFM in the regions. These include CARE-Kenya, World Vision, CIPASLA and CIPAV.

In addition to the above partners, PE-2 project also participates with Systemwide Programs (AHI, PRGA) and Challenge Programs (Water and Food CP, SSA-CP).

Project Funding:

Budgeting 2006-2010

Year	2006 (actual)	2007 (estimated)	2008 (plan)	2009 (plan)	2010 (plan)
US Dollars (millions)	6.932	6.326	6.250	6.309	6.369

CIAT TSBF PRODUCT LINE PA-2: TROPICAL SOIL BIOLOGY & FERTILITY (2008-2010)

Targets	Outputs	Intended User	Outcome	Impact
OUTPUT 1	Biophysical and socioeconomic processes understood, principles, concepts and methods developed for protecting and improving the health and fertility of soils	CGIAR, ARI, researchers from NARS and local universities, NGOs, farmers, and regional consortia	Principles, concepts and methods inform technology and system development	Improved soil health and fertility contribute to resilient production systems and sustainable agriculture
Output Targets 2008	At least three practical methods for rapid assessment and monitoring of the soil resource base status in relation to nutrients ,organic matter and biota developed / adapted for various cropping systems	CGIAR, ARI, researchers from NARS and local universities, NGOs, farmers, donors and regional consortia	Partners are using the methods with farmers	
	Direct inoculation with specific below ground biodiversity microorganisms rhizobia in legumes systems and arbuscular mycorrhizal fungi in banana systems increase crop productivity	CGIAR, ARI, researchers from NARS and local universities, NGOs, Agrodealers, farmers	Partners explore options to utilize biological means to improve crop productivity	
	The social, gender, and livelihood constraints and priorities affecting the sustainable use of soils have been identified, characterized, and documented through at least two successful case stories(fertilizer microdose and dual purpose legumes using innovative methods in the African Sahel and moist savanna	CGIAR, ARI, researchers from NARS and local universities, NGOs, farmers, and regional consortia	Partners are working to overcome the identified constraints with new proposals and on-going research	
Output Targets 2009	Modeling tools (DSSAT, APSIM, NUANCES, SWAT) for nutrient management used and disseminated to about 200 stakeholders across at least five countries in SSA	CGIAR, ARI, researchers from NARS and local universities, NGOs, farmers, and regional consortia	Partners involved in research for development are using the modeling tools	

Targets	Outputs	Intended User	Outcome	Impact
	The role of soil organic matter in regulating water , nutrient-limited and actual yield levels underlying crop production and cereal in legume systems in at least two countries in SSA quantified	CGIAR, ARI, researchers from NARS and local universities, farmers, and	Partners are adapting soil fertility management practices to support specific soil organic matter-related functions	
	Sufficient knowledge on mechanisms (solubilization or/and mycorhizal infection) driving tolerance to drought and low soil P is available to guide breeding efforts in beans and soybean rotated or intercropped with maize and sorghum in mild altitude savanna.	CGIAR, ARI, researchers from NARS and local universities, NGOs, farmers, and regional consortia	Bean and soybean breeders involve soil scientists in the breeding program in SSA	
	Knowledge on relationships between soil fertility status and the nutritional quality of bio-fortified crops is used by at least 25 development partners in at least six countries in SSA to target production of beans, soybean, cassava and maize crops	CGIAR, ARI, researchers from NARS and local universities, NGOs, farmers, and regional consortia	Stakeholders in research for development focus on food quality in addition to production	
Output Targets 2010	The role of soil organic matter in regulating soil-based functions (e.g., acidity and CEC) underlying fertilizer use efficiency and crop production in cereal , cassava and banana cropping systems in at least six countries in SSA quantified.	CGIAR, ARI, researchers from NARS and local universities, farmers, and regional consortia	Partners are adapting soil fertility management practices to support specific soil organic matter-related functions	

Targets	Outputs	Intended User	Outcome	Impact
	Functional interpretations of rhizobial and arbuscular mycorrhizal fungi linked to nutrient use efficiency and pest and diseases in legumes and banana cropping systems.	BGBD network, CGIAR, ARI, researchers from NARS and local universities, NGOs, farmers, regional consortia, policy makers and global conservation organizations	Researchers, and global conservation organizations increase their awareness of the benefits of conserving and managing BGBD in the context of ISFM and IPM	
	Beans,maize soybean, cassava, horticulture and banana nutrient requirements and impacts on nutritional quality of respective food products quantified in at least two cropping systems.	CGIAR, ARI, researchers from NARS and local universities, farmers, and regional consortia	Through collaborative research, the scientific capacities in plant nutrition research is strengthened and support of the large activities on Integrated Soil Fertility Management in SSA	
OUTPUT 2	Economically viable and environmentally sound soil, water, and nutrient management practices developed and tested by applying and integrating knowledge of biophysical, socio-cultural and economic processes	CGIAR, ARI, researchers from NARS and local universities, NGOs, farmers, and regional consortia	Technologies, systems and soil management strategies adopted and adapted through partnerships	Adapted technologies contribute to food security, income generation and health of farmers
Output Targets 2008	Communities in at least three countries demonstrate and test direct or indirect management options that enhance locally important ecosystem services using BGBD	BGBD network, CGIAR, ARI, researchers from NARS and local universities, NGOs, farmers, regional consortia, policy makers and global conservation organizations	Researchers, farmers, land users and policy makers and global conservation organizations increase their awareness of the benefits of conserving and managing BGBD	

Targets	Outputs	Intended User	Outcome	Impact
Output Targets 2009	Local baselines and interviews show that farmers' understanding of soil processes is demonstrably enhanced within community-based experimentation in at least 5 benchmark sites	CGIAR, ARI, researchers from NARS and local universities, NGOs, farmers, and regional consortia	Scientists blend local and new scientific knowledge in the experimental design	
	The potential for occurrence of positive interactions between organic and mineral inputs is evaluated for the most common cropping systems especially for root and tuber crops in each mandate area.	CGIAR, ARI, researchers from NARS and local universities, NGOs, farmers, and regional consortia	Stakeholders appreciate the complementary role of both inorganic and organic inputs and use them judiciously	
	Throughout the Institute project life, new questions generated in the evaluation efforts of the different target outputs are addressed and fed back to these evaluation activities	CGIAR, ARI, researchers from NARS and local universities, NGOs, farmers, and regional consortia	PM&E is institutionalized and used by all project partners	

Targets	Outputs	Intended User	Outcome	Impact
Output Targets 2010	Cereal-legume systems with improved germplasm as entry point tested, adapted, and validated to farmer conditions in savanna areas	CGIAR, ARI, researchers from NARS and local universities, NGOs, farmers, and regional consortia	Partners are adapting cereal-legume systems and fostering access to the inputs needed to improve their productivity	
OUTPUT 3	Partnerships and tools developed and capacity enhanced of all stakeholders for improving the health and fertility of soils	CGIAR, ARI, researchers from NARS and local universities, NGOs, farmers, regional consortia, young professionals, policy makers	Strengthened and expanded partnerships for ISFM facilitate south-south exchange of knowledge and technologies	Improved institutional capacity in aspects related to ISFM and SLM in the tropics contribute to agricultural and environmental sustainability
Output Targets 2008	Farmer-to farmer knowledge sharing and extension through organized field trips and research activities result practices in at least two sites	Researchers from NARS and local universities, NGOs, farmers, regional consortia, young professionals, policy makers	Farmers realize benefits of knowledge sharing	
	Web content in the BGBD website enhanced to contain data and information on BGBD taxonomy and species identification	Researchers, CGIAR, ARI, local universities	Increased number of biodiversity scientists use the website for proper identification and classification of soil biota to species level	

Targets	Outputs	Intended User	Outcome	Impact
Output Targets 2009	Profitable land use innovations scaled out beyond pilot learning sites through strategic alliances and partnerships, and application of alternative dissemination approaches	Researchers from NARS and local universities, NGOs, farmers, regional consortia, young professionals, policy makers	Partners incorporating new knowledge and skills in new proposals and on-going research efforts	
	Strategies for institutionalization of participatory NRM approaches and methodologies established	Researchers from NARS and local universities, NGOs, farmers, regional consortia, young professionals, policy makers	New institutional arrangement catalyze multidisciplinary work and enhance scaling up of technologies and best practices	
Output Targets 2010	Research on practical strategies and decision support tools for integrated water and nutrient management, including organic and mineral nutrient sources is further strengthened and added to the existing organic resources DSS/database	CGIAR, ARI, researchers from NARS and local universities, NGOs, farmers, regional consortia, young professionals, policy makers	The capacity of TSBF-CIAT and its collaborators strengthened in the application of decision support tools including the role of water in the interaction between the organic and inorganic inputs on crop productivity especially in semi-arid areas in SSA.	
	Social science aspects are included in the decision-making process and tools to better understand actionable management strategies, their knowledge requirements, and economics.	CGIAR, ARI, researchers from NARS and local universities, NGOs, farmers, regional consortia, young professionals, policy makers	TSBF-CIAT expand its social science activities regional hubs in Southern and Central Africa and few agro-ecosystems of major importance.	
OUTPUT 4	Improved rural livelihoods through sustainable, profitable, diverse and intensive agricultural production systems	CGIAR, ARI, researchers from NARS and local universities, NGOs, farmers, regional consortia, young professionals, policy makers	Partners promoting resilient production systems with multiple benefits (food security, income, human health and environmental services)	Improved resilience of production systems contribute to food security, income generation and health of farmers

Targets	Outputs	Intended User	Outcome	Impact
Output Targets 2008	Improved production systems having multiple benefits of food security, income, human health and environmental services identified	CGIAR, ARI, researchers from NARS and local universities, NGOs, farmers, regional consortia, young professionals, policy makers	Market-led hypothesis is incorporated in systems experimentation; Different partners linking food security, environmental sustainability and income generation to health	
Output Targets 2009	Validated intensive and profitable systems are being demonstrated, promoted by partners and adopted by farmers in 10 countries	CGIAR, ARI, researchers from NARS and local universities, NGOs, farmers, regional consortia, young professionals, policy makers	Increased sustainable productivity and profitability of major cropping systems	
	The contribution of multiple stress adapted germplasm in driving overall system resilience is understood for the conditions occurring in all mandate areas	CGIAR, ARI, researchers from NARS and local universities, NGOs, farmers, regional consortia, young professionals, policy makers	Farmers pay more attention to the sustainability of their farming system in addition to productivity	
	Products of the trade-off analysis are guiding the introduction and evaluation of alternative NRM options, better suited to the farmer production objectives and the environment of the actions sites	CGIAR, ARI, researchers from NARS and local universities, NGOs, farmers, regional consortia, young professionals, policy makers	Farmers use results of trade off analysis to make appropriate choice	

Targets	Outputs	Intended User	Outcome	Impact
Output Targets 2010	Improve linkages with the private sector to improve access to fertilizer and develop recommendations for its use by farmers and other stakeholders involved.	Private sector, NGOs, farmers, regional consortia, and policy makers	Potential adoption and impacts of mineral fertilizers in ISFM by farmers and agro dealers increase	
	The impact of cultural and social differentiation on potential markets and product supply chains as well as on processes of information exchange evaluated	CGIAR, ARI, researchers from NARS and local universities, NGOs, farmers, regional consortia, young professionals, policy makers	Up-scaling of proven technologies following targeted recommendation domains leads to increases in adoption and improvements in livelihoods of different typologies of farmers	
OUTPUT 5	Options for sustainable land management (SLM) for social profitability developed, with special emphasis on reversing land degradation	CGIAR, ARI, researchers from NARS and local universities, NGOs, farmers, regional consortia, young professionals, policy makers	Principles of sustainable land management integrated in country policies and programs	Reversing land degradation contribute to global SLM priorities and goals
Output Targets 2008	Methods developed for socio-cultural and economic valuation of ecosystem services developed and applied for trade-off and policy analysis in at least in 1 humid and 1 sub-humid agroecological zones	CGIAR, ARI, researchers from NARS and local universities, BGBD network, NGOs, farmers, regional consortia, policy makers	Methods of SLM are incorporated in the design and evaluation of landscape research	
	In at least four of the countries participating in the BGBD project, policy stimulated to include matters related to BGBD management, and sustainable utilization.	CGIAR, ARI, researchers from NARS and local universities, NGOs, farmers, regional consortia, policy makers	Policy issues related to BGBD acquisition, exchange, intellectual property rights (IPR), benefits sharing, etc. included in local, national and regional government policies	

Targets	Outputs	Intended User	Outcome	Impact
Output Targets 2009	30% of partner farmers in pilot sites used SLM options that arrested resource degradation and increased productivity in comparison with non-treated farms	CGIAR, ARI, researchers from NARS and local universities, NGOs, farmers, regional consortia, policy makers	Increased productivity and conservation of degraded landscape	
	75% of stakeholders in target areas have an improved capacity for collective action and local policy negotiation and implementation of integrated land use practices using integrated agricultural research for development	CGIAR, ARI, researchers from NARS and local universities, NGOs, farmers, regional consortia, policy makers	Improved knowledge sharing and exchange to empower stakeholder to innovate with respect to technologies and best land conservation practices	
	The benefits of community-based watershed management innovations quantified and disaggregated by wealth and gender	CGIAR, ARI, researchers from NARS and local universities, NGOs, farmers, regional consortia, policy makers	Increased investment in beneficial conservation	
Output Targets 2010	Scale-up research on soil fertility gradient to farm and landscape levels by conducting one or two carefully designed, integrated studies in collaboration with other CIAT scientists	CGIAR, ARI, researchers from NARS and local universities, NGOs, farmers, regional consortia, policy makers	Generalize the findings from on farm level gradients in soil fertility into generic rules and tools that can be used in guiding ISFM in practice across landscapes	

CIAT PRGA Product Line PA-3: Participatory Research and Gender Analysis

Narrative Of Product Line

Rationale & Changes

Rationale for MTP Project and Changes

Phase III (2008–2012) of the Systemwide Program on Participatory Research and Gender Analysis for Technology Development and Institutional Innovation (PRGA Program) builds on the Program's new strategic platform,[1] developed in early 2007 on the basis of lessons from and achievements of the earlier phases (1997–2006), the recommendations of the Program's first external review in 2006–2007, and detailed discussions within the Program's Advisory Board.

- A majority of agricultural research systems still lack a critical mass of participatory research (PR) and gender analysis (GA) practitioners, including in the CG System
- There is still little recognition and practice of gender analysis
- There is still an unmet demand for capacity development in GA and PR methods
- Learning and change need to be institutionalized, so that PR and GA can be mainstreamed in agricultural R&D thinking and practice.

The PRGA Program fits primarily into System Priority area 5 "Improving policies and facilitating institutional innovation to support sustainable reduction of poverty and hunger," and more specifically Priority 5D "Improving research and development options to reduce rural poverty and vulnerability." However, the use of gender-sensitive participatory research-for-development by the CG System and its partners, as promoted by the Program, should improve the efficiency of effort in all five Priority areas.

The PRGA Program continues to be guided by its programmatic goal "to improve the ability of the CGIAR System and other collaborating institutions to develop technology which alleviates poverty, improves food security, and protects the environment with greater equity" and its programmatic purpose "to assess and develop methodologies and organizational innovations for gender-sensitive participatory research, and operationalize their use in plant breeding, and crop and natural-resources management." The objective of the Program is to improve the competencies of the CG System and collaborating institutions to mainstream the use of gender-sensitive participatory approaches in plant breeding and natural-resources research.

The strategic platform for Phase III focuses on three thematic areas together with supporting actions for gender mainstreaming; these constitute the Outputs of the revised logframe. No longer an Output in its own right, impact assessment is now built into the strategy as a cross-cutting activity.

Important Assumptions

The success of the PRGA Program is dependent on the following.

[1] The full Strategic Platform is presented in Appendix I.

- CGIAR Centers and partner institutions are willing to become involved in learning and change by committing staff and budget to using PR and GA methods, contributing to capacity development of their members, and making the necessary organizational adjustments for integrating such approaches into their organizations.
- Donor commitment to the PRGA Program increases prior to and during the period.
- IARCs and other institutions collaborating with the PRGA Program are able to include results in their institutional reports and annual reviews.
- Stakeholders are willing to contribute actively to PRGA Program planning and evaluation.

Impact Pathways

Historically, the PRGA Program has sought the input of its stakeholders in identifying researchable problems in the fields of PR and GA. This process should be repeated at the upcoming Fourth International Seminar.

Participatory plant breeding research should identify and promote good-practice methods for use by plant breeders in all contexts. These is turn will develop varieties adapted to specific farming contexts (social, cultural, farming systems, agro-climatic) that will be adopted and promoted by participant farmers, thereby reducing farming risks (through use of adapted varieties, improved systems and increased genetic diversity in the field). With reduced risks, farmers should achieve better yields with consequent improved incomes and livelihoods.

By understanding how formally developed varieties are integrated into the seed system, and how commercial seed enterprises have succeeded, we should have a clearer overall view of the seed chain. With this knowledge, we will explore ways of influencing variety uptake into commercial seed systems and promoting the establishment of need seed enterprise. Alongside this, our research into the fit between soil mosaics and farmers' varietal preferences should enable us to guide seed industries in targeting and distributing their products. Consequently, farmers should benefit from prompt delivery of appropriate varieties, thereby improving their chances of good harvest, with consequent knock-on effects to incomes and livelihoods.

By studying successful development situations (not necessarily interventions), we aim to learn about what made them successful and feed these back into new projects. This should improve funding and resource use efficiency within newer projects, thereby achieving positive results in a shorter timeframe and at reduced cost.

In mainstreaming gender issues, partners internalize what they learn, resulting in institutional change; more specifically, partners then routinely utilize appropriate elements of PR and GA whenever appropriate. This knocks on to improved, better-targeted research, and therefore better outcomes for the ultimate target audience, i.e. the poor.

Research Approach to Develop International Public Goods

The Program is unique within the CG with its focus on PR and GA; it complements the Gender and Diversity Program, which focuses on staffing issues. The PRGA Program works alongside partners to develop methodologies that will be applicable over a much wider area. For the specific communities with which it works, there is also the benefit of direct Program input and

Outputs (e.g. varieties), which themselves may be relevant in similar socio-economic and ecological situations.

Alongside the research, the Program plays an advocacy role in promoting the use of PR and GA techniques throughout the CG Centers and beyond.

Partners' Roles[2]

- CIAT (Convening Center) — building on advantage of hosting PRGA Program
  - Greater interaction with PRGA Program at senior scientist, management and Board levels
  - 'Buy-in' to PRGA Program *raison d'être*
  - 'Experimental' case study in establishment of appropriate gender indicators in project review procedures and research evaluations (Output 4)

- CIMMYT, ICARDA, IRRI (Co-Sponsors)
  - As Co-sponsors of the PRGA Program, these Centers are prime targets for research partnerships under Themes/Outputs 1 and 2
  - ICARDA should be particularly heavily involved in Theme 1

- WOCAN (Women Organizing for Change in Agriculture and Natural Resource Management)
  - Coordination and communications for the IDRC-funded project 'Institutionalizing gender-responsive research and development in agriculture and natural-resource management through women's networks' (to 2008)

- Challenge Program on Water and Food – water productivity of crops in the Atbara basin, Eritrea project
  - PRGA Program providing backstopping to impact assessment and socio-economic monitoring and evaluation activities

Project Funding:

Budgeting 2006-2010

Year	2006 (actual)	2007 (estimated)	2008 (plan)	2009 (plan)	2010 (plan)
US Dollars (millions)	0.692	1.000	0.700	0.700	0,700

[2] Excludes recipient, network and potential future partners (*see* Appendix II).

Financial Plan

- Fundraising is a major (implicit) component of the Program's new strategic platform.
  - *See* 'Progress Report on Implementation of (draft) EPMR Recommendations' *above*, especially Recommendations 1, 2 and 5.
  - Until that process is underway, it is impossible to project the scale of the Program's budget for 2009 and beyond. Any attempt to do so now would be hypothetical and meaningless (or no more than a 'wish list').

- IDRC Special-project funding currently runs through to 2008.

- Current Core (unrestricted) donors are Italy and Switzerland.

- Projected income for 2008 is currently US$ 269,507 (assuming that current Core donors stay on board, and including the US$ 10,507 Special-project funding from IDRC).

- Specific components of the new strategic platform requiring extra funding are:
  - PPB Coordinator
  - Annual Gender Research Prize
  - *See also* 'Program structure' *above*.

- Other EPMR recommendations that require funding for implementation are:
  - Competitive Small Grants Scheme
  - Separation of Gender-mainstreaming role from Program management role (Coordinator) — i.e. creating two senior staff positions from one.
  - *See also* 'Program structure' *above*.

Appendix I: Strategic Platform for Phase III (2008–2012) of the PRGA Program

- Theme 1: New Developments in Participatory Plant Breeding
  - Activity 1.1: Development or application of new methods within PPB for maximizing the use of agro-biodiversity. *The focus is on methodological research that supports the diversification of poor people's livelihoods in agro–food chains.*
  - Activity 1.2: PPB to support the broadening of the genetic base of poor people's crops.
  - Activity 1.3: PPB as an implementation tool for farmers' rights.
- Theme 2: Institutional Innovations in Africa's Seed and Seedling Revolution
  - Activity 2.1: Learning from women's seed and seedling commercial enterprises. *The aim is to track case histories of successful commercial enterprises and synthesize lessons for supporting other women entrepreneurs, in the frame of diversification of agro-based livelihoods.*
  - Activity 2.2: Integrating the CG's and NARS' public goods outputs in poor people's seed value chains, *exploring how a more effective match can be made between what the formal system offers, and existing seed value chains.*
  - Activity 2.3: Development of methodologies for creating and applying 'good fits' among highly diverse soil mosaics, farmers' seed preferences, and seed supply systems. *This draws on the PRGA Program's experience of multi-stakeholder participation in order to match soil mosaics, farmers' seed preferences and seed supply systems. Previous work on*

'recommendation domains' and 'socio-ecological niches' lay the groundwork; spatial analysis (including GIS and imaging systems, and extending to participatory soil management) offers complementary capacity. The expanding coverage and availability of mobile telephony may offer new opportunities for integration.

- Theme 3: Re-framing Effective Action for Research and Development
  - Activity 3.1: Learning lessons from 'successful' actions. *This builds on ongoing work 'learning from the positive.'*
  - Activity 3.2: Feeding the lessons back into practice.
- Supporting Actions for Gender Mainstreaming
  - Action 1: An annual Gender Research Prize, to stimulate gender research within the CG Centers.
  - Action 2: Policy Briefs, covering the main lessons from the PRGA Program and its partners' work.
  - Action 3: Short Manuals on participatory research and gender research for key research areas within CG Centers' research portfolios.
  - Action 4: Taking stock—carrying out a re-inventory of (a) CG gender research and lessons that can be learned from this; (b) exploring the impact on the research agenda of women scientists in the CG Centers.
  - Action 5: Building advanced capacity within the host Center by (a) helping CIAT to establish appropriate gender indicators in project review procedures and research evaluations; (b) together with staff with participatory and gender research capacity, mentoring one of the new Product Lines (research themes) on incorporating participatory and gender research in their work.

Appendix II: Secondary partners[3]

'Recipients' and 'objects' of *Program* research

- Hill Leasehold Forestry and Forage Development Project, Nepal (IFAD, NGOs, FAO, government)
  - Case study in 'Poverty reduction and social inclusion: Evidence of effective ways of influencing research policy and practice' ('Learning from the positive') project
- Nepalese rice sector (PPB)
  - Case study in 'Learning from the positive' project

Partners within established networks

- PRGA Program listservs
  - CG: CIFOR; CIP; ICLARM; ICRAF; ICRISAT; IFPRI; IITA; ILRI; IPGRI; IWMI; WARDA (i.e. all the Centers)
  - ARI: ACIAR; Centre for Development Research (Denmark); CIRAD; CSIRO; Department of Rural Development Studies (Sweden); FAO; FDS; GTZ; IDRC; ILEIA; JIRCAS; KIT; Louis Bolk Instituut; NRI; ORSTOM; Swiss Agency for Environment, Forests and Landscape; USDA
  - Donors: EC/EU; IFAD; UNDP; World Bank; WorldVision Canada
  - Governmental/NARS: numerous
  - NGO: numerous

[3] For major R&D partners, *see* Project Narrative.

- University: numerous
- SRO: ASARECA
- Private: companies; individuals.

Potential future partners

- 'Learning from the positive' project:
  - CIP, ICARDA (PPB), ICRAF, ILRI
- Theme 1 – PPB:
  - ICARDA, INRA, CSOs (CWANA)
  - IPGRI, NARS, CSO (Asia)
- Theme 2 – Planting material institutions:
  - FARA, ASERECA, CORAF, SADDCC, CIAT, ICRISAT, WARDA, CIMMYT
  - The Clinton Foundation, the Volkswagen Foundation and the African Women's Development Fund
- Theme 3 – Re-framing effective action:
  - IFAD and ASARECA
- Gender-mainstreaming supporting actions
  - Regional Development Banks (AfDB, ADB, etc.)
- *This list will grow as new staff take post and work-plans are built around the new strategy.*

CIAT PRGA PRODUCT LINE PA-3: PARTICIPATORY RESEARCH AND GENDER ANALYSIS (PHASE III) DRAFT 2008–2010[4]

	Outputs	Intended users	Outcome	Impact
OUTPUT 1	New Developments in Participatory Plant Breeding • Development or application of new methods within participatory plant breeding (PPB) for maximizing the use of agro-biodiversity • PPB to support the broadening of the genetic base of poor people's crops • PPB as an implementation tool for farmers' rights	Plant breeders (CGIAR, NARS), farmers	Plant breeders adopt and adapt good-practice methods in PPB, thereby identifying adapted varieties for specific farming contexts	Improved farming community livelihoods from increased income (from better varieties and reduced risk)
Output Target 2008	• Researchable topics identified by stakeholders (through 4th PRGA International Seminar)			
Output Target 2009	• Effective methods for PPB verified, documented and disseminated			
Output Target 2010	•			

[4] *Given the fact that the new strategic platform was only developed in early 2007, the consequent needs to raise donor support, current efforts to restructure the Program, and the tardiness of the 4th International Seminar on PR and GA, this logframe is necessarily preliminary. New staff will have R&D ideas that will feed into the MTP, logframe and work-plans in due course.*

	Outputs	Intended users	Outcome	Impact
OUTPUT 2	Institutional Innovations in Africa's Seed and Seedling Revolution • Learning from women's seed and seedling commercial enterprises • Integrating the CG's and NARS' public goods outputs in poor people's seed value chains • Development of methodologies for creating and applying 'good fits' among highly diverse soil mosaics, farmers' seed preferences, and seed supply systems	CG Centers, NARS, extension services, other development actors, seed entrepreneurs, farmers	Seed sector uses knowledge to target appropriate varieties to farmers in timely manner; Farmer seed-growers supply seeds of adapted varieties of self-pollinated crops to own communities	Farmers have easy access to seed of varieties adapted to their farming systems
Output Target 2008	• Researchable topics identified by stakeholders (through 4th PRGA International Seminar)			
Output Target 2009	• First seed enterprise case study analyzed and results disseminated • First analysis of integration of varieties into seed value chains disseminated • Methodology for 'good fit' of soil type, variety preference and seed system available			

	Outputs	Intended users	Outcome	Impact
Output Target 2010	• Second seed enterprise case study analyzed and results disseminated			
OUTPUT 3	Re-framing *Effective Action* for R&D • Learning lessons from 'successful' actions which involve incorporating PR and GA methods • Feeding the lessons back into practice	CG Centers, NARS	Re-framing of PR & GA by CG Centers and NARS on basis of lessons learned	More effective targeting of the needs of the poor by the CGIAR institutions
Output Target 2008	• Researchable topics identified by stakeholders			
Output Target 2009	• 'Learning from the positive' case studies analyzed and results disseminated			
Output Target 2010	• PPB impact studies analyzed and results disseminated			

	Outputs	Intended users	Outcome	Impact
OUTPUT 4	Supporting Actions for Gender Mainstreaming	CG Centers, NARS, NGOs	CIAT and other direct beneficiaries have mainstreamed GA, thus routinely take gender issues into consideration at every level of project planning, implementation and assessment; Indirect beneficiaries mainstream GA, using PRGA publications as source material	All social groupings benefit from implemented research (e.g. women, ethnic minorities)
Output Target 2008	• Annual Gender Research Prize is established (to help stimulate gender research within the CG Centers) • Main lessons in PR & GA summarized in *Policy Briefs* and disseminated • Methods for PR & GA in key CG research areas compiled into *Manuals* and disseminated • CIAT has appropriate gender indicators in project review procedures and evaluations			

	Outputs	Intended users	Outcome	Impact
Output Target 2009	• Inventory of CG gender research completed, analyzed and disseminated • Main lessons in PR & GA summarized in *Policy Briefs* and disseminated • Methods for PR & GA in key CG research areas compiled into *Manuals* and disseminated • PR and GA mainstreamed in one CIAT Product Line • Dissemination of IDRC-funded WOCAN project results			
Output Target 2010	• Findings from an exploration of the impact of women scientists on the CG research agenda are analyzed and disseminated • Main lessons in PR & GA summarized in *Policy Briefs* and disseminated • Methods for PR & GA in key CG research areas compiled into *Manuals* and disseminated			

CIAT Bean Product Line SBA-1: Improved Beans for the Developing World

Common bean germplasm and technologies that improve food security and income of poor producers, and health of bean consumers

Narrative Project Description

Rationale & Changes

Rationale:

The common bean (*Phaseolus vulgaris* L.) is the world's most important grain legume for direct human consumption. Its total production exceeds 12 million MT, of which 7 million MT are produced in tropical Latin America and Africa. Beans are the "poor man's meat" and are particularly important in the diet of the underprivileged. Beans, like other legumes, supply proteins, carbohydrates, vitamins and minerals, and complement cereals, roots and tubers that compose the bulk of diets in most developing countries.

Common bean is also one of the most diverse crops in terms of its cultivation methods and its uses. It serves as mature grain, as immature seed, and as a vegetable (both leaves and pods), and after harvest the stover is used as animal fodder. It is cultivated from sea level up to 3000 masl in monoculture, in association, or in rotations. The possibility of obtaining a harvest in as little as two months offers quick income, quick food supply, and also permits rotating with other crops or inter-planting among fruit trees or coffee before the primary crop produces income. At the other extreme are the aggressive climbing beans that subsistence farmers maintain in the garden for food security and continual harvest over a six month period.

Apart from subsistence cultivation, beans have become increasingly commercial over the past thirty years in national, regional and international markets. In Central America beans are the #1 income generator among the traditional field crops. In Africa farmers tap into regional bean markets in Nairobi, Kinshasa and Johannesburg. With the onset of globalization, the past decade has seen a growing international market that is now reported to reach 2.4 million MT. This heightens issues of equity for the small bean producers that have little other stable source of income, but some also see this as an opportunity. For example, bean represents 6% of external income for Ethiopia, and small farmers in Bolivia produce the large white and red mottled classes for export. Snap beans are a high value, labor intensive crop of small farmers in Kenya and the Andes.

Besides the common bean, another four cultivated species are conserved in the CIAT gene bank, as well as wild relatives. This collection is the largest of the genus in the entire world, representing more than 35,000 accessions that have been declared as part of the designated collection before FAO. These other cultivated species fill niches that are unsuitable for the common bean, for example, *P. acutifolius* that thrives in desert environments.

Our primary mission is to contribute to household and global food security by assuring an adequate supply of beans as a culturally acceptable and traditional staple; and to improve

the income of small bean producers of Latin America and Africa, by making bean production more profitable. We also seek to improve human nutrition, both by augmenting the supply of beans, and by improvement of their nutritional value.

Our outputs are designed to respond in particular to the needs of small, resource-poor bean farmers in Latin America and Africa. Thus, we seek to create solutions to biotic and abiotic production limitations that require minimal inputs, and in the case of improved germplasm, with good market potential. **Our research strategy** focuses on the exploitation of the vast genetic resources of bean that exist as a complex array of major and minor gene pools, races and sister species. CIAT's gene bank with 41,000 accessions of common bean and related species is our most unique resource, and has been the source of genes for disease and insect resistance, abiotic stress tolerance, nutritional quality and yield potential. Most traits are still selected by conventional means in field sites (in some cases backed up by greenhouse evaluations) where most important diseases, edaphic constraints and drought can be manipulated for purposes of selection. However, Marker Assisted Selection (MAS) is employed selectively but strategically, in most cases for disease resistance genes. CIAT pioneered participatory selection with farmers and this practice is being extended and systematized. While most outputs are seed based, others involve agronomic practices or are knowledge based. Our research is strategic combined with both basic and applied elements, as called for by the particular challenge.

Changes:
Budgetary adjustments in CIAT will not alter the essential priorities nor the research strategy of the bean project, but output targets will be delayed somewhat in relation to previous predictions. Thus the timescale for output targets has been lengthened. However, outputs have been restructured to be more client- and product-oriented rather than structured along gene pools as in the past. A modest output target on high value beans has been added in response to demands for more market orientation in dry grain (including both canning and export types), and for snap beans. In the case of dry grain this often implies no more breeding work but rather, the opportune testing of breeding lines for the processing industry.

CG System Priorities:
CIAT's bean project is housed principally under CG System Priority Area 2: Producing more and better food at lower cost through genetic improvements. Efforts are dedicated to improving yields through control of diseases and pests, tolerance to abiotic stresses (drought, aluminum toxicity and low soil fertility in particular), and expanding the adaptation range of climbing beans. The bean project also places heavy emphasis on improvement of nutritional quality, especially through increase in iron and zinc content in the grain. There is potential to contribute to Priority Area 3A: Increasing income from fruits and vegetables, through the improvement of snap beans for both Africa and Latin America. The bean team collaborates with marketing specialists to create varieties with better market potential, including international export markets (Priority Area 5B). Finally, strengthening national institutions (Priority Area 5A) continues to be an important output, both in Africa where novel institutional arrangements and relations have been productive to achieve wide impact, and in Latin America where staff reductions have weakened national

programs. On both continents national programs seek support to incorporate modern selection techniques.

Impact Pathways:

Output 1 (Beans with improved micronutrient concentration that have a positive impact on human health) is targeted to small farmers and poor rural and urban consumers in Africa and Latin America. Targeting is developed in collaboration with nutritionists and with experts in GIS, to address human populations with nutritional deficiencies in iron and zinc. This output involves both small seeded germplasm that is often targeted to warmer climates or more difficult environments in Central America, Mexico, Venezuela, East Africa and Brazil. Large seeded germplasm is usually cultivated in more temperate climates in the Andean zone, the East African highlands and southern Africa, although in the African highlands small and large seeded types overlap, sometimes differentiated by soil fertility gradients within the farm, prevailing biotic constraints and household preferences. Improved germplasm is shared or developed jointly with NARS partners, who supply basic seed to a range of organizations interested in production of seed (local seed companies, NGO's, CBO's, women's groups) who in turn distribute to farmers. NGOs and health workers play a special role in delivery. Benefits accrue to farmers/consumers through stable food supply of more nutritious beans for home consumption, and potentially to poor urban consumers. Assumptions for the successful delivery of these outputs include institutional and financial stability of partners, political stability, and institutional support. The role of CIAT is that of a primary research provider (of improved germplasm), at times a secondary research provider (backing up national bean improvement programs with technical expertise and training), and catalyser (to promote downstream alliances in the uptake chain). This output is complementary to those of CIMMYT and

Beneficiaries of ***Output 2*** (Beans that are more productive under low input agriculture of poor farmers) are in some cases researchers (both inside and outside of CIAT), and in some cases are bean producers. For example, molecular markers for resistance genes benefit researchers directly, and farmers indirectly as subsequent beneficiaries. Uptake pathway for such methodologies is direct communication through workshops and courses, and indirectly through publications, leading to benefits of more efficient and effective bean research. This assumes that partners are in a position to implement such technologies. On the other hand, crop management practices are of direct benefit to farmers as users, potentially across all bean ecosystems. Uptake chain for agronomic practices are similar to those for seed based technologies; results are communicated to NARS and other partners (NGO's, CBO's etc) who have successfully diffused practices to farmers, to the benefit of farmers who enjoy more stable productivity. Improved germplasm is diffused through many of the same channels as beans with improved nutritional value, with the exception that partners may have less specific interests, and may be more production oriented. The role of CIAT is that of primary source of research for development.

Output 3 (Beans that respond to market opportunities) benefit small farmers in both Latin America and Africa. Farmers in Ethiopia have already benefited from tapping into export markets for canning beans, and other countries are positioning themselves to follow suite. In Central America exporters are seeking to fill a niche created by the Latin population in

the USA. This is a demand-driven activity, and in large part has generated its own impact pathway. Exporters and international grain buyers have established market chains that give them access to export quality beans. CIAT's role has been that of supplying germplasm in some cases, and in others to facilitate communication, and to give support in seed systems to avail quality seed to farmers of very specific varieties.

Output 4, (Strengthened institutions that enhance product quality and delivery) seeks to benefit partners at multiple levels through facilitated interaction, including farmers who are at the end of the organizational chain. NGOs, government extension agencies, farmer organizations, local seed companies, and non-conventional seed actors such as women groups, people living with HIV/AIDS and tobacco companies all participate and benefit. The output will generate impact on target beneficiaries through their participation in development of innovations, knowledge and technologies in strategic alliances with multidisciplinary research teams and NGOs. Scaling out of innovations and best practices to areas with similar environments will be done through strategic alliances of research and development actors. The latter will use their network and other communications mechanism to adapt knowledge and results relevant to them. Scaling up regionally and internationally will be done through international NGOs, advocacy, and communication. The outcome is enhanced communication and complementarity of actors with resulting cost efficiencies, and in the case of technology diffusion, increased and diversified adoption. Another dimension of this output is support to NARS in development of projects, benefiting national program researchers and with the outcome of their integration into the research project mode. This assumes a degree of consistency in partner personnel, while CIAT's role is that of facilitator.

International Public Goods:

The IPG of the bean project include:

- Improved germplasm with biotic and abiotic stress tolerance, and/or enhanced nutritional value, drawing upon the genetic resources of CIAT's extensive gene bank, pathogen isolate collections, and 30 years of experience in bean improvement. CIAT's geographical position and access to varied altitudes and research sites facilitates study and selection of germplasm.
- Improved practices for the management of pests and diseases, including monitoring of pathogen populations with modern molecular tools developed at CIAT.
- Knowledge and tools that contribute to the development and implementation of the above IPG's. For example, molecular markers for useful traits, developed with CIAT's in-house resources of genetic maps and markers. Knowledge of the structure of genetic resources housed in the gene bank, and ways to exploit them. Screening methods to identify biotic and abiotic stress resistant genotypes. Participatory breeding methods with varying degrees of involvement of farmers, traders and other key actors.
- Methods for networking, both formal among official sector researchers, and less formal among a broader range of partners, with special emphasis on research partnerships and on effective and sustainable seed systems reaching a large number of households.

Partners:
Most important partners and the respective person-years of professionals dedicated to bean research within the (several) outputs are:

Output 1: NARS in Latin America, including those of Mexico (6), Guatemala (2.5), Honduras (2, including EAP-Zamorano), El Salvador (2), Cuba (2), Brazil (4) participate in the AgroSalud project to improve nutritional quality and productivity of bean, while Venezuela (2) and Bolivia (2) have participated in a similar project funded by FONTAGRO (the latter ending in 2007). NARS in South America, including those of Colombia (5 between university staff, an NGO and the NARI), Bolivia (4 between university staff and a foundation) collaborate in the improvement of disease resistance of Andean bean with better nutritional quality under the AgroSalud and FONTAGRO projects. NARS in East, Central and Southern Africa, including those of Kenya (5), Rwanda (6), and Uganda (5) Tanzania (4) are partners in the improvement of nutritional qualities in large seeded Andean beans. Linkage funds finance a project with one Canadian university, and with a partner in USDA.

Output 2: Nicaragua (4.5) is a partner in breeding for drought tolerance. NARS in East, Central and Southern Africa including those of Ethiopia (3), Rwanda (4), Malawi and DRCongo (4), participate in the improvement for low soil fertility, productivity and drought. The University of Hannover, Germany participates in a project for transformation methods of bean to improve drought tolerance (2), and in a second project, seeking to define physiological mechanisms of aluminum tolerance and drought resistance (2), which also includes Malawi (2) and Rwanda (4). Catholic University of Leuven (3) is a partner to improve nitrogen fixation technology. NARS in South America, including those of Colombia (5 between university staff, an NGO and the NARI), Bolivia (4 between university staff and a foundation) collaborate in the improvement of disease resistance of Andean bean. NARS in East, Central and Southern Africa, including those of Kenya (5), Rwanda (6), and Uganda (5) Tanzania (4) are partners in the development of disease resistance, medium altitude climbing beans (MAC), and productivity in large seeded Andean beans. NARS in Honduras (Zamorano) (1), Colombia (2), Uganda (3), Rwanda (4), share in the use of markers for MAS, especially for resistance. South Africa (3) participates in pathogen characterization, evaluation and validation of resistance sources. Agriculture and Agri-Food Canada (AAFC) is a partner in diagnosis and characterization of soil borne pathogens (especially *Pythium* species) using molecular techniques, and development of molecular based diagnostic assays for soil borne pathogens.

Output 3: Partners in Latin America with specific attention to breeding market quality include NARS in Honduras and Nicaragua. NARS in Africa with active participation in canning beans include those of Ethiopia and Uganda. Partners in the development of snap beans include a university in Colombia, one in Kenya, and potentially a private company in Guatemala.

Output 4: NARS as above –plus a wide range of NGOS, CBOS, farmers' groups, women's groups, –totaling over 300 direct-link partnerships, to make users aware of technologies and to get these technologies widely disseminated.

The ECABREN and SABRN bean networks coordinate nine NARS in East Africa and ten NARS in southern Africa, respectively. These networks participate in Outputs 1, 2, 3 and 4 with input from African NARS cited above, plus NARS in Burundi (3), Sudan (2), Zambia (1), Zimbabwe (1), Mozambique (3), Lesotho (3) and Swaziland (3).

HarvestPlus Challenge Program: IFPRI, CIMMYT, and CIP are immediate collaborators in the CP and the AgroSalud (Latin American) nutritional improvement project, working in the same agro-ecological zones, while ICRISAT, IITA, IRRI, and ICARDA are indirect collaborators under HarvestPlus. ECABREN and SABRN networks in Africa also participate in HarvestPlus.

Generation Challenge Program: Partners include EMBRAPA-Brazil (2), INTA-Cuba (1), Pairumani (an NGO) in Bolivia (2), National University in Colombia (2).

Sub-Saharan Africa Challenge Program: ICIPE, AHI and NARS in Rwanda, Uganda and D.R. Congo are immediate partners.

Project Funding:

Budgeting 2006-2010

Year	2006 (actual)	2007 (estimated)	2008 (proposal)	2009 (plan)	2010 (plan)
US Dollars (millions)	6.276	7.333	6.768	6.831	6.897

CIAT BEAN PRODUCT LINE SBA-1: IMPROVED BEANS FOR THE DEVELOPING WORLD (2007-2010)

Targets	Outputs	Intended user	Outcome	Impact
OUTPUT 1	Beans with improved micronutrient concentration that have a positive impact on human health	NARS, farmers & consumers in Central America, the Caribbean, Brazil, East and Southern Africa	Adoption of improved varieties by farmers	Better nutritional status, especially of rural consumers
Output Targets 2008	• ~30 small seeded F3-derived F5 bush bean families developed with tropical adaptation, 60% more minerals, abiotic stress tolerance, and 2 biotic resistances for Central America (HarvestPlus)	• NARS, NGO's CBO's, health workers, and farmers in target countries	• Farmers incorporate high mineral and disease resistance lines into diverse production systems	• Reduced levels of iron and zinc deficiency in bean consumers
Output Targets 2009	• 50 improved lines with varietal potential and 90 ppm iron (ie, 80% more iron) • 15 new large seeded climbing beans with high mineral trait (HarvestPlus) • Marker assisted selection for one nutritional trait (iron) tested	• NARS, NGO's CBO's, health workers, and farmers in target countries	• Adoption of micronutrient rich beans	• Reduced levels of iron and zinc deficiency in bean consumers
Output Targets 2010	• Four fast track micronutrient dense bean varieties disseminated and promoted in two countries in eastern and southern Africa • Two large seeded lines with 50% more iron enter formal varietal release process in eastern Africa	• NARS, NGO's CBO's, health workers and consumers	• Adoption of micronutrient rich beans	• Reduced levels of iron and zinc deficiency in bean consumers
OUTPUT 2	Beans that are more productive in smallholder systems of poor farmers	Breeders and pathologists in CIAT and NARS; farmers in E and S Africa, Andean zone, Caribbean	Adoption of improved varieties by farmers; Best bet IDPM practices and genetic combinations for stable resistance deployed.	More stable production, food availability and income

Targets	Outputs	Intended user	Outcome	Impact
Output Targets 2008	• 5 molecular markers for detection, diagnosis and diversity studies of ALS and anthracnose pathogens made available • At least 10 lines in major market classes combining resistance to Pythium root rots, BCMV and angular leaf spot • An IPM system for whiteflies on snap beans refined and promoted in 2 major bean producing areas of the Andean zone	• NARS, NGO's and farmers' groups • CIAT and NARS breeders • NARIs researchers in LAC, Africa, IARCs	• Disease and pest characterization tools adopted by researchers • Adoption of disease resistant lines in marginal environments • Increased utilization of integrated management approaches.	• Improved food security, & income. • More stable disease resistance in advanced lines leads to stable yield
Output Targets 2009	• An IDM system for bean root rots implemented and promoted in 2 major bean producing countries in Africa • At least 40 lines combining drought resistance with resistance to BCMNV, root rots, and/or ALS available for testing in Africa • 2 molecular markers linked to ALS and Pythium root rot implemented in MAS	• NARS breeders, NGO's, CBOs, and farmer groups • NARS pathologists,	• Resistant lines incorporated into improved systems • Drought resistant lines with disease resistance used in drought prone areas in Africa • Breeders improve efficiency of genetic improvement	• Reduced yield losses from ALS, root rots and drought
Output Targets 2010	• Resistance genes for anthracnose or ALS introgressed into 5 BCMNV resistant climbing beans • At least 10 genotypes combining drought resistance with aluminium resistance available for testing in Africa	• NARS breeders, NGO's, CBOs, and farmer groups • NARS soil scientists and agronomists	• Farmers benefit from yield stability of high yield climbers • Farmers benefit from stable yields in marginal areas	• Improved food security, & income.

Targets	Outputs	Intended user	Outcome	Impact
OUTPUT 3	Beans that respond to market opportunities	NARS in Africa and Latin America	Adoption of commercial varieties by farmers, enhancing access to markets	Higher income, especially for the poor and women farmers
Output Targets 2008	• 10 lines of snap beans with confirmed resistance to Gemini virus in Colombia • 1 variety released in Nicaragua for export market	• NARS, NGOs, CBOs, farmer groups, seed producers	• Farmers reduce pesticide use, assuring production and profitability	• Less pesticide intoxication in rural communities and urban consumers • Increased production and incomes.
Output Targets 2009	• At least 3 snap bean lines with resistance to rust and quality characteristics preferred in regional and export markets for Africa. • 4 bean genotypes with very high commercial or export quality made available to farmers in 4 countries in Latin America and Africa	• NARS, NGOs, CBOs, farmer groups, seed producers	• Adoption of snap bean and reduced chemical use. • Farmers in marginal environments assure market access	• Increased production and incomes.
Output Targets 2010	• 5 canning bean lines with acceptable quality characteristics in yield trials in two countries in eastern Africa	• NARS, NGOs, CBOs, farmer groups, seed producers	• Farmers improve yields and quality of product with improved varieties	• Increased production and incomes.
OUTPUT 4	Strengthened institutions that enhance bean product development and delivery	NARS in Africa and Latin America	Improved institutional performance by NARS, NGOs and other partners, reflected in more effective technology development	More stable production, improved food availability, income and nutrition, especially for the poor and women farmers

Targets	Outputs	Intended user	Outcome	Impact
			and dissemination	
Output Targets 2008	• One comprehensive methodology developed for assessing seed security and targeting responses in acute and chronic stress situations. • Lessons from 3 case studies (approaches for partnership; capacity building; alternative seed delivery systems) of strategies for product development and delivery in PABRA analyzed. • Protocols developed and adapted to facilitate application of MAS for disease resistance in 3 African countries • Breeding programs for higher iron levels established in Honduras, Nicaragua, Bolivia, Venezuela, Kenya and Malawi	• NARS, NGOs, CBOs, farmer groups, seed certification agencies, seed producers • UN, humanitarian and post-stress recovery organizations • PABRA	• Frameworks and methodologies for seed systems, PM&E, and MAS are in use by PABRA partners	
Output Targets 2009	• A guide for mainstreaming and sustaining wider impact, developed and recommendations availed for 5 countries in East, Central and 4 countries in Southern Africa • Three delivery channels strategies tested for reaching the poor and in marginal areas with new variety innovations and information • At least 1 methodological frameworks/strategies for testing and evaluating multi-stakeholder networks and	• NARS, NGOs, Decentralized Local Governments, CBOs, farmer groups, seed certification agencies, seed producers ,agro-processors, local financial institutions • UN, humanitarian and post-stress	• Increased partner involvement in accessing technologies to a greater number of end users • Increased capacities of partner organizations / institutions to develop and promote integrated and	

Targets	Outputs	Intended user	Outcome	Impact
	platforms (between private-public) for facilitating decentralized targeting for pro poor impact. • Capacity to evaluate root systems in soil tubes established in Honduras and Nicaragua	recovery organizations •	decentralized strategies for reaching pro-poor farmers	
Output Targets 2010	• Elements of Pro-poor seed delivery and production systems confirmed and such pro-poor seed enterprises established in 2 PABRA network countries. • One strategy for wider utilization of non varietal bean technologies (IPM; soil management) developed and widely shared in 4 countries in Africa	• NARS, NGOs, CBOs, farmer groups, seed certification agencies, seed producers		
OUTPUT 5	More than 35,000 accessions are conserved, documented and available for distribution	Breeders, geneticists, and other bean scientists; national gene banks	Bean genetic resources are used directly or employed in breeding programs	More stable production, improved food availability, income and nutrition
Output Targets 2008	• 1500 accessions conserved in long term storage and in back-up in CIMMYT • 1000 samples of bean seed distributed	• Bean scientists; other gene banks	• Novel genes incorporated into breeding programs	
Output Targets 2009	• Another 1500 accessions conserved in long term storage and in back-up in CIMMYT • Another 1000 samples of bean seed distributed • A plan formulated to establish a database of evaluation data	• Bean scientists; other gene banks	• Novel genes incorporated into breeding programs	

Targets	Outputs	Intended user	Outcome	Impact
Output Targets 2010	• Another 1500 accessions conserved in long term storage and in back-up in CIMMYT • Another 1000 samples of bean seed distributed	• Bean scientists; other gene banks	• Novel genes incorporated into breeding programs	

CIAT Cassava Product Line SBA-2: Improved Cassava for the Developing World

Cassava varieties, production systems and technologies for competitive and sustainable production and processing resulting in improved food security and higher income to farmers and rural communities.

Narrative Project Description

Rationale & Changes

Rationale:

Cassava is a very rustic crop that grows well under marginal conditions where few other crops could survive. Most cassava varieties are drought tolerant, can produce in degraded soils, and are resistant or tolerant to several of the most important diseases and pests. The crop is naturally tolerant to acidic soils, and offers the convenient flexibility that it can be harvested when the farmers need it. These characteristics make this crop a fundamental food security component in marginal agriculture lands. In addition to its important role in subsistence farming and food security, cassava is acquiring an increased role in rural development as raw material for many processing pathways. The most important industrial uses of cassava are as a source of energy in animal diets in the feed industry, for the starch industry and, more recently, for the production of ethanol.

Cassava research at CIAT has traditionally focused in high and stable productivity through breeding and adequate cultural practices, which remains a fundamental goal for the varieties to be grown by resource-limited cassava farmers. However, there is an increasing interest in cassava as cash crop and its processing from households up to large industrial facilities, which not only require high and stable productivity but also would benefit from specialty cassava with specific properties. Unfortunately, very little effort has been made to make a qualitative improvement of cassava to better fit the needs of the different industries. The globalization of economies and new technological breakthroughs are offering a unique opportunity for cassava not previously available to the crop. Tropical production of maize is facing increasing problems in competition with maize from temperate regions. This situation has prompted government and private sectors of many tropical countries to turn to cassava as a competitive alternative to imported maize. In addition, advances in molecular biology, genetic engineering, plant-tissue culture protocols and starch technologies provide important tools that will allow bridging the main technological gaps between cassava and the cereals.

Our primary mission is to contribute to household and global food security in societies where cassava products are an important and traditional staple; to improve the income of farmers, rural communities and processing facilities; and to develop and promote sustainable production and processing systems. Our outputs are designed to adapt to the rapidly changing economic environment for cassava and cassava farmers and communities that produce and/or process it. Cassava research at CIAT is aware of the cultural and ecological differences, challenges and opportunities that cassava offer in

Latin America and the Caribbean (LAC), Asia and Africa regions. There are three main approaches that have been implemented to face the new opportunities and challenges for cassava in the third millennium, which are described below.

More efficient breeding scheme. For cassava to remain competitive, a more efficient breeding scheme, particularly for low heritability traits such as yield, has been implemented. Changes introduced ranged from simple approaches such as the stratification of evaluation trials all the way to sophisticated molecular approaches such as marker -assisted selection for resistance to the Cassava Mosaic Disease, which is not present in the Americas. In addition, cassava gene pool is still largely unknown and needs to be further screened for an adequate exploitation of its genetic variability. Therefore an aggressive approach to screen the germplasm collection has been implemented.

Qualitative traits. In addition to changes for a more efficient breeding system for quantitative traits, CIAT has shifted the objectives of cassava research to produce high-value cassava based on qualitative traits. The HarvestPlus program will produce clones with enhanced nutritional value particularly in relation to carotenoids. For the animal feed industry and human nutrition, increased protein content is the main objective. For the starch industry novel starch types are of huge economic relevance. Different strategies have been implemented to develop these novel types. As a proof of concept, the long sought after mutation for a waxy cassava starch has recently been found. For the production of bioethanol we are searching for a "sugary" cassava and other mutations that will reduce the costs of the fermentation process. Several promising mutations have been found and will be evaluated for their ethanol producing characteristics.

Sustainable and competitive production. Cassava cultivation can lead to negative impact on the environment because it is typically grown in marginal environments, which are more susceptible to degradation; because it is grown by resource-limited farmers that have little flexibility or capacity to introduce sound agronomic practices because they increase their production costs; and because of the scarcity of research in developed countries that may contribute to a more sustainable production of cassava. CIAT and the valuable intervention of CLAYUCA are conducting research to reduce the negative impact that cassava cultivation may have on the environment. This research has been particularly important in Asia where the introduction of contour hedgerows has been successful. In addition certain processing activities (such as starch extraction and modification) can have a negative impact on the environment, which in some cases can be reduced through research conducted at CIAT.

Changes:

The new opportunities opened to cassava along with budgetary constraints have led the cassava product line at CIAT to reduce emphasis in world-wide breeding and emphasize more strategic pre-breeding activities developing high-value genetic stocks that can be efficiently developed in spite of limited resources.

CG System Priorities:

CIAT's cassava project is housed principally under Priority area 2 (Producing more and better food at lower cost through genetic improvements). All the priorities listed within this area are considered by the project: Maintaining and enhancing yields and yield potential of food staples; Improving tolerance to selected abiotic stresses (in our case particularly drought, low-fertility soils and acid soils); Enhancing nutritional quality and safety (specifically cassava roots with enhanced protein, carotenoids, Fe and Zn); and genetically enhancing selected high-value species. The last priority somewhat relates to the concept of high-value cassava such as the development of what is basically a "new crop" such as a clone whose starch contains almost no amylose (waxy starch).

The cassava project is also connected with Priority Area 4 (Promoting poverty alleviation and sustainable management of water, land and forest resources). The cassava project has conducted extensive research for the last decade and a half to promote sustainable production of cassava in Asia, particularly on sloped land. The main emphasis has been promoting adequate fertilization and the use of hedgerows to prevent soil erosion. These activities can be seen as related to priority 4D (Promoting sustainable agro-ecological intensification in low- and high-potential areas). Our efforts to develop high-value clones relate to priorities 5B (Making international and domestic markets work for the poor); and 3B (Increasing income from livestock), for instance through the development of clones with enhanced nutritional value. Cassava research at CIAT promotes conservation and characterization of staple crops (1A) and the conservation and characterization of underutilized plant genetic resources (1B).

Impact Pathways:

One major competitive advantage that CIAT has is the benefit of the Manihot collection with about 6500 accessions including about 200 accessions from wild relatives ***(Output 1)***. Manihot gene pools has been poorly screened and insufficiently exploited so far. Therefore the access to this wealth of genetic variability remains an important asset for CIAT, which is expected to benefit several of the outputs described below. Landraces of *Manihot esculenta* and other Manihot species proved to be important sources of high-value traits (such as high-protein in the roots), tolerance to abiotic (such as post-harvest physiological deterioration and drought) and biotic stresses (whiteflies, CMD, etc.) and they will be incorporated and delivered through the different product lines described herein.

Output 2 (Genetic stocks adapted to the most common cassava growing environments and their abiotic stresses, with emphasis in drought.) describes the traditional breeding activities conducted by the project. A significant change in this activity has been the recent introduction of high-value traits in the list of objectives and this creates a connection with Output 3. These two outputs ultimately involve the same end-users but with varying emphases: national research programs; the processing sectors; cassava farmers and rural communities; and production chains. Whereas this is true for Asia and LAC, in the case of Africa, we have the strategic presence of IITA.

Output 2 involves the development of improved germplasm to be shared, typically through NARs and IITA, with cassava farmers. Because of the diversity of environments where cassava is grown and the frequency of different production constraints, this germplasm has to have specific traits that allows it to adapt to these conditions characterized by biotic and/or abiotic stresses. The main outcome for this Output is the consolidation and strengthening of cassava based agriculture by developing a germplasm that will allow for a high and stable productivity. A competitive production of cassava is a key factor to be able to compete with other commodities, typically (imported) maize. The competitiveness of cassava can be increased considerably with the introduction of high-value traits, which is the main objective of the third output. Germplasm is shared through direct shipment of *in vitro* plants from outstanding clones identified in CIAT's breeding activities in the sub-humid, acid soils, or mid-altitude valleys environments. CLAYUCA has greatly facilitated the distribution of elite cassava germplasm through its stakeholders. In addition CIAT routinely produces and ships thousands of botanical seeds to NARs and IITA, who initiate evaluation and selection schemes with this seed. Assumptions for the successful delivery of these outputs include institutional and financial stability of partners, political stability, and institutional support. It is always a matter of concern the phytosanitary restrictions for the shipment of plants in vitro. The African Cassava Mosaic Disease is not present in the Americas. If the disease (or a similar one) appeared in Colombia, the shipment of germplasm *in vitro* would be greatly hampered. The role of CIAT is that of a primary research provider of the improved germplasm. It is important to emphasize that, at times, our role is of secondary research provider exploiting traits or elite germplasm developed (and generously shared) by NARs. *Manihot esculenta* originated and was domesticated in the region where CIAT is located. Consequently most pest and diseases have co-evolved with cassava in the region. This implies that CIAT has to be extremely cautious in the process of shipping germplasm outside the region by a thorough indexation process to prevent the shipment of pathogens and/or pests as well.

Output 3 (Clones with high-quality traits for food, feed, starch and ethanol industries identified or bred) is closely associated with output 2. The end-users are national research programs; the processing sectors; cassava farmers and rural communities; and production chains. The emphasis, however, are the processing sectors and production chains. New actors that are particularly important for this output are universities and the private sector in developed and developing countries. A good example of the economic relevance of the outcomes of this output is when cassava is used as source of energy in animal feed. Its price cannot be higher than 70% of the price of maize. This is because of the lower protein content in the roots. A cassava clone with 8% protein in their roots (dry weight basis) would make the value of that root similar to that of maize (provided the quality of the protein was similar). The immediate consequences of deploying such cassava germplasm would be that the income of farmers will increase; the feed industry will be more interested in incorporating cassava roots in their feeds; and because there is an intermediate process (drying the roots) which typically takes place near the production fields, there will be enhanced economic activity in rural communities as well. IITA is an important partner for deploying this high-protein trait in Africa. The pathway to impact of high-value traits related to the starch and bio-ethanol industries can be illustrated by

current negotiation with a consortium of Thai institutions for the development and deployment of a waxy-starch cassava variety adapted to Thailand. The agreement implies a detailed scheme for deploying the germplasm on one hand, and important revenues for the cassava product line at CIAT on the other. Similar situations are envisioned for the bio-ethanol factories such as the ongoing partnership with Petrotesting in Colombia.

Assumptions for the successful delivery of these outputs include institutional and financial stability of partners, political stability, and institutional support. CIAT can be the primary research provider but also may act as secondary provider, if it was a partner who discovered the high-value trait. A key collaborator in this case is EMBRAPA-Brazil because of the wealth of genetic variation found in that country for *Manihot* species. This collaboration may result in a study case for the exploration, analysis and exploitation of Manihot species different from cassava because they have not been included as those with facilitated access in the International Treaty on Plant Genetic Resources for Food and Agriculture. The targeted end-users that will benefit from this output are ultimately the actors of the production chains involved in the production of animal feed (higher nutritional value, particularly the high-protein trait); starches (novel types such as the waxy starch) and ethanol for vehicles (roots that store energy in molecules simpler than starch).

Output 4 (Management of pests and diseases, likely to cause acute problems in large areas planted with cassava) has been an integral part of the cassava research at CIAT since its inception. The ultimate end-users of the results of this income are the farmers that grow cassava. However, the immediate beneficiary may be different. For the exploitation of genetic resistance to pests and diseases the breeding projects from CIAT, IITA and NARs are clearly the first one benefiting from these products. For approaches related to the biological control of diseases and pests NARs can promote their use but farmers can almost immediately benefit from implementing them. In addition to farmers rural communities benefit from the positive impact that these approaches have on the environment and human health, by preventing or reducing the uses of agro-chemicals. These technologies also have a direct impact on the production costs and/or the sustainability of cassava productivity. CIAT's role is as a primary (in some instances as secondary) research provider. An interesting impact from this output could be a benefit to other crops grown in temperate regions. For instance, cassava is one of the few crops susceptible to white flies, which has genetic resistance to this pest. It is conceivable that the genetic source of the resistance can be identified, cloned and transferred to other crops so that an additional tool to control "the pest of the century" becomes available. This output reflects one of the main strengths that cassava research at CIAT has had since its creation: its integral approach. As more cassava is demanded by different processing facilities, larger areas and continuous growth for a constant supply of raw materials will be required. This in turn will certainly result in better conditions for pests and diseases to become more prevalent. An integral approach for cassava production will then become more relevant than ever. It has to be said that one of the challenges that cassava research at CIAT faces is the weakening of our capacities in this area.

One interesting example of pathway to impact related to this output is the commercialization by a private company of different agents for the biological control identified at CIAT for major pests. As for other outputs, IITA is a relevant partner for this activity. Perhaps the best example of collaboration within the CG system is the successful deployment in Africa by IITA of agents for the biological control of the mealybug and mites identified by CIAT scientists and collaborators in LAC.

Output 5 relates to cultural practices and processing approaches for a competitive and sustainable cassava production and/or processing. The expected outcomes are improved yields and more sustainable production in target countries; increased and more stable income for farmers (for example through improved nutrition and health of farm animals fed with cassava roots and foliage especially during the dry season); and more alternatives for the use of cassava products open to farmers. A key activity is the promotion of adequate fertilization practices and the use of hedgerows to prevent soil erosion in sloped land. NARs are also beneficiaries because the participatory methodologies employed were introduced through this project and is now used for other purposes in the region. The focus of this output has gradually changed over the years. Whereas prime agriculture areas (for cassava standards) of Thailand were the target ten years ago, now the project concentrates in more marginal environments and resource-limited farmers in Cambodia, Laos and East Timor. CIAT's role is as a primary (in some instances as secondary) research provider. Because of the very nature of this output, CIAT's role can also be envisioned as an advocate or catalyst for the development and deployment of sound agricultural practices. Assumptions for the successful delivery of these outputs include institutional and financial stability of partners, political stability, infrastructure, and institutional support. In the particular case of our operations in Asia, we are through an inter-phase because the scientist that has been working in cassava research during the last 20 years is close to retirement and a replacement (and the resources required for the position) will soon be needed. This output also relates to the activities conducted by CLAYUCA (Latin American and the Caribean Consortium on Cassava Research and Development), which result in a productive and close collaboration between the two research groups. The main outcome related to this interaction is the efficient adaptation and/or promotion of technologies and products developed by CIAT by CLAYUCA. The strategic positioning of CLAYUCA as a bridge between CIAT and NARs associated with CLAYUCA has been of great help in making these technologies and products available to NARs. In this regard, therefore, CLAYUCA has been a key partner in the pathway to impact.

Output 6 (New breeding tools: genetic transformation, use of molecular markers, rapid multiplication and production of doubled-haploids) is closely linked to most of the previous outputs. For cassava to remain competitive, efficient breeding methods need to be developed and implemented. The intended users of this output are mostly NARs involved in cassava research. Eventually processing companies will make a significant jump and start using some of the technologies developed at CIAT. This is the case, for example, of starch companies in Colombia, Nigeria and South Africa, implementing rapid multiplication methods (including tissue culture protocols) for the production of clean planting material of elite germplasm. The product of this output is knowledge,

which is shared with the intended beneficiaries through scientific publications, training courses, conferences and presentations at scientific meetings. An important vehicle is personal communication through internet, including CIAT Webpage. The products of this output range from introduction of inbreeding in cassava genetic enhancement, the development of a protocol for the production of doubled-haploids; the identification and use of molecular markers, tissue culture protocols for rapid multiplication and exchange of cassava germplasm, protocols and gene constructs for the genetic transformation of cassava. The outcomes of this output will be more efficient breeding system that will allow cassava to remain competitive in the global markets, but also a subtle consequence will be the stimulus for cassava breeders that a new era of advanced technologies has arrived for cassava. This is important because cassava is typically an undervalued crop within the NARs systems.

The role of the cassava project at CIAT in relation to the fifth output is mostly as primary research provider. Because of the strong links with partners there is a flow of information among us and, therefore, our role may also be of secondary research provider exploiting ideas developed by IITA and NARs. In the case of the activities related to the development of a protocol for the production of doubled-haploids there is an interaction with ETH (Zurich/Shanghai). CIAT role can also be to catalyze the promotion and incorporation of new ideas into cassava genetic improvement. Doubled-haploids are a promising avenue for the rapid production of homozygous cassava, which offers many advantages (identification of useful recessive traits, elimination of genetic load, making possible the implementation of back-cross, facilitated shipment and exchange of germplasm, facilitated genetic studies, etc.) in the genetic improvement of cassava. CIAT has been a pioneering research institution in the area of genetic transformation of cassava and is currently a member of a consortium involving several Advanced Research Laboratories in the USA and Europe to improve and apply this technology for the benefit of the cassava community. In the case of molecular markers, CIAT's role is clearly as a primary research provider. Of particular relevance is the fact that we can now select in Colombia for germplasm that is resistant to a disease not present in the Americas (CMD). This is very important because it facilitates greatly the flow of germplasm from CIAT to Africa, knowing in advance that it will possess a high frequency of clones with the critical trait for their survival in that target environment. Furthermore molecular markers facilitate the pyramiding of genes against the same disease or the accumulation of sources of resistance to different pests and diseases. Therefore, molecular markers are actually facilitating (even creating) a pathway for impact that allows NARs in Africa, as well as IITA, to introgress new genetic variability into their breeding projects.

The last output (Knowledge, training and scientific publications.) is actually systematic and organized consolidation of results produced by the previous outputs. It is mentioned as a separate output to emphasize the commitment of CIAT and CLAYUCA to help cassava researchers, producers and processors world-wide gain access to all products and technologies developed.

International Public Goods:
There are two main types of products developed by the cassava product line at CIAT: knowledge and improved germplasm (including genes and DNA sequences). The project has been successful in writing a large number of research articles describing and sharing the knowledge and discoveries made in our project with the scientific community. The distribution of germplasm is cumbersome because of the phytosanitary restrictions imposed in the movement of in vitro vegetative tissues from country to country. Nonetheless CIAT has been generous and responsible in making the germplasm collection and improved clones available to IITA and NARs. CLAYUCA has played a fundamental role in the introduction of many elite clones to its member countries.

The existence of the world cassava germplasm collection at CIAT offers us a unique situation to screen the germplasm in search of useful traits. It has been from the collection that a unique source of resistance to white flies was found and introduced into Africa. The search of high-value traits finds the collection a valuable source of genetic variability as well. In most cases these traits are readily made available to partners and collaborators. For instance the high-protein trait has been recently shared with IITA. Because of the declining core resources for the genetic improvement of cassava in some cases CIAT may develop strategic alliances with the private sector for their access to specific traits. This is the case of ongoing negotiations with the private sector for the deployment of waxy starch clones in Thailand, Colombia and Brazil. This is done with full knowledge and approval of official institutions in the host countries. This will generate resources that allow us to continue the activities that are considered strategic but that, unfortunately, do not receive the necessary funds from the system.

Partners:
A key partner for IP3 project is CLAYUCA with whom it interacts on a day-to-day basis, complementing or benefiting from its work and presenting join research proposals. This document does not mention specifically all and each one of the activities where CLAYUCA and IP3 collaborate but the reader should be aware of this close partnership.

Africa. IITA in Nigeria is a key partner in the deployment of knowledge and germplasm developed by CIAT in Africa. Since it is another CG Center we prefer not to mention their contributions to the different partnerships. National Research Programs of Africa include those of **Tanzania** (0.5); **Uganda** (0.5); **Kenya**; **Ghana** (0.5); **Nigeria** (0.5); **Mozambique** and **South Africa**. These countries contribute with access to field and laboratory facilities and, within parenthesis, the time of scientists directly involved with collaborative special projects.

Asia. **Thailand**: Department of Agriculture (0.25), Field Crops Research Institute (2) and Kasetsart University. **Vietnam:** Thai Nguyen University (1); National Institute of Soils and Fertilizers; Hue University of Agriculture and Forestry (0.25); and Institute of Agric. Sciences (1). **China:** CATAS – Hainan (0.25). **Laos**: National Agric. and Forestry Research Institute (NAFRI) (1) and Provincial Agric. Forestry Offices (1). **Cambodia**: Cambodia Agric. Research and Developm. Inst. (CARDI) (1); Provincial Dept. Agric. For. Fish (1); CelAgric; C.J Cambodia Co. **India**: CTCRI (0.25). These countries

contribute with access to germplasm, field and laboratory facilities and, within parenthesis, the estimated time of scientists directly involved with collaborative special projects.

Latin America and the Caribbean. **Brazil**: EMBRAPA-CNPMF (2); EMBRAPA-CENARGEN; IAC-Campinas. **Colombia**: CORPOICA (1); National University of Colombia (0.2);. Petrotesting (0.5); **Venezuela**: Agropecuaria Mandioca (0.5); Universidad Central de Venezuela; INIA (0.5). **Cuba**: INIVIT (0.5); and CLAYUCA (2). These countries/institutions contribute with access to germplasm, field and laboratory facilities and, within parenthesis, the estimated time of scientists directly involved with collaborative special projects.

Advanced Laboratories in Developed Countries. Wageningen University in The Netherlands (0.25); ETH – Zurich, Switzerland (1); Ohio State University in USA; Danforth Center (0.5) in USA; Uppsala University in Sweden (0.25); Natural Resources Institute in Enhgland (0.5). Collaboration between CIAT and these Laboratories is in joint projects where a field worker or a post-doctoral fellow is involved.

Private Companies. National Starch Company (USA / UK). AVEBE Starch Company (The Netherlands); Corn Products (Colombia and Brazil) Cassava Starch Manufacturing Mill (South Africa); Nigeria Starch Mill (Nigeria); PETROTESTING (Colombia) (1); DESARGO Ltda (Colombia). In most cases, these companies have been supporting cassava research at CIAT and also benefiting from it. One assistant originally working under CIAT payroll is now paid by PETROTESTING to develop clones adapted to the acid soil environment specifically for the production of ethanol.

Project Funding:

Budgeting 2006-2010

Year	2006 (actual)	2007 (estimated)	2008 (proposal)	2009 (plan)	2010 (plan)
US Dollars (millions)	6.168	6.090	5.691	5.744	5.799

CIAT CASSAVA PRODUCT LINE SBA-2: IMPROVED CASSAVA FOR THE DEVELOPING WORLD (2008-2010)

Targets	Outputs	Intended users	Outcome	Impact
Output 1: Maintenance and distribution of accessions from the germplasm collection.				
Output Targets 2008, 2009, and 2010	Accessions from the cassava germplasm collection maintained	Cassava scientists, breeders, geneticists, cassava networks and consortia, from both public and private sectors, interested in using cassava germplasm directly or in breeding or in other studies	Cassava genetic resources are maintained as insurance for future generations.	High-value traits, resistance and tolerance to pests and diseases and tolerance to the most relevant abiotic stresses (with emphasis in drought) identified and exploited for the benefit of farmers and processors.
Output Targets 2008, 2009, and 2010	Accessions from the germplasm collection made available and distributed to users following international standards.	Cassava scientists, breeders, geneticists, cassava networks and consortia, from both public and private sectors, interested in using cassava germplasm directly or in breeding or in other studies	Genetic resources are better known and used. Breeders indentify genes they need for improvement. The entire cassava chain use germplasm better adapted to agronomic and market conditions	Through better cassava varieties and better known cassava genetic resources, economic income of producers is increased, and through genetic resistances to abiotic and biotic stresses, less negative impact on farm environment (less pesticides, less fertilizers)
Output 2: Genetic stocks adapted to the most common cassava growing environments and their abiotic stresses, with emphasis in drought.				
Output Targets 2008	Transfer of at least 50 CMD resistant, early dry matter yield, and delayed PPD cassava germplasm to National programs	National research programs and cassava farmers and communities in Nigeria, Uganda, Tanzania, Ghana, and India IITA	Increased productivity of cassava production systems from the introduction of elite cassava varieties from South America with CMD resistance	Improved food security and processing opportunities for rural communities that depend on cassava
Output Targets 2008, 2009, and 2010	Generation, identification and transfer to national programs of at least 20 elite cassava germplasm with high and stable productivity	National research programs and cassava farmers and communities in Africa, Asia and Latin American and the Caribbean (LAC). IITA	Consolidation and strengthening of cassava-based agriculture.	Increased and stable income of cassava farmers and processing facilities. Enhanced food security of rural communities that grow cassava. Rural development.

Targets	Outputs	Intended users	Outcome	Impact
Output Targets 2009	Most important mechanisms for drought tolerance in cassava established	National research programs and universities in Africa, Asia and LAC. IITA	More efficient breeding for water-stress conditions where cassava can be grown	Enhanced food security of rural communities that grow cassava.
Output Targets 2008	Recovery of at least 10 clones with high fresh root, low dry matter content but overall high dry matter productivity per area, (HFR-LDM) useful for ethanol production	National research programs and cassava farmers and communities in Africa, Asia and LAC. Ultimately ethanol producing facilities. IITA	Enhanced competitiveness of the bio-ethanol production chain. Increased variability of cassava gene pool Specialization of cassava farmers.	Stronger markets for cassava products. Increased incomes for farmers and ethanol-producing facilities.
Output Targets 2009	Indexation of at least 10 HFR-LDM clones and production of vitro-plants			
Output Targets 2010	Shipment of at least 10 HFR-LDM vitroplants			
Otuput 3: Clones with high-quality traits for food, feed, starch and ethanol industries identified or bred.				
Output Targets 2008	Shipment of at least 50 genotypes with high carotene & protein in the roots and CMD resistance	National research programs and cassava farmers and communities in Nigeria, and Mozambique. IITA	Availability of high nutritional status cassava germplasm for evaluation of its agronomic and nutritional value	Improved nutritional status of communities in target countries that rely on cassava as a staple

Targets	Outputs	Intended users	Outcome	Impact
Output Targets 2008, 2009, and 2010	Field evaluation of first cycle of crosses for increased protein content and selection of at least 30 new genotypes with average crude protein levels 2 standard deviations above the mean.	IITA. Scientists from national programs and universities in developing and developed countries. Feed industry. Farmers that use cassava on farm for animal feeeding	Cassava breeding projects learn to interact with processing sector and deliver better products. Shift in breeding objectives and methods at NARs. Protein quality in these high-protein clones determimed. The N-to-protein conversion ratio determined.	Enhanced industrial uses of the crop. Stronger markets for cassava. Rural development in cassava growing communities and reduction of poverty. Alternative sources of financing cassava research in Africa, Asia and LAC.
Output Targets 2009	Identification and characterization of at least three new mutants for starch and/or root quality traits from the different strategies implemented.	NARs, private sector, processing companies and cassava farmers in Africa, Asia and Latin American and the Caribbean. Universities and advanced laboratories in developed countries.	Enhanced interest of different processing industries in cassava.. Appreciation of the high-value traits concept Specialization of cassava farmers.	Enhanced industrial uses of the crop. Stronger markets for cassava. Rural development in cassava growing communities and reduction of poverty.
Output Targets 2009	Field results of the second batch of crosses (10,000 genotypes) to introgress the waxy starch trait into elite germplasm obtained.	Scientists from national programs, IITA and universities in developing and developed countries. Starch factories	A practical method to introduce high-value traits developed and tested. Alternative methods of breeding developed for different purposes	Increased and more stable income of cassava farmers and processing facilities. Motivation to cassava-breeding scientists creating diversity of breeding methods. Alternative approaches for breeding other tropical crops.

Targets	Outputs	Intended users	Outcome	Impact
Output Targets 2009 and 2010	Production and shipment of at least 1,000 botanical seeds combining the high-protein trait with adaptation to different environments in Africa, Asia and LAC.	IITA National research programs, private sector, processing companies and cassava farmers in Africa, Asia and Latin American and the Caribbean.	Enhanced interest of the starch and feed industries (domestic and export markets) to incorporate cassava as source of raw material in their operations. First step for the exploitation of high-value traits.	Enhanced nutritional status of people consuming higher-protein roots. Increased value and stronger markets for cassava products. Higher income of cassava communities. Reduced environmental impact in the process of production of modified starches.
Output Targets 2010	Production of at least 10 genotypes combining the waxy starch and small-starch granule mutations in homozygous state.	Scientists from national programs, IITA and universities in developing and developed countries. Ethanol factories	Possibility of a "sugary" type of cassava created by this directed cross. Demonstration of power of conventional breeding.	Enhanced competitiveness of processing cassava facilities, particularly for ethanol production. Rural development in cassava growing communities and reduction of poverty.
Output Targets 2010	Field evaluation of at least 500 genotypes involving the small-starch granule mutation in search of starch with higher than 50% amylose	Scientists from national programs, IITA and universities in developing and developed countries. Starch factories	Enhanced interest of the starch and food industries on cassava.. First steps for exploiting high-value traits through designed crosses	Increased value and stronger markets for cassava products. Higher income of cassava communities. Enhanced health of people consuming "resistant starches", particularly those affected by diabetes.
Output Targets 2008, 2009 and 2010	Crosses and screening for at least 1000 genotypes each year, with high carotenoid content in the roots.	National research programs and cassava farmers and communities in Africa, Asia and LAC.	Cassava clones with enhanced nutritional quality. Awareness of the importance of nutritional quality	Opportunities for a better nutrition in target sites affected by vitamin A deficiency.
Output 4: Management of pests and diseases, likely to cause acute problems in large areas planted with cassava.				
	Entire collection plus 200 wild	Primarily the genebanks of	Widening access to the	

Targets	Outputs	Intended users	Outcome	Impact
Output Targets 2010	genotypes are certified against frog-skin disease (FSD). A PCR based molecular test is validated .	CIAT (in vitro collection, bonsai collection, and field genebank), and from there the cassava breeding projects of CIAT, CLAYUCA and partners	whole Manihot collection facilitates new discoveries. Additional knowledge on the pathogens involved in diseases such as FSD, and on ways to detect them.	Full availability of existing germplasm collections for any kind of evaluation, and also safe movement of cassava germplasm across boundaries.
Output Targets 2008 and 2009	Crosses with 7 or more wild *Manihot* species to introgress genetic variability in search of resistance genes for insects and diseases.	Breeders, entomologists and pathologists from national programs, IITA and universities in developing and developed countries. Cassava farmers.	Better understanding and exploitation of the genetic variability in the *Manihot* gene pool. Justification for the need of exploration & conservation of genetic resources.	Proof of concept for cassava of the value represented by related *Manihot* species. Increased collaboration with Brazilian and African research institutions. Improved health and productivity of cassava.
Output Targets 2008 and 2009	Cassava resistant to FSD and molecular markers associated with resistance genes identified	Researchers in LAC. Cassava producers. Universities. Biological inputs producers	DartT markers on genome-wide basis for QTL mapping for molecular breeding. QTL analisis of nmapping populations for FSD resistance.	Improved crop productivity for more efficient and accurate tools for disease en LAC. Facilitated breeding and production of healthy planting material at CIAT.
Output Targets 2009	Development of of at least one marker for resistance to white flies	Breeders, and entomologists from national programs, IITA and universities in developing and developed countries. Cassava farmers.	Enhanced use of this source of resistance to develop clones with higher and more stable productivity. Interaction with scientists working with other crops.	Increased and more stable income of cassava farmers and processing facilities. Reduction in the negative impact on the environment from the use of pesticides.
	Identification of the insect vectors of CFSD	National Research Institutes,Universities and	Molecular tools for detection.	More income to farmers by using environmentally friendly

Targets	Outputs	Intended users	Outcome	Impact
Output Targets 2009		farmers in LAC	Bioassays for transmission developed & implemented	disease managing strategies
Output Targets 2010	Identification of the pathogen(s) responsible for the frog skin disease (FSD)	Breeders, and pathologists from national programs, IITA and universities in developing and developed countries.	Better diagnostic tools to identify planting material contaminated with FSD	Healthier cassava grown by farmers. Enhanced exchange of germplasm. Increased and more stable income of cassava farmers.
Output 5: Organizational approaches, processing technologies and cultural practices for competitive and sustainable cassava production, processing and utilization systems.				
Output Targets 2008	Validation, under commercial conditions, of at least three productions systems for the production and exploitation of cassava foliage, including the evaluation of at least five outstanding clones.	Cassava agro-industrial projects in Colombia and other countries in the region, Asia and Africa. IITA	Cassava foliage consolidated as a raw material for animal feeding systems.	Higher income for cassava farmers. Enhanced food security. South-to-south cooperation
Output Targets 2009	Evaluation of conversion rates from root to ethanol of at least 30 elite clones, including two starch mutations and quantification of reduction in production costs.	Cassava projects for the production of ethanol (from cassava and other starch crops) in Colombia and other countries in the world. IITA	Cassava roots consolidated as a raw material for the production of ethanol. Better understanding of the interaction between germplasm and processing in the production of ethanol.	Higher economic value for cassava production systems. Rural development in cassava growing communities.
Output Targets 2010	Development, testing and dissemination of at least one decentralized approach to poduce bio-fuel, based on enhanced participation of small-holder farmers in the biofuel value chain	Smallholder farmers in LAC, Asia and Africa NARS Private sector agroindustries Universities NGOs	Enhanced engagement of smallholders farmers in all phases of the field-to-fuel value chain	Improved capacity of smallholder farmer organizations to participate in biofuel production chains Reduced environmental impact Stimulated rural development at village level

Targets	Outputs	Intended users	Outcome	Impact
				Market diversification for smallholder farmers
Output Targets 2010	*Development, validation and* dissemination of at least three added-value technologies for competitive, sustainable and environmentally friendly management of solid and liquid residues generated in cassava industries.	Cassava-based agroenterprises in LAC, Asia and Africa Smallholder cassava farmers in LAC, Asia and Africa NARS Scientists working with other crops Universities NGOs	Cassava crop consolitad as a sustainable feedstock for agroindustrial processes in LAC, Africa and Asia	Higher incomes and enhanced food security for smallholder cassava farmers in LAC, Asia and Africa Sustainable, competitive management of the environment Enhanced rural development
Output Targets 2008, 2009 and 2010	Introduction of at least 20 elite clones and multiplication of the best ones based of farmer participatory research trials in East Timor, Laos, Cambodia	Research and extensionists from NARs, cassava farmers and/or small scale processors.	Improved yields and more sustainable production of cassava in Laos, Cambodia, East Timor and Indonesia. Promotion of balanced fertilization for cassava.	Increased and more stable income of cassava farmers. Reduction of the negative impact on the environment of cassava cultivation, particularly in marginal sloped land.
Output Targets 2008 and 2009	Two bio-ethanol prototypes and demonstration plants constructed and validated	Research and extensionists from national programs, large and/or small scale processors.	*Detailed technical and* economical information on the production process of bio-ethanol form cassava	Enhanced competitiveness of processing cassava facilities, particularly for ethanol production.
Output Targets 2008 and 2009	*Bio-ethanol production process* optimized by evaluating at least 30 different cassava genotypes and at least five enzymatic processes.	Research and extensionists from national programs cassava farmers and/or small scale processors.	Enzymes, yeasts and nutrients selected. Identification of the highest yielding ethanol cassava varieties and factors affecting the conversion rate.	Rural development in cassava growing communities and reduction of poverty. Production process of decentralized production of bio-ethanol identified. Increased and more stable income of cassava farmers
Output 6: New breeding tools: genetic transformation, use of molecular markers, rapid multiplication and production of doubled-haploids.				
	Development of markers	Field and molecular breeders	Cost-effective markers aid	Improved nutritional status of

Targets	Outputs	Intended users	Outcome	Impact
Output Targets 2008	associated with protein content and delayed PPD, from wild Manihot sp.	from national programs, IITA	breeding for the transfer of root quality traits identified in wild relatives of cassava.	rural and urban populations that rely on cassava as a staple
Output Targets 2008	Identification of at least one root promoter for genetic transformation using genes to be expressed in the roots.	Molecular breeders from national programs and universities in developing and developed countries.	Cassava roots are its more important economic product, identification and cloning of root promoters are fundamental for the genetic transformation of the crop with genes affecting root quality traits.	Improved nutritional conditions of communities where cassava is an important component in the diet. More efficient breeding methods lead to faster and more consistent genetic gains. Root promoters found in cassava can help other root and tuber crops, as well. Enhanced economic value of cassava.
Output Targets 2008	Quantification of inbreeding depression in eight families of cassava based on the field evaluation of 100 S1 genotypes per family.	Scientists from national programs, IITA and universities in developing and developed countries.	Proof of concept that inbreeding of cassava facilitates its genetic improvement. First systemic study of inbreeding depression in cassava conducted and published	Increased and more stable income of cassava farmers and processing facilities. Enhanced food security or rural communities that grow cassava.
Output Targets 2009	Generation of 30,000 unigene full length cDNA collections which will be covered more than 50% of genes in cassava genome	Scientists including molecular breeders in cassava research community	Enhanced identification of genes and genomic region for more efficient molecular breeding tool development	Cassava varieties with improved target traits by more efficient molecular breeding tool for people that rely on cassava as a staple
Output Targets 2009	Development of cassava genomic database	Scientists including molecular breeders in cassava research community	Better understanding of cassava genome and genomics towards more	Faster and cost effective cassava breeding process by MAS and transgenic approach

Targets	Outputs	Intended users	Outcome	Impact
			efficient molecular breeding tool development	
Output Targets 2010	Production of at least 3 lines of homozygous tissue in the process of developing a protocol for the production of doubled haploids.	Field and molecular breeders from national programs, IITA and universities in developing and developed countries.	Introduction of inbreeding in cassava is a key step for a more efficient breeding. Inbreeding by self-pollinations is proving to be very difficult.	More efficient breeding methods leads to faster and more consistent genetic gains. Increased and more stable income of cassava farmers and processing facilities. Enhanced food security.
Output Targets 2010	Proof of concept work by genetic transformation of genes associated with traits including delayed PPD and drought	Field and molecular breeders from national and international programs	Development of efficient molecular breeding tools for improved cassava varieties	Cassava varieties with improved target traits for people that rely on cassava as a staple
Output 7: Knowledge, training and scientific publications.				

CIAT FORAGES PRODUCT LINE SBA-3: IMPROVED FORAGES FOR THE DEVELOPING WORLD

Multipurpose Forages for Improving Livelihoods of Smallholder Farmers

NARRATIVE OF PRODUCT LINE

Rationale & Changes

Rationale:

Livestock development is recognized as a key element for increasing the income of poor smallholders given the increased demand for animal products that is being experienced in developing countries. Recent analysis indicates evolving market opportunities for forages as prices for alternative, mostly grain-based feeds are increasing and consumers request higher quality products. However, a high proportion of smallholder crop/livestock systems are located in areas with prolonged dry seasons and with land in different stages of degradation, which lead to an inadequate supply of high quality feed for livestock throughout the year. In addition, in many cases smallholders with livestock and limited land (i.e., Southeast Asia) do not have easy access to fodder and have to walk long distances to harvest forages. On the other hand forages are one of the few opportunities available to a large number of smallholder farmers to produce high value or added value products, due to the fact that forages can be cultivated not only under favorable conditions but also in marginal environments. Improved forages could play a key role in maintaining and improving agricultural productivity through their effects on soil fertility, restoring degraded lands, reducing deforestation and mitigating the effects of climate change. Thus, development and expansion of high yielding and high quality forages, particularly at the livestock – crop interface can enable smallholders to be more competitive, with positive effects on poverty alleviation; improved food security and related effects on health are an additional benefit. At the same time forages contribute to resource conservation and reversing land degradation, with an additional potential in the area of environmental services (e.g., carbon sequestration, biological nitrification inhibition).

To address the issues of scarcity of feed resources for livestock encountered by small producers and to capture emerging opportunities, the research portfolio of CIAT includes the Product Line entitled 'Multipurpose Forages for Improving Livelihoods of Smallholder Farmers' which is housed in the Sharing the Benefits of Agrobiodiversity Research for Development Challenge Program. The goal of the work on forages is to conserve and exploit the genetic diversity – either induced or natural variation - of tropical grasses and legumes to improve the livelihoods of poor rural livestock producers through linkages to traditional and emerging markets and to contribute to greater access of poor urban consumers to high quality animal products that are safe, while taking advantage of the potential of forages to enhance natural resource base and provide environmental services.

To accomplish the objectives of the Forage Product Line, the research is organized around four major outputs/products: 1) Long term production and environmental

benefits of multipurpose grasses and legumes secured through conservation, documentation and distribution, of forage germplasm, 2) Improved *Brachiaria* grasses, 3) Forages as and for high value products developed to capture differentiated markets for smallholders, and 4) Benefits of multipurpose grasses and legumes realized in crop/livestock systems through adaptation, innovation and adoption.

Partnerships are formed with private industry, ARIs, universities and NARS to carry out strategic research to breed *Brachiaria* hybrids, on developing screening methods based on improved knowledge of mechanisms of adaptation of forage species to biotic and abiotic stresses (output 2) , to develop targeting, processing and evaluation techniques and employ operational research principles to define forages for specific production and market niches (output 3) and on developing improved crop/livestock and feeding systems using an innovation approach (output 4).

As an activity across outputs to target and deliver our research products we form partnerships with different groups to define environmental and market niches, document on-farm performance of released grass and legume cultivars, and quantify the impact of selected forages in improving livelihoods and protecting the environment (outputs 2 to 4).

Capacity building remains an important component of our agenda, to improve: a) our research capacity through pre- and post-graduate research and strengthening/benefiting from the research capacity of partners, and b) our capacity to deliver research outputs in different environments. Capacity building includes group and individual training and activities in the area of knowledge management.

CGIAR System Priorities:

Among the CGIAR Research Priorities (2005-2015), livestock is recognized as being crucial to improve the livelihoods of many poor rural and peri-urban farmers in tropical regions. It is recognized, however, that for poor farmers to capitalize on evolving commodity markets, there is a need to improve the availability of improved feed resources in areas of both low and high potential. This implies the challenge of developing forages capable of producing high quality biomass to feed ruminant animals in environments characterized by having pest and disease pressures, low fertility soils, long dry seasons and/or poorly drained soils. Development of forage-based feeding systems for monogastric animals to complement existing home-grown feed resources and replace expensive commercial concentrates is also seen as an important research output to assure improved productivity and competitivity of swine, poultry and fish in smallholder systems.

To address the priorities of the CGIAR on livestock, the Forage Product Line of CIAT has the global mandate of developing forage-based technologies suitable for extensive and intensive crop/livestock systems in contrasting environments. Selected forages are expected to perform well in infertile soils and to contribute to reduce seasonal variation in both feed quality and quantity and as a result reduce livestock mortality and increase productivity. In addition, grasses and legumes with broad adaptation to soils and climate in sub-humid and humid environments can contribute to better use of family labor

(especially women) and to recuperate degraded soil/pastures in pastoral and crop/livestock systems through the enhanced capacity of grasses with deep root systems to improve physical structure of soils and of legumes to improve soil fertility through their contribution via biological N_2 fixation. Furthermore, improved forages contribute to soil improvement through improved soil organic matter quality thereby enhancing soil biological activity and below-ground biodiversity. The benefits of multipurpose forages are captured by forming strong research linkages with the Research for Development Challenge (RDC) dealing with People and Agroecosystems, and with TSBF (Tropical Soil Biology and Fertility) Institute of CIAT. These strong internal linkages together with external partnerships will contribute to better targeting of research products to environments and clients thus facilitating improved and more equitable linkages of farmers to markets.

Specific activities carried out by the Forage Product Line to contribute to the CGIAR System Priorities (SP) are:

- Conservation and dissemination of forages germplasm, mainly wild relatives (SP 1b)
- Characterization of the genetic diversity in legume collections from the Gene Bank of CIAT, other CG Centers and research institutions to select new alternatives with superior forage quality, yield and resistance to biotic and abiotic stress factors (SP 1b, 2b, 3b);
- Development of methodologies for screening forages for quality and for major abiotic and biotic constraints (SP 2b);
- Breeding to develop superior grasses (*Brachiaria*) that combine quality attributes with adaptation to major abiotic and biotic constraints (SP 2b, 2c, 2d, 3b);
- Development of molecular map of *Brachiaria* and discovery of genes associated with adaptation to abiotic stresses (SP 2b, 2d, 3b).
- Exploring the role of biological nitrification inhibition (BNI) on the trade-offs between forage productivity and forage quality (SP 2a, 4d).
- Exploring the potential to manipulate biological nitrification inhibition (BNI) by breeding in *B. humidicola* (SP 2a).
- Development of methods for evaluating forages in different production systems with farmer participation (SP 5b);
- Development of Data Bases and Decision Support Tools to help target forages to different environments and production systems (SP 5a);
- Improving income from livestock through improved forages for feeding ruminants and monogastric animals and improved equity in value chains (SP 3b, also 2c and 5b, and spillover effects on 3c);
- Analysis of trade-offs between use of legumes for soil enhancement or as animal feed resource on crop/livestock productivity and environmental quality (SP 4b); and
- Capacity building consisting of individuals short term and long term training, group training and knowledge management (SP 5a)

Changes:

To capture emerging market and research opportunities targeted at smallholder farmers CIAT has refocused its forage research into the Forage Product Line entitled 'Multipurpose Forages for Improving Livelihoods of Smallholder Farmers'. As reflected in the attached logframe this is an evolutionary change building on past experiences and competencies while responding to a changing external context. The outputs and outcomes described in the former Mega Project entitled 'Tropical Grasses and Legumes: Optimizing Genetic Diversity for Multipurpose Use' presented in the MTP 2007 - 2009 are maintained. However, they are reorganized under the newly defined products; outputs and outcomes from 2010 onwards will follow the new product line structure. The most significant change is the inclusion of targeting and delivery of research products, as integral parts across the new outputs and more concretely addressing emerging market opportunities for forage-based high value and added value products. To achieve the more focused targeting and delivery of research results, research work will integrate more strongly with the 'People and Agroecosystems' RDC and emphasize current and new partnerships with the private sector and NGOs.

The Genetic Resources Unit, its responsibilities on forage germplasm now being integrated into the product line has registered 23,140 accessions of tropical forages (668 taxa of legumes and grasses) in the Multilateral System of Access and Benefit Sharing of the International Treaty on Plant Genetic Resources for Food and Agriculture on October 16, 2007. This is currently by far the largest and most diverse collection in the world of forages for the tropics and subtropics below 1,400 masl; the importance of this collection is further increased since Australia has stopped its active genebank.

Following on changes in the last MTP (2007-2009) more emphasis is placed on livestock other than cattle (such as monogastrics), stronger market orientation addressing the demand for higher value products and other kinds of benefits (such as freeing up labor) that improve poor farmers' welfare.

With these changes in objectives we will contribute more effectively to income generation and the improvement of livelihoods of poor rural communities that depend on livestock and also to improve access to safe, high quality animal products for poor urban consumers.

The annual budget of the Forage-related work in CIAT has again been cut substantially in 2007. However, with the refocused strategy it is hoped that new funding opportunities can be realized and that through synergies with other CIAT research areas and strengthening partnerships most of the negative effects of the cut can be mitigated. The joint appointment with ILRI on forages for Eastern and Southern Africa has not been renewed, however as a high priority together with ILRI we are elaborating a research and funding strategy; limited donor funded work in Rwanda is supervised jointly by ILRI and CIAT. With the departure of our experienced animal nutritionist we are phasing out work on antinutritional factors as a separate strategic research area. However, we were able to secure external funding to contract an early career animal nutritionist with an initial research emphasis on forages for monogastric animals, contributing to study on

trade-offs in the use of forages between feed resource and soil improvement and continuing to support the *Brachiaria* breeding program; delays in the interim on delivering commitment on project on trade-offs have been addressed in a revised research plan and are consolidated with partners. Stronger linkage with partners in Australia, Laos and Colombia and the People and Agroecosystems RDC within CIAT have allowed us to maintain the research focus on forages for monogastrics but additional partners and funding have been sought through additional proposals for donors . The loss of our in-house capacity in statistical analysis is a concern.

Stability of core resources at the current level will be needed to deliver the outputs stated in this document and additional resources to expand our contribution to forage-related work in Sub-Saharan Africa.

Impact Pathways:

To contribute to the improvement of livelihoods of poor rural livestock owners through high quality forages (output 2 and 3) adapted to major biotic and abiotic constraints, forage researchers rely on natural genetic diversity from core germplasm collections housed in the GRU of CIAT and other international and national centers. Artificial hybridization to create novel genetic combinations is used when major limitations in successful commercial cultivars have been identified and where evaluation of large germplasm collections has failed to identify the required character combinations (e.g., spittlebug resistance and acid soil tolerance in *Brachiaria*). Screening methods and selected genotypes with superior forage quality, with resistance to major pests and diseases and with adaptation to acid, low fertility soils, to poorly drained soils and to drought are the output targets to be used by different partners engaged in research and development activities. To improve the efficiency of partners to better target forages to diverse environments, production systems and market niches, the forage team collaborates with the RDC on People and Agroecosystems to develop methods of participatory evaluation of forages, decision support tools and more effective and equitable market interactions. Selected forage genotypes are evaluated and disseminated with and by partners in different environments and production systems. The superior grass and legume genotypes are released and promoted by NARS and private seed companies and adapted and adopted by farmers to intensify and diversify their production systems.

For its work in Sub-Saharan Africa, Southeast Asia and Latin America and the Caribbean CIAT has developed a joint strategy with ILRI, with complementary research priorities and expertise to include forages in diverse crop/livestock systems, particularly in Sub-Saharan Africa and Southeast Asia. This partnership and the interaction with the private sector have allowed us to amplify networks for delivery of research products. Information sharing through knowledge tools such as SoFT (www.tropicalforages.info) reaches a wide audience ranging from researchers and development practitioners to educational institutions and complements our continued efforts of individual and group training. A particular objective for the revision of SoFT is the linkage SoFT with forage germplasm distribution.

Adoption of new forage varieties results in more income to livestock farmers through more efficient use of land and labor, and more animal products for urban consumers, with impacts demonstrated in Latin America and the Caribbean and Southeast Asia.

International Public Goods:

In the past there were a number of strong organizations in developed countries (e.g., Australia, USA) involved in development of forages for sub-tropical and tropical environments. However, currently there are only a few suppliers of improved forages with an international mandate as is the case for CIAT, ILRI and ICARDA. The forage work carried out by the CGIAR Centers is complementary. For example, forages developed at ICARDA are mostly for the arid and semi-arid regions, and ILRI is concentrating its work on developing forages for cooler environments and the assessment of food-feed crops, while forages developed by CIAT are for tropical lowlands to mid-altitudes. With ILRI we are discussing a joint strategy. An additional important participant in tropical Forage R&D is EMBRAPA in Brazil, but with a national mandate.

The research outputs of CIAT's Tropical Forage Product Line are in line with the mandate of the CGIAR of producing international public goods (IPGs). The IPGs of the research ***outputs*** of the Forage Product Line can be grouped into the following categories:

1. Defining mechanisms/Processes (to assist in the development of screening methods)
   - Understanding how forage quality affects monogastric productivity and product quality
   - Understanding how forages adapt to acid soils with high levels of Al and low levels of P
   - Understanding how forages adapt to drought and waterlogging
   - Understanding how grasses resist pests (spittlebug) and diseases (*Rhizoctonia*)
   - Understanding how grasses inhibit biological nitrification in soil

2. Developing screening and evaluation methods (to select improved genotypes)
   - Forage quality (i.e., crude protein and *in vitro* digestibility) for ruminants and monogastrics
   - Biotic constraints (i.e., spittlebugs and *Rhizoctonia* foliar blight)
   - Abiotic constraints (i.e., adaptation of grasses to low soil nutrient status and high Al; adaptation to drought and to poorly drained soil conditions)
   - Selection of forages by farmers using participatory methods

3. Developing superior grass and legume genotypes and cultivars (to contribute to increased livestock productivity)
   - Grasses and legumes selected from germplasm collections that have broad adaptation to environmental factors prevailing in target areas and with multiple uses in crop/livestock production systems

   - Grasses with high forage quality and combined resistance to biotic and abiotic constraints

- Accessing new forage genetic resources remains of high priority though it is severely constrained under the current writing of the International Treaty and the Convention on Biological Diversity

4. Targeting and delivery of research results through dissemination of forage germplasmd and decision support tools
   - Documented conservation and distribution of germplasm by the Genetic Resources Unit, with support for larger quantities of selected material from the forage seed unit.
   - Decision Support Tools with information on adaptation, uses and management of different forage species
   - Understanding trade-offs between use of legumes for soil enhancement or as animal feed

PARTNERS:

Through partnerships with different organization from developed and developing countries, the Forage Product Line conducts research to develop improved grasses and legumes as feed resources. In what follows we present some key partnerships and the nature of the work being done as it relates to the four outputs of the Forage Product Line shown in parenthesis.

1. Australia- CSIRO and QDPI; Germany- U of Hohenheim, ILRI and FAO: (Output 1-4) Development of a tool - Selection of Forages in the Tropics (SoFT). Funds from ACIAR, DFID and BMZ.

2. Brazil- EMBRAPA: (Output 4). Development of a multidisciplinary network for research on acid soils involving different systems, crops and forages. Funds from Brazil to the CG.

3. Costa Rica – SIDE; Guatemala – ICTA and MAGA; Honduras- DICTA; Nicaragua- IDR, IICA and ILRI: (Output 4). Analysis of the Beef Chain in Central America. Funds from CFC.

4. Colombia- CORPOICA and Mexico- PAPALOTLA -Seed Company: (Output 2). On-farm evaluation of selected *Brachiaria* hybrids. Funds from PAPALOTLA.

5. Colombia-CORPOICA-CVS-CARSUCRE-GANACOR-FEGASUCRE: (Output 4). Recuperation of degraded pastures

6. Germany- U of Hohenheim; Colombia -CORPOICA and U del Cauca: (Outputs 3 and 4). Development of multipurpose forage legumes for smallholder crop/livestock systems in the hillsides of Latin America. Funds from Volkswagen Foundation

7. Germany—U of Hohenheim; Nicaragua- INTA; Honduras- DICTA: (Outputs 3 and 4). Demand-Driven Use of Forages in Fragile, Long Dry Season Environments of Central America to Improve Livelihoods of Smallholders. Funds from BMZ.

8. Germany-University of Hannover; Nicaragua-INTA: (Output 2): Developing Brachiaria hybrids with combined resistance to drought and aluminum toxicity. Funds from BMZ.
9. Guatemala- ICTA and Mexico- PAOLOTLA Seed Company: (Output 2): On-farm evaluation of selected *Brachiaria* hybrids. Funds from PAPALOTLA.
10. Honduras- DICTA and Mexico- PAPLOTLA Seed Company: (Output 2). On-farm evaluation of selected *Brachiaria* hybrids. Funds from PAPALOTLA.
11. Japan – JIRCAS: (Output 2). Exploration of the role of selected forage grasses in biological nitrogen inhibition and the potential to manipulate this trait in *B. humidicola* by plant breeding.
12. Lao PDR- National Agriculture and Forestry Research Institute, Australia- Department of Primary Industry and Forestry (DPI & F), Queensland and Canada- Nutrition Prairie Swine Centre, Saskatoon (Output 3) – Forage legumes for supplementing village pigs in Lao PDR. Funded by ACIAR
13. Japan- Hokkaido University: (Output 2). Mechanisms of plant adaptation to low P and high Al in contrasting forages. Funds from the University
14. Japan- Yamagata University: (Output 2). Mechanisms of Al resistance in *Brachiaria*. Funds from the University
15. Switzerland – ETHZ; and Colombia- CORPOICA, Universidad Nacional de Colombia- Bogotá: (Output 3). The forage potential of tannineforus legumes. Funds from ZIL- SDC
16. Switzerland –ETHZ; and Colombia- CORPOICA: (Output 2). Adaptation of *Brachiaria* grasses to low-P soils. Funds from ZIL- SDC
17. Switzerland- ETHZ; and INTA- Nicaragua: (Output 4). Improved feeding systems for dairy cattle in tropical smallholder farms. Funds from ZIL-SDC
18. Switzerland-ETHZ; and INTA-Nicaragua: (Output 4). Realizing the benefits of cover crop legumes in smallholder crop/livestock systems. Funds from ZIL-SDC
19. Switzerland-ETHZ; INTA-Nicaragua; and ILRI-Colombia: (Output 4). Trade-off analysis of using legumes for soil enhancing or as animal feed resource. Funds from Systemwide Livestock Program (SLP)
20. United States- U of Kentucky: (Output 2). Endophytes in grasses- Alkaloid detection. USAID linkage fund
21. United States- U of Florida- (Output 2). Biochemical mechanisms of resistance of *Brachiaria* to spittlebug. USAID linkage fund

Project Funding:

Budgeting 2006-2010

Year	2005 (actual)	2006 (estimated)	2007 (proposal)	2008 (plan)	2009 (plan)
US Dollars (millions)	4.349	4.389	3.834	3.870	3.907

CIAT FORAGES PRODUCT LINE SBA-3: IMPROVED FORAGES FOR THE DEVELOPING WORLD (2008-2010)

	Outputs	Intended User	Outcome	Impact
OUTPUT 1	Long term production and environmental benefits of multipurpose grasses and legumes secured through conservation, documentation and distribution, of forage germplasm	CIAT, CG centers, NARS, forage networks and development projects in LAC, Sub-Saharan Africa and South East Asia, and other users anywhere in the world interested in clean and documented forage genetic resources.	Conservation, multiplication, documentation and worldwide availability of tropical forage germplasm under mandate of CIAT	Short and long term availability of forage germplasm to ensurae sustainable agriculture based production of smallholders in the tropics
Output Targets 2008	Tropical forage collection of 23,140 materials is maintained fully viable, clean, and documented, and available at any time for distribution to any bona fide user, according to procedures set in the MTA/ SMTA of the Treaty. 1,400 accessions/ year conserved in long-term conservation (-20C) at CIAT and safely duplicated at CIMMYT as security back-up.	CIAT forage projects in LAC, Sub-Saharan Africa and South East Asia, forage networks, development projects, NARS, CG centers, others users anywhere in the world interested in clean and documented forage genetic resources.	On demand availability of forage germplasm to users throughout the world	
	Identified, clean and documented germplasm of forages (anticipated at 600 samples/ year) is distributed to users in accordance with international standards (plant quarantine, IP norms as applicable)	Forage scientists, breeders, agrostologists, forage networks and consortia from both public and private sectors	Forage genetic resources adapted to specific agronomic and market conditions are better known and used troughout the; the entire forage/ animal production chain	

	Outputs	Intended User	Outcome	Impact
Output Targets 2009	Tropical forage collection of 23,140 materials is maintained fully viable, clean, and documented, and available at any time for distribution to any bona fide user, according to procedures set in the MTA/ SMTA of the Treaty. 1,400 accessions/ year conserved in long-term conservation (-20C) at CIAT and safely duplicated at CIMMYT as security back-up.	CIAT forage projects in LAC, Sub-Saharan Africa and South East Asia, forage networks, development projects, NARS, CG centers, others users anywhere in the world interested in clean and documented forage genetic resources.	On demand availability of forage germplasm to users throughout the world	
	Identified, clean and documented germplasm of forages (anticipated at 600 samples/ year) is distributed to users in accordance with international standards (plant quarantine, IP norms as applicable)	Forage scientists, breeders, agrostologists, fo rage networks and consortia from both public and private sectors	Forage genetic resources adapted to specific agronomic and market conditions are better known and used troughout the ; the entire forage/ animal production chain	
Output Targets 2010	Tropical forage collection of 23,140 materials is maintained fully viable, clean, and documented, and available at any time for distribution to any bona fide user, according to procedures set in the MTA/ SMTA of the Treaty. 1,400 accessions/ year conserved in long-term conservation (-20C) at CIAT and safely duplicated at CIMMYT as security back-up.	CIAT forage projects in LAC, Sub-Saharan Africa and South East Asia, forage networks, development projects, NARS, CG centers, others users anywhere in the world interested in clean and documented forage genetic resources.	On demand availability of forage germplasm to users throughout the world	

	Outputs	Intended User	Outcome	Impact
	Identified, clean and documented germplasm of forages (anticipated at 600 samples/ year) is distributed to users in accordance with international standards (plant quarantine, IP norms as applicable)	Forage scientists, breeders, agrostologists, fo rage networks and consortia from both public and private sectors	Forage genetic resources adapted to specific agronomic and market conditions are better known and used troughout the ; the entire forage/ animal production chain	
OUTPUT 2	Improved Brachiaria grasses	CIAT and NARS researchers and seed companies	New cultivars of *Brachiaria* with high feed quality and resistance to major biotic and abiotic stress factors are released by partners and adopted by farmers in LAC, Asia and Africa	Increased efficiency of livestock production of livestock through feeding high quality grasses
Output Targets 2008	Developed at least 5 *Brachiaria* sexual hybrids with resistance to *Rhizoctonia* foliar blight as high as that of the commercial *B. decumbens* cv Basilisk	NARS researchers, CIAT researchers	*Brachiaria* hybrids with resistance to *Rhizoctonia* are evaluated in multilocational trials in humid areas of LAC and Asia	
	A screening method to assess waterlogging tolerance in *Brachiaria* hybrids streamlined in the breeding program	NARS researchers, CIAT researchers	Selected *Brachiaria* hybrids tolerant to waterlogging tested in different regions in LAC and Asia	
Output Targets 2009	Developed at least 2 apomictic *Brachiaria* hybrids that combine high digestibility (>60%) and crude protein (>10%) with spittlebug resistance	NARS researchers, and seed companies	New cultivars of *Brachiaria* with potential to increase livestock productivity are released and adopted by farmers in LAC and Asia	
	Released for regional testing at least 5 *Brachiaria* hybrids that combine resistance to spittlebugs with adaptation to acid soils	NARS researchers, CIAT researchers	*Brachiaria* hybrids with superior traits available for multilocational testing in LAC	

	Outputs	Intended User	Outcome	Impact
	Developed at least 5 *Brachiaria* hybrids with combined resistance to spittlebugs and tolerance to waterlogging	NARS researchers, CIAT researchers	*Brachiaria* hybrids with resistance to spittlebug and adaptation to poorly drained soils evaluated in multilocational trials in LAC	
Output Targets 2010	Developed a screening method for selecting *Brachiaria* hybrids for combined adaptation to drought and aluminum toxicity	NARS researchers, CIAT researchers	New genotypes incorporated into the *Brachiaria* breeding program to develop cultivars with combined adaptation to drought and aluminum toxicity	
	An apomictic hybrid with phenotype similar to cv. Basilisk (stoloniferous, spreading) with good spittlebug resistance in advanced testing for commercial release.	NARS, private seed company	A "spittlebug-resistant *B. decumbens*" to replace cv. Basilisk on large areas subject to spittlebug attack	
OUTPUT 3	Forages as and for high value products developed to capture differentiated markets for smallholders	CIAT and NARS researchers, and seed companies	New stress adapted cultivars of *Brachiaria* and high quality legumes with resistance to prevalent pests and diseases to capture emerging markets are released by partners and adopted by farmers in LAC and Southeast Asia	Increased efficiency of livestock production and income of smallholder farmers through planting forage grasses and legumes that are adapted to major production constraints and market opportunities
Output Targets 2008	Identified at least 3 legume varieties with high nutritional quality, capable of improving	CIAT and NARS researchers	Small pig producers in extensive production systems in Asia evaluate and adopt forage	

	Outputs	Intended User	Outcome	Impact
	village pig production by at least 30% in extensive production systems		legumes as supplementary feed	
Output Targets 2009	Developed a methodology to correlate *in vitro* and *in vivo* screening of legumes for monogastric utilization	NARS and CIAT researchers	Resource efficient screening of high potential forages for monogastric feeding	
Output targets 2010	At least one forage based feed for monogastric production adopted by smallholders in one country in Southeast Asia and one country in Latin America and the Caribbean	CIAT and NARS researchers	Small-scale monogastric producers adopt forage legumes as supplementary feed	
OUTPUT 4	Benefits of multipurpose grasses and legumes realized in crop/ livestock systems through adaptation, innovation and integration	CIAT, ARIs and NARS researchers, and seed companies	New cultivars of *Brachiaria* and legumes with adaptation to production constraints released by partners and adopted by farmers in LAC, Asia and Africa	Increased profitability and sustainability of livestock/ crop production and improved NRM through planting multipurpose forage species adapted to production constraints
Output Targets 2008	Identified perennial and annual herbaceous legume accessions (5) that perform well under residual soil moisture and that are suited for hay and silage production	NARS researchers and development programs	Livestock and non-livestock farmers in dry hillsides adopt annual legumes to make high quality hay and silage	
	Released CaNaSTA for targeting forages (and other crops) to specific environmental and market niches	NARS researchers and development programs	Researchers and development workers are using CaNaSTA to target forages to specific production and market niches	

	Outputs	Intended User	Outcome	Impact
Output Targets 2009	Released a revised version of SoFT (Selection of Forages for the Tropics) to target forages to different niches	NARS researchers and development programs	Large number of researchers and development workers use SoFT to identify, access and promote best-bet forage species for different environments and uses	
Output Targets 2010	Production vs environmental trade-offs determined between use of 2 cover legumes as feed supplement and for soil fertility improvement in maize-based systems in one hillside region	CIAT and NARS researchers	Livestock and non-livestock farmers in dry hillsides adopt at least one cover legume in their production systems	
	Production and soil quality improvement benefits from introducing 2 multipurpose forage grass and legume options to restore degraded pastures quantified in one savanna region	NARS researchers and development programs	Livestock farmers in savannas realize the benefits of the multipurpose forages	

CIAT Rice Product Lines SBA-4: Improved Rice for Latin America and the Caribbean

To generate food security and employment associated with rice production with emphasis on improving the health and nutrition and economic options for the small farmers.

Narrative Project Description

Rationale & Changes

Rationale

There are opportunities for growth in the rice sector, because land and water are more abundant in Latin America than in other rice growing regions. Besides, the rice sector faces risks because there is a trend for more open markets and production costs in many countries are so high that they can not compete in the international market. The Rice Product Line will focus on strengthening the rice sector, in the low and mid altitude regions of Latin America and the Caribbean. We concentrate great part of our activities on developing advanced materials with broad genetic diversity that incorporates a range of grain quality traits and resistance to the pest and diseases common in this region. Our rice breeding activities are for both irrigated and upland rice, focused on problems that are locally important, and especially in the area of pest and diseases, many of these constraints are unique to Latin America and the Caribbean. On the other hand, climatic and soil conditions, consumer preferences, and social and cultural practices are different from those prevalent in Asia and Africa. To increase the genetic diversity of rice, we work with interspecific crosses, composite populations and we are developing biotechnology methods that allow the incorporation of traits more efficiently. These activities are generating both segregating populations and advanced lines, which are transferred to partners through either bilateral agreements or networks including FLAR, GRUMEGA, AgroSalud, and INGER. Jointly with the Biotechnology Research Unit and in collaboration with JIRCAS (Japan), gene technology is being explored as an alternative to incorporate increased efficiency in water use for the irrigated rice ecosystems targeting reduction of water consumption.

The CIAT Rice team is conducting research that is complementary to research carry out by both IRRI and WARDA. Through the Generation Challenge Program (GCP) and Harvest Plus (HP+) we have linkages with both of them, especially in the development of breeding populations via the utilization of wild rice species. IRRI has a long and successful history in the characterization, classification and utilization of wild rice species where a series of interspecific hybrids between rice and almost all wild rice species have been produced. This material is very useful as cytogenetic and genetic tools. One example of the introgression of a useful gene from wild species is the transfer of cytoplasmic male stererility (CMS) from *O .sativa f. spontanea*, to develop CMS lines for commercial hybrid rice production. This particular gene has been used by CIAT breeders to develop broad base populations via recurrent selection methods for both irrigated and upland rice, which are being used by several NARS in LAC; three rice varieties have been released out of recurrent selection in Bolivia, Brazil and Chile. Our Rice Team is focused in the utilization of *O. rufipogon, O. glaberrima, O. barthii, O. meridionalis* and *O. latifolia* as sources of new alleles associated

with traits of agronomic importance for LAC, mainly yield potential and yield components, grain quality, resistance to RHBV and its vector Tagosodes, blast, Rhizoctonia, Rice necrotic virus (Entorchamiento), and more recently to improve the nutritional quality of milled rice. Interspecific breeding lines and populations are shared via GCP with IRRI and WARDA, as well as introductions from the germplasm banks as progenitors. Breeding lines are also exchanged via IRRI's network known as INGER. Additionally, regular visits by our scientists are made to IRRI. Both CIAT and IRRI played a complementary role in the interspecific hybridization project led by WARDA since 1996 that resulted in the development and release of the NERICA lines. CIAT also provided some training in anther culture and developed and shared with WARDA interspecific breeding populations for rainfed and irrigated conditions. Complementarity, collaboration and linkages will be further analyzed, discussed and fine tuned in a workshop to be held at WARDA at the end of June/2007 as a WARDA/IRRI/CIAT programmatic alignment in Africa.

Following the new structure of CIAT's research based on Product Lines, the previous IP-4 Rice Project will become the Product Line on Improved Rice for Latin America and the Caribbean and our research will be organized around three major products with the following rationale:

Product 1: Rice germplasm for improving human health and nutrition in Latin America.

Micronutrient malnutrition, the result of diets poor in vitamins and minerals, affects more than half of the world's population. Women and children are especially susceptible to deficiencies in micronutrients, particularly vitamin A, iron and zinc. As a result, they are at risk of disease, premature death, lower cognitive capacity, and poor quality of life. The costs of these deficiencies are high. In Latin America and the Caribbean (LAC) economic and health indicators have been deteriorating. To meet this challenge, the CGIAR is implementing a new paradigm that views agriculture as an instrument for improving human health and nutrition, as well as for increased productivity. Nutritionally improved staple food provides an inexpensive, cost-effective, sustainable, long-term means of delivering micronutrients to the poor. The goal of the Biofortificaton Challenge Program (BCP) is to improve the health of the poor by breeding staple foods that are rich in iron, zinc and vitamin A, for poor consumers with priority on Africa and Asia. This program gets funding from diverse sources, including among others, The Melinda and Bill Gates Foundation.

A project funded by CIDA-Canada complements the Biofortification Challenge Program and extends its benefits to Latin America and the Caribbean, through the development of and deployment of high iron and zinc rice lines. Rice has become the most important food grain in LAC, supplying consumers with more calories than other staple crops. Rice has become particularly important in the diets of poor people, who make up about 40% of LAC's total population. Among the poorest 20% of the population, rice supplies more protein to the diet than any other food source, including beef and milk. However, people living in several areas where rice consumption is high have been suffering from a number of major nutritional problems. This is the result of vitamins and/or minerals naturally present in the rice grain but otherwise removed during the milling process or that naturally are not present in sufficient amounts. Preliminary data obtained at CIAT from 11 cultivars planted under irrigated

conditions indicated that on average 59 and 26% of the total iron and zinc present in brown rice is lost after milling, respectively, and there were significant differences among genotypes tested. Research carried out at IRRI suggests that there is genetic variability in the rice genome to increase iron and zinc in the rice grain. More recently, it has been reported that consumption of biofortified rice, without any other changes in diet, is efficacious in improving iron stores in women with iron-poor diets in the developing world. In this project we plan to develop rice lines containing in the grain high iron (6-8ppm) and zinc (22-25ppm) to combat malnutrition in Latin America and the Caribbean using different breeding strategies, and we have already established a clean lab for preparing rice samples for iron and zinc analysis.

Product 2: Broadening the genetic base of irrigated rice in Latin America
Wild species are valued as a unique source of genetic variation; however, they have rarely being used for the genetic improvement of quantitative traits. Since 1994 the CIAT Rice Project in close partnership with the CIAT Biotechnology Unit has been characterizing and utilizing wild rice species to broaden the genetic base of cultivated rice in Latin America. In this project we are utilizing wild rice species to broaden the genetic base of cultivated rice in Latin America and develop commercial rice cultivars with higher yields and resistance to pests for the benefit of farmers in general, urban/rural consumers, and industry and seed producers. The strategy in place make use of molecular maps in combination with backcrossing to elite breeding lines or commercial varieties to develop populations that are used to identify and transfer quantitative trait loci (QTLs) associated with traits of agronomic importance to cultivated rice. Results to date indicate that several traits of agronomic importance, including yield and yield components, and tolerance to biotic and abiotic stresses, have been transferred from *Oryza rufipogon, O. glaberrima,* and *O. barthii* to improved rice cultivars. Elite lines derived from these three wild species showed good field performance and high yield potential in replicated trials carried out by one of our main partners. Additionally, samples of wild rice populations collected in two sites in Colombia were classified as *O. latifolia*, a tetraploid wild species from Latin America carrying the CCDD genome. Preliminary evaluations suggest that these accessions carry resistance genes to all rice blast lineages found in our "hot spot" Santa Rosa, as well as resistance to rice hoja blanca virus and its insect vector *Tagosodes orizicolus.* We have been studying the meiotic behavior of the interspecific cross between *O. sativa* and *O. latifolia* in their F1 finding that all meiotic phases were normal and pollen viability was high in both parents. Meiotic process of the F1 hybrids presented abnormalities in spindle formation, chromosome segregation and cytokenisis leading to polyads formation, which give rise to unviable pollen. However, some BC2 and BC3 plants were completely diploid and fertile, which makes the use of this wild species suitable for broadening the genetic base of rice.

Broadening the genetic base of irrigated rice is also conducted trough the development of synthetic rice populations using recurrent selection. The main purpose of a breeding project is to create variability and develop breeding materials that may lead to identifying promising lines and new cultivars for release. Recurrent selection methods contribute to meeting the goals for continuous genetic improvement but should be integrated with other breeding methods to deliver superior breeding materials and improved varieties. Recurrent selection should not be considered a separate phase of an applied breeding program. Selfed progenies

extracted from recurrent populations are evaluated and then recombined to obtain improved populations. Superior progenies also have to be included in the applied breeding program, passing trough cycles of selection and agronomic evaluation. Advanced lines are the starting point for developing commercial varieties and are donors in crossbreeding programs. These lowland irrigated rice activities for rice improvement are carried out in close collaboration with partners in the LAC region. In Colombia, the CIRAD-CIAT rice project started developing basic populations targeting the various lowland rice ecosystems present in LAC, in partnership with scientists in Colombia, Venezuela and Cuba for the tropical ecosystem; Argentina for the subtropics; and Chile and France for the temperate zone. The basic populations were shipped to regional partners and evaluated locally. Most of the cooperators used this material to develop site-specific populations by introgressing additional variability to meet their specific breeding objectives. They then use these populations in their rice-improvement programs by recurrent selection.

Product 3: Broadening the genetic base of upland rice in Latin America
Since the 1960s, commercial rice cultivars have been developed by conventional crossbreeding, often from breeding populations derived by crossing two inbreed lines. This approach encourages inbreeding and so narrows the genetic base of breeding materials. Narrow genetic diversity is of major concern to breeders, geneticists and the agricultural community in general. In LAC, the genetic diversity of rice cultivars depends on a small core of landraces. This finding led the rice project at CIAT to direct its efforts toward broadening the genetic base in rice using different approaches. In 1996, a collaborative project between the Centre de cooperation internationale en recherché agronomique pour le dévelopment (CIRAD), CIAT and LAC-NARS was established to develop and enhance at regional level, synthetic rice populations for the different rice ecosystems (upland, aerobic and irrigated). The objective is to broaden the genetic base of Latin American rice by assessing genotype x environment interactions to identify specific potential parents and pooling then to create site-specific synthetic rice populations with a broader genetic base.

The CIRAD-CIAT project set out to develop collaboration with rice breeders throughout LAC and took the lead in creating and sharing synthetic populations and providing training. In 1999, the Working Group on Advanced Rice breeding (GRUMEGA) was set up during a regional rice breeders' conference organized in Brazil by the Empresa Brasileira de Pesquisa Agropecuaria (EMBRAPA), CIRAD and CIAT and sponsored by the Food and Agriculture Organization of the United Nations (FAO). The leadership in networking activities of the group is assumed by the rice projects of CIRAD-CIAT and EMBRAPA's Arroz e Feijao Center. Population breeding by recurrent selection is efficient for traits that show low heritability. Through short cycles of selection and recombination, linkage barriers are broken down and favorable genes are accumulated. This is a smooth process of continuous improvement. We have already developed improved basic populations using recurrent selection in centralized pre-breeding activities. Upland composite populations are observed, characterized and improved by recurrent selection in Colombia, and improved lines are distributed to national programs in the region for further testing.

In 2002, CIRAD and CIAT established a new collaborative project in Nicaragua on participatory breeding of upland rice and sorghum for poor farmers in Central America. This

project is developing and testing breeding schemes, including population improvement methods in which farmers are fully involved, to develop varieties that are better adapted to the farmer's specific cropping conditions and needs. For the small farmers, jointly with our partners, we put in place participatory variety selection and breeding schemes in different agro ecosystems of Central America. Early maturity, vigorous, high yielding varieties with adequate grain quality are some of the traits selected by farmers to assure the food security needed for their families. It is expected that participatory breeding methods and the genetic materials developed with this approach in Nicaragua will be applicable to most Central American countries.

To sustain yields preventing the pressure of pests and diseases, we work in collaboration with our partners to disseminate Integrated Crop Management practices. FLAR has been active in promoting Integrated Crop Management Practices. With water becoming a more expensive and/or scarce resource and the need to produce rice at competitive prices, we expect to work with FLAR and other partners to develop a comprehensive set of management guidelines to reduce inputs while increasing yields. These activities are information intensive and require local support to be successful.

Significant Changes

The main significant changes affecting the Rice Project are related to the new CIAT organization where some research activities were eliminated or consolidated into Product Lines. The previous IP-4 Rice project is the new Product Line "Improved Rice Germplasm for Latin America". This new Product Line has three main Products: 1- Rice germplasm for improving human health and nutrition in Latin America; 2- Broadening the genetic base of irrigated rice in Latin America; and 3- Broadening the genetic base of upland rice in Latin America. The previous output 1, "enhanced gene pools", was divided into the Products 2 and 3 of the new organization; many activities of the previous output 2, "integrated crop, pest and disease management", were eliminated while others consolidated into the Product 2. The previous output 3, "intensification and diversification of rice cropping systems for small farmers", was consolidated into Product 3. A new Product, **"Rice germplasm for improving human health and nutrition in Latin America." was added.**

For 2007, the core resources for the rice research activities have been significantly reduced. These changes are reflected in the consolidation or elimination of several of the Output Targets. For example, the 2007 and 2008 Output 1 and 2 targets "Characterization and development of markers for 6 major rice blast resistance genes", and "Implementation of Marker Aided Selection techniques for rice hoja blanca virus (RHBV) and Rice Blast in variety development" have been eliminated. Activities in rice Pathology in 2007 will concentrate on the evaluation of rice populations for sheath blight resistance (special Project funded by USDA), and between 2007-2009 on two projects funded by FONTAGRO: the identification of fungicide resistance problems in the rice blast and sheath blight pathogens, and on the characterization of the bacterial pathogen (*Burkholderia glumae*) associated to the mite-bacterium-fungus complex affecting rice production in Central America. In addition, most activities on the use of anther culture and embryo rescue for enhancement of gene pools will be significantly reduced, and activities on gene flow analysis from rice into weedy rice will be integrated within biotechnology tools activities supporting rice research. Some of

these activities will be carried out as special projects if proposals already presented to potential donors are approved.

CG System Priorities

The Rice Product Line promotes the conservation and characterization of the relatives of rice. Red rice, which is a major weed is also being characterized, both to understand the origin of this pest and to consider using it as a new source of genetic diversity for selected traits. The following species: *O. glaberrima, O. rufipogon, O. barthi, O. glumaepatula, O. meridionalis* and most recently *O. latifolia* were crossed with cultivated rice (*O. sativa*) in efforts to increase the biodiversity of rice varieties and introduce traits of importance to Latin America. All these activities are in accordance with the CGIAR system priorities 1A and 1B on sustaining biodiversity through promoting conservation and characterization of a staple crop and of underutilized plant genetic resources. The Rice Project develops breeding populations and advanced lines with traits that include high yield, good grain quality, early vigor, strong tillers, tolerance to water stress, rice blast, Rhizoctonia, rice hoja blanca virus and the plant hopper *T. orizicolus*, activities which are in accordance with the CG system priorities 2A and 2B on the genetic improvement of crops. More recently in collaboration with IRRI, we have started enhancing the nutritional quality of rice by developing lines that are higher in iron and zinc, activity within the system priority 2C on enhancing the crop nutritional quality. The pest and disease traits that are incorporated into the new varieties are helping the farmer to reduce the use of pesticides. Using integrated crop and pest management is central to producing a sustainable agro-ecological system, following the recommendations of system priority 4D on promoting a sustainable management of natural resources. The efforts to develop rice with better water use efficiency benefits the rice farmers with the least amount of infrastructure and should lead to the reduction of water in the irrigated systems, and to the promotion of integrated land and water management at landscape level as recommended in the system priorities 4A and 4C. Our upland rice varieties are well adapted to be integrated within the named rice-pastures agro-ecosystem, which indirectly help to increase income from livestock, contributing to the CG system priority 3B. All our different products conduct activities related to capacity building contributing to the improvement of science and technology in the region, therefore, contributing to the CG system priority 5A.

Impact Pathways

The Rice Product Line focuses on strengthening the rice sector, in the low and mid altitude regions of Latin America and the Caribbean. Our research is organized around three major products: 1) Rice germplasm for improving human health and nutrition in Latin America 2) Broadening the genetic base of irrigated rice in Latin America and 3) Broadening the genetic base of upland rice in Latin America.

Product 1: Rice Germplasm for Improving Human Health and Nutrition in Latin America. This product is concerned with the development of high iron (6-8 ppm) and zinc (22-25 ppm) rice lines to combat malnutrition in Latin America and the Caribbean. The final intended users of these products will be the urban and rural consumers, especially poor sectors in Latin America, although in the development process, rice scientist and breeding programs from the region will benefit from the materials developed with high iron and zinc content as well as they will play an important role in the identification, evaluation and adoption of the improved

germplasm. Using GIS tools and socioeconomic studies we will identify the targeting areas and populations in Latin America suffering from malnutrition. Improved rice germplasm as an instrument for improving human health and nutrition as well as for increasing productivity will benefit the poor people in Latin America (40% of LAC's population). Nutritionally improved staple food will provide an inexpensive, cost-effective, sustainable, long-term means of delivering micronutrients to the rural small resource poor farmers and the urban resources poor consumers. This project is carried out in close partnership with research institutions in Colombia (FEDEARROZ), Bolivia (CIAT-Bolivia, and ASPAR), Cuba (IIA), Brazil (EMBRAPA), Dominican Republic (IDIAF), Nicaragua (INTA), and more recently Panama (IDIAP).

After careful evaluation of the germplasm available in germplasm banks, seed of high iron and zinc rice lines or commercial varieties will be multiplied at CIAT-Palmira for distribution to our partners for evaluation /testing under local conditions in key sites selected via GIS and following participatory breeding approaches. Once results are confirmed, seed of promising lines will be multiplied by our local partners for further evaluation in several sites in demonstration plots. At the same time, in collaboration with AgroSalud nutritionist and economist, agronomic/efficacy and impact assessment studies will be conducted to assess the impact on human health of the promising lines in selected sites and urban/rural groups. Local health and nutrition people will be involved in these studies. Finally, lines with increased iron and zinc content will be named and release locally by our partners in AgroSalud..

Additional activities carried out by CIAT within the project include GxE studies to determine the influence of climatic and soil factors in the expression of iron and zinc in the rice grain, marker assisted selection, and visits and coordination of collaborative activities carried out by participating NARs. It has been shown that land races and wild rice species contain more iron and zinc than modern cultivated rice. Based on this, breeding lines derived mainly from crosses between elite lines and wild species were evaluated under biotic and abiotic stresses in Santa Rosa and Palmira experiment stations. Good lines have been identified in terms of agronomic traits, tolerance to main diseases and insects, yield potential and grain quality. These lines will be evaluated for iron and zinc in 2007. Our partners, whom will operate based on a network of germplasm exchange and participatory breeding activities in the region will be in charge of testing, distributing, and evaluating together with socioeconomics the benefits of the technology on the improvement of human health and nutrition as well as on increasing the productivity of rice and farmers well-being.

Product 2: Broadening the Genetic Base of Irrigated Rice in Latin America. Wild species are valued as a unique source of genetic variation; however, they have rarely being used for the genetic improvement of quantitative traits. Since 1994 the CIAT Rice Project in close partnership with the CIAT Biotechnology Unit has been characterizing and utilizing wild rice species to broaden the genetic base of cultivated rice in Latin America. In this project we are utilizing wild rice species to broaden the genetic base of cultivated rice in Latin America as a breeding tool that will be further used by the rice community in LAC to develop commercial rice cultivars with higher yields and resistance to pests for the benefit of farmers in general, urban/rural consumers, and industry and seed producers. In the late 80s CIAT made the decision not to name and release rice varieties any more but leave this decision to NARS. So

the impact pathway depends entirely on the local evaluation, testing and selection of the breeding nurseries (CIAT-ION) that are prepared and sent to our collaborators every year, based on local demand. Most of the time our breeding lines are used as progenitors in further crossing by national rice breeding programs. In some cases these lines are released as commercial varieties after further selection, purification and seed multiplication. Typically this process takes 10-12 years after receiving the CIAT-ION nursery.

The main role of CIAT at present in this product is to make use of molecular maps in combination with backcrossing to elite breeding lines or commercial varieties to develop populations that are used to identify and transfer quantitative trait loci (QTLs) associated with traits of agronomic importance to cultivated rice. Results to date indicate that several traits of agronomic importance, including yield and yield components, and tolerance to biotic and abiotic stresses, have been transferred from wild species to improved rice cultivars. CIAT's role is also broadening the genetic base of irrigated rice trough the development of synthetic rice populations using recurrent selection. Recurrent selection methods contribute to meeting the goals for continuous genetic improvement but should be integrated with other breeding methods to deliver superior breeding materials and improved varieties. Advanced lines are the starting point for developing commercial varieties and are donors in crossbreeding programs. These lowland irrigated rice activities for rice improvement are carried out in close collaboration with partners in the LAC region. In Colombia, the CIRAD-CIAT rice project started developing basic populations using recurrent selection targeting the various lowland rice ecosystems present in LAC, in partnership with scientists in Colombia, Venezuela and Cuba for the tropical ecosystem; Argentina for the subtropics; and Chile and France for the temperate zone. The basic populations are shipped to regional partners and evaluated locally. Most of the cooperators used this material to develop site-specific populations by introgressing additional variability to meet their specific breeding objectives. They then use these populations in their rice-improvement programs by recurrent selection. Recurrent selection is an activity that has been promoted through the GRUMEGA network. During the last 10 years, it has held many Rice Breeder Workshops and many local partners have populations and advanced rice lines from these activities. We are member of FLAR and most of the FLAR germplasm is developed using some of the CIAT germplasm. FLAR includes some of the strongest rice research institutions in Latin America and this is also a valuable source for Germplasm Enhancement as well as other forms of collaboration. Again, our regional rice partners are responsible for the release of varieties, which is the main impact of this Product 2. A very high percentage of the new rice varieties contain CIAT germplasm. The need for germplasm is highly variable and depends on the amount of rice production in a given country. In general, the less rice that is produced the more these programs need advanced materials. The larger rice programs use germplasm and segregating populations to make their own selections. At the end, our impact will be measured by an expected increase and more sustainable rice production in the LAC region, with improved rice competitiveness through lower production costs and higher yields.

Product 3: Broadening the Genetic Base of Upland Rice in Latin America. This product is related to the use of rice synthetic population breeding and participatory breeding of upland rice small farmers for the release of commercial upland rice varieties in LAC. Since the 1960s, commercial rice cultivars have been developed by conventional crossbreeding, often

from breeding populations derived by crossing two inbreed lines. This approach encourages inbreeding and so narrows the genetic base of breeding materials. This problem led the rice project at CIAT to direct its efforts toward broadening the genetic base in rice using different approaches. In 1996, a collaborative project between the Centre de cooperation internatinale en recherché agronomique pour le dévelopment (CIRAD), CIAT and LAC NARS was established to develop and enhance at regional level, synthetic rice populations for the different rice ecosystems (upland, aerobic and irrigated). The objective is to broaden the genetic base of Latin American rice by assessing genotype x environment interactions to identify specific potential parents and pooling then to create site-specific synthetic rice populations with a broader genetic base. Improving rice synthetic populations by recurrent selection is not intended to replace conventional breeding but to supplement other techniques in the breeder's arsenal for developing improved varieties.

The CIRAD-CIAT project set out to develop collaboration with rice breeders throughout LAC and took the lead in creating and sharing synthetic populations and providing training through the Working Group on Advanced Rice breeding (GRUMEGA). The leadership in networking activities of the group is assumed by the rice projects of CIRAD-CIAT and EMBRAPA's Arroz e Feijao Center. Our pathway to impact will be GRUMEGA, which is a framework for collaborative research built on five pillars: (i) capacity building, (ii) germplasm development and sharing; (iii) workshops for germplasm evaluation and selection, (iv) conferences to present results and advances, and (v) publications with and by collaborators.

Upland composite populations are observed, characterized and improved by recurrent selection in Colombia, and improved lines are distributed to national programs in the region for further testing. For the smallholders, earliness and drought tolerance associated with good yield potential are important traits. These varieties allow rotation with other food and cash crops. Earliness also allows farmers to place rice to the market early in the season, when prices are high. Thanks to the enthusiasm and constant dedication of LAC rice breeders, the regional rice recurrent selection-breeding project has been adopted, developed and implemented in several countries.

In addition, a Regional Technical Cooperation Project (TCP): "Capacitación en fitomejoramiento genético e intercambio de germoplasma para utilizar los recursos genéticos del arroz en America Latina y el Caribe" involving 7 countries (Argentina, Bolivia, Chile, Cuba, Guatemala, Nicaragua, and Dominican Republic) and CIRAD and CIAT was funded by FAO for 2 years, starting in 2006. In this framework, workshops have been organized for the evaluation and selection of upland and irrigated segregating and fixed rice lines. The next step in rice population improvement is to take advantage of new molecular tools to increase the efficiency of recurrent selection breeding. Molecular tools are now used, for example, to better determine the level of genetic diversity in a population.

In 2002, CIRAD and CIAT established a new collaborative project in Nicaragua on participatory breeding of upland rice and sorghum for poor farmers in Central America. This project is developing and testing breeding schemes, including population improvement methods, in which farmers are fully involved, to develop varieties that are better adapted to

the farmer's specific cropping conditions and needs. For the small farmers, jointly with our partners, we put in place participatory variety selection and breeding schemes in different agro ecosystems of Central America. Early maturity, vigorous, high yielding varieties with adequate grain quality are some of the traits selected by farmers to assure the food security needed for their families. It is expected that participatory breeding methods and the genetic materials developed with this approach in Nicaragua will be applicable to most Central American countries.

The main participatory rice breeding mechanism is working with farmer organizations. The small farmers generally have the least amount of land, equipment, irrigation systems, and credits (infrastructure) and need upland or aerobic rice varieties that use water and fertilizers efficiently. These activities integrate the advances in breeding methodology (recurrent selection), the use of diverse germplasm including the interspecifics and in the future the high iron and zinc rice lines using participatory methods to focus on the needs of the small rice farmers. These activities help the farmers by developing their organizational skills and can aid in their eligibility for credits and other assistance. These farmers need to be aware of other opportunities to include other crops into their agro ecosystems especially high value crops. Rice is a food security crop that also contributes to the farmer's income. We expect at the end of this period to have an increased and more sustainable rice production highly competitive through lower production costs. This production system should also be friendlier to the environment and people trough lower use of pesticides. Our impact should also be measured by developing a more robust rice sector that will generate employment and maintain low rice prices for the poor consumers. We also expect that the expansion of this broad genetic base will lead to yield stability and better adaptability for abiotic and biotic stresses.

International Public Goods

The "International Treaty on Plant Genetic Resources for Food and Agriculture" is an international agreement governing many of the world's most important crop diversity collections. The treaty will ensure that this diversity, which is critical for the rice crop improvement will remain in the public domain. In the area of germplasm, CIAT has decided to place most of its elite lines into this system. To do this, we will use the database format of IRRI and these should become part of the Future Harvest genetic resources.

Most of the technologies including database management programs, breeding methodologies, rice lines that are developed at CIAT enter into the public domain as international public goods.

One of the most relevant and important products of the CIAT Rice Product Line is the development and deployment of interspecific rice lines derived from crosses between wild rice species and cultivated rice. Most of our partners and NARs in LAC are not in a position to carry out this type of breeding work since they lack the expertise, resources and funding to do it. Besides, they are more concerned with the development of improved lines to address production problems that impinge on today's rice production but not on broadening the genetic base of rice or on problems for which no sources of genetic resistance are known.

Partners

IRRI and WARDA are CGIAR institutions working on rice and with whom we collaborate in germplasm exchange and on problems of global importance. The Generation Challenge Program and INGER are two of the major joint activities.

We have an alliance with CIRAD and IRD of France, which is vital to our research activities. Two CIRAD scientists and one IRD scientist hold joint appointments with the CIAT rice project and contributed extensively to activities in Product 1 and Product 2.

To increase our impact, we are member of FLAR. This network includes members from fourteen countries. FLAR is a partnership of the private and public sectors for the international research of rice. Its mission is to generate new technologies to allow the Latin American rice sector to become more competitive, profitable and efficient with low environmental impact practices that propitiate lower unit costs and, as a consequence, lower rice prices to consumers. It generates both genetic resources and technology transfer of integrated crop management practices (contributing to Products 2 and 3).

The AgroSalud Project aiming at increasing the iron and zinc content in the rice grain includes partners throughout the region:

Brazil EMBRAPA & IRGA, Colombia FEDEARROZ, CORPOICA, U. Nacional U. del Tolima & U. de Antioquia, Peru INIA, Venezuela INIA, IVIC, FUNDARROZ & DANAC, Cuba IIA, Nicaragua INTA, Costa Rica CONARROZ, SENUMISA, INTA & U. Costa Rica, Guatemala ARROZGUA, Mexico Consejo Mexicano del Arroz, Bolivia CIAT Santa Cruz, ASPAR & CONARROZ, Dominican Republic IDIAF, Chile INIA, Panama U. de Panama, IDIAP, Uruguay INIA, Argentina INTA, CIB-FIBA, U. Corrientes & U. Tucuman are national institutions and we have activities many of which are carried out using the networks of FLAR, GRUMEGA, INGER and AgroSalud (Biofortification). Many of these institutions develop rice varieties while other are more involved in the transfer of technologies to the rice farmers.

Universities including KSU, Cornell, Purdue, LSU, U. of Arkansas, Texas A&M, U. Missouri, Rutgers, and Yale. We have collaborative projects and students (from Colombia and Mozambique) that work on research of mutual interest. IAEA collaborates in the use of induced mutations for crop improvement.

Project Funding:

Budgeting 2006-2010

Year	2006 (actual)	2007 (estimated)	2008 (proposal)	2009 (plan)	2010 (plan)
US Dollars (millions)	3.998	3.299	2.874	2.901	2.928

CIAT RICE PRODUCT LINES SBA-4: IMPROVED RICE FOR LATIN AMERICA AND THE CARIBBEAN (2008-2010)

Targets	Outputs	Intended users	Outcome	Impact
PRODUCT 1: Rice germplasm for improving human health and nutrition in Latin America Description: Development of high iron and zinc rice lines to combat malnutrition in LAC				Agronomically superior rice varieties with 6-8 ppm iron/ 22-25 ppm zinc as an instrument for improving human health and nutrition as well as for increasing productivity and rice farmers well being. Reduced micronutrient deficiency and increased food and nutrition security among vulnerable populations living in Colombia, Bolivia, Brazil, Nicaragua, Cuba, Panama and Dominican Republic.
Output Targets 2008	At least 4 lines with increased iron and zinc identified/ distributed to NARs	Rice scientists and breeding programs throughout the region	1.High yielding rice lines with enhanced nutritional quality. 2. Network of six collaborating partners. 3.GIS studies on testing sites.	
Output Targets 2009	At least two lines with increased iron and zinc grown in demo plots by collaborators in at least two countries.	Rice scientists and breeding programs throughout the region	1.High yielding rice lines with enhanced nutritional quality. 2. Network of six collaborating partners. 3. GIS studies on testing sites. 4. Participatory breeding	

Targets	Outputs	Intended users	Outcome	Impact
			activities.	
Output Targets 2010	At least one variety with increased Fe and Zn released in at least one country.	Urban and rural consumers, especially poor sectors in Latin America.	1. Economic and agronomic impact studies of biofortified rice. 2. Efficacy studies of biofortified rice or in combination with other crops.	
PRODUCT 2: Broadening the genetic base of irrigated rice in Latin America Description: Utilization of wild rice species and synthetic populations to broaden the genetic base of irrigated rice in LAC				1. Increased and more sustainable rice production. 2. Improved rice competitiveness through lower production costs and higher yields. 3. A more friendly rice production to the environment and people through lower use of pesticides. 4. Trained personnel.
Output Targets 2008	A CIAT-ION nursery made up of about 120-150 rice lines.	**For the benefit of farmers in general, urban and rural consumers, industry and seed producers, and the rice community at large.** **FLAR, GRUMEGA, INGER-LAC, and rice breeding programs throughout the region.** **Rice breeders, pathologists,**	Breeding lines, populations and progenitors with broaden genetic base, high yield potential, tolerance/ resistance to major pests and good grain quality to be used by our collaborators in their breeding programs. New alleles associated with agronomic traits of importance available to our	

Targets	Outputs	Intended users	Outcome	Impact
	Two breeding populations characterized for resistance to sheath blight for QTL analysis. Diagnosis of at least 50 rice panicles per country for the presence of the bacterial panicle blight associated to the mite-fungus-bacterium complex in Panama, Costa Rica and Nicaragua. Twenty fungicides evaluated for fungicide resistance levels in the rice pathogens causing rice blast and sheath blight	**and molecular biologists.** Rice breeders, pathologists, and farmers. Rice scientists, extension agents, rice farmers and regulatory agencies.	partners for further breeding work. Kits of molecular markers and molecular data available to our partners. Breeder's workshops and capacity building. Double haploid and recombinant inbred lines evaluated for sheath blight resistance. Screening methods developed for evaluating bacterial panicle blight resistance Fungicide resistance levels determined for the rice blast and sheath blight pathogens in Colombia and Venezuela	
Output Targets 2009	A CIAT-ION nursery made up of about 120-150 rice lines carrying the Pi-1, Pi-2, and Pi-33 genes for durable resistance to	**For the benefit of farmers in general, urban and rural consumers, industry and seed producers, and the rice community at large.** **FLAR, GRUMEGA, INGER-LAC, and rice breeding programs throughout the region.**	Breeding lines, populations and progenitors with broaden genetic base, high yield potential, tolerance/ resistance to major pests and good grain quality to be used by our collaborators in their breeding programs. New alleles associated with agronomic traits of	

Targets	Outputs	Intended users	Outcome	Impact
	rice blast. At least five crosses and populations developed for selecting rice lines tolerant to the bacterial panicle blight pathogen in Central America. Collection of at least 50 rice blast and sheath blight pathogen isolates for fungicide resistance studies.	**Rice breeders, pathologists, and farmers.** Rice scientists, extension agents, rice farmers and regulatory agencies.	importance available to our partners for further breeding work. Kits of molecular markers and molecular data available to our partners. Breeder's workshops and capacity building. Resistant lines identified and crosses made to develop rice cultivars with resistance to bacterial panicle blight. Fungicide resistance levels monitored in rice fields and capacity building on fungicide resistance management established.	
PRODUCT 3: **Broadening the genetic base of upland rice in Latin America Description: Rice synthetic population breeding and participatory breeding of upland rice for small farmers**				1. Increased and more sustainable rice production. 2. Improved rice competitiveness through lower production costs and higher yields. 3. A more friendly rice production to the environment and people through lower use of pesticides. 4. Trained personnel 5. A robust rice sector will generate employment and

Targets	Outputs	Intended users	Outcome	Impact
				maintain low rice prices for the poor consumers. The expansion of the genetic base of rice is leading to yield stability and better adaptability for abiotic and biotic stresses
Output Targets 2008	One hundred advanced lines arising from recurrent selection will have been widely distributed and tested in more than 11 countries throughout the region	FLAR, GRUMEGA, INGER-LAC and Rice breeding programs throughout the region	These recurrent selection populations will be a major basis for expanding the genetic diversity of cultivated rice in LAC. Increase interactions and efficiency of Rice Breeding Programs throughout LAC. Rice breeding strategies for evaluation and selection of promising rice lines that resu in more and better varieties released by the at a faster rate by rice sector.	
Output Targets 2009	Integrated regional collaboration for the use and development of rice genetic resources through networking will result in at least 2 new varieties released by national breeders.	FLAR, GRUMEGA, INGER-LAC, Rice breeding programs, and rice farmers throughout the region	These recurrent selection populations will be a major basis for expanding the genetic diversity of cultivated rice in LAC and for giving origin to new rice cultivars. Increase interactions and efficiency of Rice	

Targets	Outputs	Intended users	Outcome	Impact
			Breeding Programs throughout LAC. Rice breeding strategies for evaluation and selection of promising rice lines that resu in more and better varieties released by the at a faster rate by rice sector.	
Output Targets 2010	Integrated regional collaboration for the use and development of rice genetic resources through networking will result in at least 2 new varieties released by breeders.	FLAR, GRUMEGA, INGER-LAC, Rice breeding programs, and rice farmers throughout the region	These recurrent selection populations will be a major basis for expanding the genetic diversity of cultivated rice in LAC and for giving origin to new rice cultivars. Increase interactions and efficiency of Rice Breeding Programs throughout LAC. Rice breeding strategies for evaluation and selection of promising rice lines that resu in more and better varieties released by the at a faster rate by rice sector.	

Appendix I

Financial Tables 2007-2009

Table 1. CIAT - Cost Allocation : Financial Requirements by CGIAR Priorities 2008

(expenditure in $ million)

Priorities ---->		1A	1B	2A	2B	2C	2D	3A	3B	4A	4C	4D	5A	5B	5C	5D	Non Priority Areas			Total
Projects		Conservation of staple crops	Conservation of under utilized crops	Genetic improvement ofYields of food staples	Genetic improvement against abiotic stresses	Genetic improvement of nutrional quality	Genetic improvement of high value species	Fruit & Vegetables	Livestock	Integrated land & water management at landscape level	Water productivity	Intensification	Science & technology policies	Markets for the poor	Rural Institutions	Options to reduce rural poverty	Dev. activities	Stand-alone training	New research area	
SBA-1	Improved Beans for the Developing World	2.301	-	1.083	1.015	1.015	0.677	-	-	-	-	-	-	-	-	-	0.135	0.203	0.338	**6.768**
SBA-2	Improved Cassava for the Developing World	2.163	-	0.683	0.911	1.138	-	-	-	-	-	-	-	-	-	-	0.171	0.228	0.398	**5.691**
SBA-3	Improved Forages for the Developing World	1.610	-	-	-	-	-	-	1.534	-	-	-	-	-	-	-	0.115	0.268	0.307	**3.834**
SBA-4	Improved Rice for Latin America	0.718	-	0.718	0.575	0.431	-	-	-	-	-	-	-	-	-	-	0.086	0.115	0.230	**2.874**
SBA-5	HarvestPlus Challenge Program	1.440	0.120	0.120	0.120	0.120	0.120	-	-	-	-	-	-	-	-	-	-	0.120	0.240	**2.400**
PA-1	Markets, Institutions and Livelihoods	-	0.839	-	-	-	-	0.959	-	1.799	0.360	1.199	0.600	2.638	2.399	0.360	0.120	0.480	0.240	**11.993**
PA-2	Tropical Soil Biology & Fertility (TSBF)	-	-	-	-	-	-	-	-	4.375	-	1.250	-	-	-	-	0.125	0.313	0.188	**6.250**
PA-3	PRGA	-	-	-	-	-	-	-	-	-	-	-	-	-	0.490	0.070	0.056	0.084	-	**0.700**
Total		**8.233**	**0.959**	**2.604**	**2.621**	**2.704**	**0.797**	**0.959**	**1.534**	**6.174**	**0.360**	**2.449**	**0.600**	**2.638**	**2.889**	**0.430**	**0.808**	**1.810**	**1.941**	**40.510**

Table 1a. CIAT - Cost Allocation: Allocation of Projects Costs to CGIAR System Priorities, 2006-2010 (expenditure in $ million)

	2006 (actual)	2007 (estimated)	2008 (proposal)	2009 (plan)	2010 (plan)
1A Conservation of staple crops	8.136	8.915	8.233	8.296	8.361
1B Conservation of under utilized crops	0.914	1.044	0.959	0.967	0.975
1C Conservation of indigenous livestock	-	-	-	-	-
1D Conservation of aquatic animals	-	-	-	-	-
2A Genetic improvement of yields of food staples	2.813	2.849	2.604	2.628	2.651
2B Genetic improvement against abiotic stresses	2.797	2.854	2.621	2.644	2.668
2C Genetic improvement of nutritional quality	2.844	2.933	2.704	2.729	2.754
2D Genetic improvement of high value species	0.697	0.853	0.797	0.803	0.810
3A Fruit & Vegetables	0.965	1.056	0.959	0.968	0.978
3B Livestock	1.740	1.756	1.534	1.548	1.563
3C Fisheries	-	-	-	-	-
3D Forests & Trees	-	-	-	-	-
4A Integrated land & water management at landscape level	6.662	6.409	6.174	6.232	6.291
4B Aquatic ecosystems	-	-	-	-	-
4C Water productivity	0.362	0.396	0.360	0.363	0.367
4D Intensification	2.593	2.586	2.449	2.472	2.496
5A Science & technology policies	0.603	0.660	0.600	0.605	0.611
5B Martkets for the poor	2.654	2.905	2.638	2.663	2.688
5C Rural institutions	2.898	3.341	2.889	2.911	2.934
5D Options to reduce rural poverty	0.431	0.496	0.430	0.433	0.437
Development activities	0.876	0.899	0.808	0.815	0.823
Stand-alone training	1.881	1.987	1.810	1.825	1.841
New research area	2.001	2.102	1.941	1.957	1.973
Total:	**41.869**	**44.041**	**40.510**	**40.860**	**41.220**

Table 2. Allocation of Resources by CIAT Projects, 2006-2010
(in $ million)

	2006 (actual)	2007 (estimated)	2008 (proposal)	2009 (plan)	2010 (plan)
RDC1: Sharing the Benefits of Agrobiodiversity					
Improved Beans for the Developing World	6.276	7.333	6.768	6.831	6.897
Improved Cassava for the Developing World	6.168	6.090	5.691	5.744	5.799
Improved Forages for the Developing World	4.349	4.389	3.834	3.870	3.907
Improved Rice for Latin America and the Caribbean	3.998	3.299	2.874	2.901	2.928
HarvestPlus Challenge Program	1.387	2.400	2.400	2.400	2.400
Sub Total	**22.179**	**23.511**	**21.567**	**21.746**	**21.931**
RDC2: People and Agroecosystems					
Markets, Institutions and Livelihoods	12.065	13.205	11.993	12.105	12.220
TSBF - ISFM	6.932	6.326	6.250	6.309	6.369
Participatory Research and Gender Analysis (PRGA)	0.692	1.000	0.700	0.700	0.700
Sub Total	**19.690**	**20.531**	**18.943**	**19.114**	**19.289**
Total	**41.869**	**44.041**	**40.510**	**40.860**	**41.220**

Table 3. CIAT- Cost Allocation: Allocation of Projects Costs to CGIAR Priority, 2006-2010

(in $ million)

Project	Priority		2006 (actual)	2007 (estimated)	2008 (proposal)	2009 (plan)	2010 (plan)
Improved Beans for the Developing World	1A	Conservation of staple crops	2.134	2.493	2.301	2.323	2.345
	2A	Genetic improvement of yields of food staples	1.004	1.173	1.083	1.093	1.103
	2B	Genetic improvement against abiotic stresses	0.941	1.100	1.015	1.025	1.034
	2C	Genetic improvement of nutritional quality	0.941	1.100	1.015	1.025	1.034
	2D	Genetic improvement of high value species	0.628	0.733	0.677	0.683	0.690
		Development activities	0.126	0.147	0.135	0.137	0.138
		Stand-alone training	0.188	0.220	0.203	0.205	0.207
		New research area	0.314	0.367	0.338	0.342	0.345
		Total	**6.276**	**7.333**	**6.768**	**6.831**	**6.897**
Improved Cassava for the Developing World	1A	Conservation of staple crops	2.344	2.314	2.163	2.183	2.204
	2A	Genetic improvement of yields of food staples	0.740	0.731	0.683	0.689	0.696
	2B	Genetic improvement against abiotic stresses	0.987	0.974	0.911	0.919	0.928
	2C	Genetic improvement of nutritional quality	1.234	1.218	1.138	1.149	1.160
		Development activities	0.185	0.183	0.171	0.172	0.174
		Stand-alone training	0.247	0.244	0.228	0.230	0.232
		New research area	0.432	0.426	0.398	0.402	0.406
		Total	**6.168**	**6.090**	**5.691**	**5.744**	**5.799**
Improved Forages for the Developing World	1A	Conservation of staple crops	1.827	1.844	1.610	1.625	1.641
	3B	Livestock	1.740	1.756	1.534	1.548	1.563
		Development activities	0.130	0.132	0.115	0.116	0.117
		Stand-alone training	0.304	0.307	0.268	0.271	0.273
		New research area	0.348	0.351	0.307	0.310	0.313
		Total	**4.349**	**4.389**	**3.834**	**3.870**	**3.907**
Improved Rice for LAC	1A	Conservation of staple crops	1.000	0.825	0.718	0.725	0.732
	2A	Genetic improvement of yields of food staples	1.000	0.825	0.718	0.725	0.732
	2B	Genetic improvement against abiotic stresses	0.800	0.660	0.575	0.580	0.586
	2C	Genetic improvement of nutritional quality	0.600	0.495	0.431	0.435	0.439
		Development activities	0.120	0.099	0.086	0.087	0.088
		Stand-alone training	0.160	0.132	0.115	0.116	0.117
		New research area	0.320	0.264	0.230	0.232	0.234
		Total	**3.998**	**3.299**	**2.874**	**2.901**	**2.928**
HarvestPlus Challenge Program	1A	Conservation of staple crops	0.832	1.440	1.440	1.440	1.440
	1B	Conservation of under utilized crops	0.069	0.120	0.120	0.120	0.120
	2A	Genetic improvement of yields of food staples	0.069	0.120	0.120	0.120	0.120
	2B	Genetic improvement against abiotic stresses	0.069	0.120	0.120	0.120	0.120
	2C	Genetic improvement of nutritional quality	0.069	0.120	0.120	0.120	0.120
	2D	Genetic improvement of high value species	0.069	0.120	0.120	0.120	0.120
		Stand-alone training	0.069	0.120	0.120	0.120	0.120
		New research area	0.139	0.240	0.240	0.240	0.240
		Total	**1.387**	**2.400**	**2.400**	**2.400**	**2.400**

Table 3. CIAT- Cost Allocation: Allocation of Projects Costs to CGIAR Priority, 2006-2010

(in $ million)

Project		Priority	2006 (actual)	2007 (estimated)	2008 (proposal)	2009 (plan)	2010 (plan)
Markets, Institutions and Livelihoods	1A	*Conservation of staple crops*	-	-	-	-	-
	1B	Conservation of under utilized crops	0.845	0.924	0.839	0.847	0.855
	3A	Fruit & Vegetables	0.965	1.056	0.959	0.968	0.978
	4A	Integrated land & water management at landscape level	1.810	1.981	1.799	1.816	1.833
	4C	Water productivity	0.362	0.396	0.360	0.363	0.367
	4D	Intensification	1.207	1.320	1.199	1.210	1.222
	5A	Science & technology policies	0.603	0.660	0.600	0.605	0.611
	5B	Martkets for the poor	2.654	2.905	2.638	2.663	2.688
	5C	Rural institutions	2.413	2.641	2.399	2.421	2.444
	5D	Options to reduce rural poverty	0.362	0.396	0.360	0.363	0.367
		Development activities	0.121	0.132	0.120	0.121	0.122
		Stand-alone training	0.483	0.528	0.480	0.484	0.489
		New research area	0.241	0.264	0.240	0.242	0.244
		Total	**12.065**	**13.205**	**11.993**	**12.105**	**12.220**
TSBF - ISFM	1A	Conservation of staple crops	-	-	-	-	-
	4A	Integrated land & water management at landscape level	4.852	4.428	4.375	4.416	4.458
	4D	Intensification	1.386	1.265	1.250	1.262	1.274
		Development activities	0.139	0.127	0.125	0.126	0.127
		Stand-alone training	0.347	0.316	0.313	0.315	0.318
		New research area	0.208	0.190	0.188	0.189	0.191
		Total	**6.932**	**6.326**	**6.250**	**6.309**	**6.369**
PRGA - Participatory Research & Gender Analysis	1A	Conservation of staple crops	-	-	-	-	-
	5C	Rural institutions	0.485	0.700	0.490	0.490	0.490
	5D	Options to reduce rural poverty	0.069	0.100	0.070	0.070	0.070
		Development activities	0.055	0.080	0.056	0.056	0.056
		Stand-alone training	0.083	0.120	0.084	0.084	0.084
		Total	**0.692**	**1.000**	**0.700**	**0.700**	**0.700**
		TOTAL	**41.869**	**44.041**	**40.510**	**40.860**	**41.220**

Table 4. CIAT - Undertaking, Activities and Sectors, 2006-2010

(expenditure in $ million)

	2006 (actual)	2007 (estimated)	2008 (proposal)	2009 (plan)	2010 (plan)
Increasing Productivity	**18.767**	**19.753**	**18.140**	**18.296**	**18.457**
Of which:					
Germplasm Enhancement & Breeding	13.228	13.997	12.869	12.978	13.090
Production Systems Development & Management	5.539	5.756	5.271	5.318	5.367
Of which:					
Cropping Systems	3.547	3.742	3.427	3.458	3.490
Livestock Systems	1.992	2.014	1.844	1.860	1.878
Protecting the Environment	**7.570**	**7.763**	**7.200**	**7.265**	**7.332**
Saving Biodiversity	**8.679**	**9.160**	**8.405**	**8.474**	**8.546**
Improving Policies	**1.345**	**1.560**	**1.439**	**1.450**	**1.462**
Strengthening NARS	**5.508**	**5.805**	**5.326**	**5.374**	**5.423**
of which:					
Training and Professional Development	1.358	1.450	1.335	1.346	1.358
Documentation, Publications, Info. Dissemination	0.815	0.887	0.800	0.807	0.814
Organization & Management Counselling	1.341	1.473	1.333	1.346	1.358
Networks	1.993	1.996	1.858	1.875	1.893
TOTAL	**41.869**	**44.041**	**40.510**	**40.860**	**41.220**

Table 5. CIAT- Cost Allocation: Allocation of Projects Costs to CGIAR Regions, 2006-2010

(in $ million)

Project	Region	2006 (actual)	2007 (estimated)	2008 (proposal)	2009 (plan)	2010 (plan)
SBA-1 : Improved Beans for the Developing World	Sub-Saharan Africa (SSA)	3.389	3.960	3.655	3.689	3.724
	Asia	-	-	-	-	-
	Latin America and the caribbean (LAC)	2.875	3.358	3.100	3.129	3.159
	Central West Asia and North Africa (CWANA)	0.013	0.015	0.014	0.014	0.014
		6.276	**7.333**	**6.768**	**6.831**	**6.897**
SBA-2 : Improved Cassava for the Developing World	Sub-Saharan Africa (SSA)	1.851	1.827	1.707	1.723	1.740
	Asia	1.851	1.827	1.707	1.723	1.740
	Latin America and the caribbean (LAC)	2.467	2.436	2.276	2.298	2.320
	Central West Asia and North Africa (CWANA)	-	-	-	-	-
		6.168	**6.090**	**5.691**	**5.744**	**5.799**
SBA-3 : Improved Forages for the Developing World	Sub-Saharan Africa (SSA)	0.400	0.330	0.287	0.290	0.293
	Asia	1.199	0.990	0.862	0.870	0.878
	Latin America and the caribbean (LAC)	2.399	1.979	1.724	1.740	1.757
	Central West Asia and North Africa (CWANA)	-	-	-	-	-
		3.998	**3.299**	**2.874**	**2.901**	**2.928**
SBA-4 : Improved Rice for Latin America and the Caribbean	Sub-Saharan Africa (SSA)	-	-	-	-	-
	Asia	-	-	-	-	-
	Latin America and the caribbean (LAC)	4.349	4.389	3.834	3.870	3.907
	Central West Asia and North Africa (CWANA)	-	-	-	-	-
		4.349	**4.389**	**3.834**	**3.870**	**3.907**
SBA-5: HarvestPlus Challenge Program	Sub-Saharan Africa (SSA)	0.723	1.250	1.250	1.250	1.250
	Asia	0.455	0.787	0.787	0.787	0.787
	Latin America and the caribbean (LAC)	0.209	0.362	0.362	0.362	0.362
	Central West Asia and North Africa (CWANA)	-	-	-	-	-
		1.387	**2.400**	**2.400**	**2.400**	**2.400**
PA-2: TSBF Institute	Sub-Saharan Africa (SSA)	5.546	5.061	5.000	5.047	5.095
	Asia	0.693	0.633	0.625	0.631	0.637
	Latin America and the caribbean (LAC)	0.693	0.633	0.625	0.631	0.637
	Central West Asia and North Africa (CWANA)	-	-	-	-	-
		6.932	**6.326**	**6.250**	**6.309**	**6.369**
PA-1 : Markets, Institutions and Livelihoods	Sub-Saharan Africa (SSA)	3.620	3.961	3.598	3.631	3.666
	Asia	2.413	2.641	2.399	2.421	2.444
	Latin America and the caribbean (LAC)	6.033	6.602	5.996	6.052	6.110
	Central West Asia and North Africa (CWANA)	-	-	-	-	-
		12.065	**13.205**	**11.993**	**12.105**	**12.220**
PA-3: PRGA SW	Sub-Saharan Africa (SSA)	0.242	0.350	0.245	0.245	0.245
	Asia	0.208	0.300	0.210	0.210	0.210
	Latin America and the caribbean (LAC)	0.104	0.150	0.105	0.105	0.105
	Central West Asia and North Africa (CWANA)	0.138	0.200	0.140	0.140	0.140
		0.692	**1.000**	**0.700**	**0.700**	**0.700**

Summary by Regions:

	2006 (actual)	2007 (estimated)	2008 (proposal)	2009 (plan)	2010 (plan)
Sub-Saharan Africa (SSA)	15.770	16.739	15.743	15.876	16.013
Asia	6.819	7.177	6.590	6.643	6.696
Latin America and the Caribbean (LAC)	19.129	19.910	18.023	18.188	18.357
Central West Asia and North Africa (CWANA)	0.151	0.215	0.154	0.154	0.154
Total:	41.869	44.041	40.510	40.860	41.220

Table 6. CIAT- Expenditures, 2006 - 2010

(in $ million)

OBJECT OF EXPENDITURE	2006 (actual)	2007 (estimated)	2008 (proposal)	2009 (plan)	2010 (plan)
Personnel	21.781	20.831	18.191	18.737	19.299
Supplies and Services	10.701	9.760	8.799	8.532	8.257
Collaboration/Parnerships Cost	4.397	8.000	8.000	8.000	8.000
Operational Travel	3.605	3.500	3.570	3.641	3.714
Depreciation	1.385	1.950	1.950	1.950	1.950
TOTAL	**41.869**	**44.041**	**40.510**	**40.860**	**41.220**

Table 7. CIAT - Financing: Unrestricted and Restricted Grants and Center Income, 2006-2008

(in $ million)

Member	2006 ($ actual)	2006 (nat. currency)	2007 ($ estimated)	2007 (nat. currency)	2008 ($ proposal)	2008 (nat. currency)
Unrestricted Contributions						
AUSTRALIA	0.374	0.500	0.000	0.000	0.200	0.250
BELGIUM	0.245	0.194	0.253	0.194	0.258	0.194
BRAZIL	0.100	0.100	0.120	0.120	0.120	0.120
CANADA	1.024	1.189	1.275	1.486	1.039	1.189
GERMANY	0.443	0.350	0.456	0.350	0.463	0.350
JAPAN	0.037	4.486	0.000	0.000	0.000	0.000
NETHERLANDS	0.422	0.422	0.000	0.000	0.000	0.000
NEW ZEALAND	0.277	0.450	0.311	0.450	0.323	0.450
NORWAY	1.460	9.500	0.969	6.000	0.987	6.000
SWEDEN	0.447	3.400	0.482	3.400	0.490	3.400
SWITZERLAND	0.828	1.000	0.907	1.000	0.915	1.000
UNITED KINGDOM	1.410	0.755	1.478	0.755	1.493	0.755
USA	2.100	2.100	1.575	1.575	1.575	1.575
THAINLAND	0.020	0.020	0.020	0.020	0.020	0.020
WORLD BANK	2.589	2.589	3.500	3.500	2.000	2.000
subtotal	11.776		11.241		9.771	

	2006 ($ actual)		2007 ($ estimated)		2008 ($ proposal)	
Restricted Contributions						
AAFT	0.114		0.028		-	
ACENTURE LIMITED	0.083		0.050		-	
ADB	0.152		0.300		0.243	
ASARECA	0.298		0.250		0.251	
AUSTRALIA	0.207		0.141		0.285	
AUSTRIA	0.490		0.500		0.323	
BELGIUM	0.975		0.900		1.047	
BRAZIL	-		0.139		0.140	
BWP	0.016		0.000		-	
CANADA	4.015		5.450		4.582	
CFC	0.495		0.700		0.880	
CIMMYT	0.079		-		-	
CIP	0.022		(0.000)		0.034	
CLAYUCA	0.131		0.054		0.050	
CRS			0.050		0.018	
COLOMBIA	0.653		0.700		0.879	
DENMARK	0.029					
EC	0.099		2.469		1.810	
FAO	0.045		0.040		-	
FIDAR	0.021		0.000			
FLAR	0.816		0.400		0.400	
FONTAGRO	0.140		0.330		0.291	
FRANCE	0.228		0.250		0.250	
GEF	0.162		0.200		0.250	
Generation Challenge Program	1.054		0.948		0.900	
GENOPLANTE	0.099		-		-	
GERMANY	1.262		1.344		1.829	
HarvestPlus Challenge Program	1.389		2.400		2.400	
ICRAF	0.087		-		-	
ICRISAT	0.179		(0.000)		0.007	
IDB	0.064		-		-	
IDRC	0.755		0.850		0.767	
IFAD	0.478		0.450		0.954	
IFDC	0.125		0.280		0.240	
IFPRI	0.022					
IICA	0.237		0.100		0.200	
ILRI	0.048		0.000		0.093	
IPGRI	0.074		(0.000)			
IPICS	0.027		0.000		-	
ITALY	0.007		0.200		0.200	
JAPAN	0.200	24.334	0.200	24.000	0.200	24.000
KELLOGG FDN	0.409		0.860		0.570	
NETHERLANDS	0.044		0.000		-	
NIGERIA	0.009					
NIPPON FDN	0.275		0.300		0.338	
North Carolina State University	0.028		0.049			
OTHERS:	0.272		0.234		1.858	
PAPALOTLA	0.319		0.250		0.281	
PERU	0.055		-		0.050	
ROCKEFELLER FDN	1.038		0.900		0.900	
SPAIN	0.231		0.181		0.150	
SWITZERLAND	1.299		1.300		1.367	
Sub-Saharan Africa Challenge Program	0.249		0.400		0.400	
TNC - The Nature Conservancy	0.045		(0.000)		-	
UNEP	0.386		2.900		1.421	
UNITED KINGDOM	1.142		2.500		2.953	
UNIVERSITY CALIFORNIA	0.040		0.000		-	
UNIVERSITY OF OHIO	0.077		0.083			
USA	1.768		2.025		1.972	
Water & Food Challenge Program	1.110		1.000		0.800	
WORLD BANK	-		0.400		0.450	
WORLD VISION	0.055		-		-	
WU - Wageningen University	0.015		0.038		0.008	
subtotal	24.830		32.609		31.810	
TOTAL GRANTS	36.606		43.851		41.580	

Summary Statement of Activitiy	2006 ($ actual)	2007 ($ estimated)	2008 ($ proposal)
Member Grants	36.606	43.851	41.580
+ Center Income (other revenues)	1.411	1.550	1.100
= Total Revenues	38.017	45.401	42.680
Less:			
Total Expenses	41.869	44.041	40.510
Surplus/ (Deficit) of *total revenues over* total expenses	(3.852)	1.360	2.170

Table 9. CIAT- Staff Composition: Internationally and Nationally Recruited Staff, 2006-201(

Staff Type	2006 (actual)	2007 (estimated)	2008 (proposal)	2009 (plan 1)	2010 (plan 2)
Internationally-Recruited Staff (IRS)	90	85	81	81	81
Other Staff	640	585	565	565	565
TOTAL	730	670	646	646	646

Table 10. CIAT- Financial Position: Currency Structure of Expenditures, 2006-2008

Currency	2006 (actual)			2007 (estimated)			2008 (proposal)		
	Amount	$ value	% share	Amount	$ value	% share	Amount	$ value	% share
US Dollar		19.678	47%		20.699	47%		19.445	48%
Colombian Peso	45,654	19.678	47%	46,573	20.699	47%	43,791	18.635	46%
Others		2.512	6%		2.642	6%		2.431	6%
TOTAL		41.869	100%		44.041	100%		40.510	100%

Table 11: Centro Internacional de Agricultura Tropical (CIAT)

Statements of Financial Position

As of December 31, 2006 and 2005
(expressed in thousands of U.S. dollars)

	Note	2006	2005
Assets			
Current Assets			
Cash and cash equivalents	3	18,514	14,559
Accounts receivable			
Donors	4	5,244	7,181
Employees		366	357
Others CGIAR Centers	5	195	57
Others	6	2,754	1,489
Inventories	7	430	348
Prepaid expenses		97	176
Total Current Assets		**27,600**	**24,167**
Non-Current Assets			
Property, and equipment	8	9,525	10,021
Other assets		6	6
Total Non-Current Assets		**9,531**	**10,027**
Total Assets		**37,131**	**34,194**
Liabilities and Net Assets			
Current Liabilities			
Accounts payable			
Donors	9	13,399	8,551
Employees	10	776	774
Others	11	3,766	2,356
Support to Partners Challenge Programs	12	2,852	3,620
Funds in trust	13	2,775	1,950
Accruals and provisions	14	304	145
Total Current Liabilities		**23,872**	**17,396**
Non-Current Liabilities			
Others	11	477	514
Accruals and provisions	14	1,441	1,091
Total Non-Current Liabilities		**1,918**	**1,605**
Total Liabilities		**25,790**	**19,001**
Net Assets - Unrestricted	15		
Designated		10,260	11,125
Undesignated		1,081	4,068
Total Net Assets		**11,341**	**15,193**
Total Liabilities and Net Assets		**37,131**	**34,194**

The financial statements were approved by the Board of Trustees on ____May, 2007 and were signed on its behalf by:

Joachim Voss
Director General

Luis Roberto Sanint
Acting Director of Finance, 2006

See accompanying notes to the financial statements

Table 12: Centro Internacional de Agricultura Tropical (CIAT)

Statement of Activity

For the years ended as of December 31, 2006 and 2005

(expressed in thousands of U.S. dollars)

	Notes	Unrestricted	Restricted		Total 2006	Total 2005
			Temporary	Challenge Programs		
Revenue and Gains						
Grants	Exhibit I & II	11,776	21,030	3,800	36,606	40,216
Other revenues and gains	16	1,411			1,411	1,248
Total revenues and gains		**13,187**	**21,030**	**3,800**	**38,017**	**41,464**
Expenses and Losses						
Program related expenses	17	10,412	20,729	3,620	34,761	37,312
Management and general expenses	18	6,002	301	180	6,483	7,645
Other losses expenses	19	530	-	-	530	198
Sub total expenses and losses		**16,944**	**21,030**	**3,800**	**41,774**	**45,155**
Indirect cost recovery		(2,719)	-	-	(2,719)	(2,797)
Total expenses and losses		**14,225**	**21,030**	**3,800**	**39,055**	**42,358**
Net Surplus (Deficit) from ordinary activities		**(1,038)**	**-**	**-**	**(1,038)**	**(894)**
Extraordinary Items:						
Reorganization Phase out costs	20	(2,814)	-	-	(2,814)	-
		-			-	
NET SURPLUS (DEFICIT) :		**(3,852)**	**-**	**-**	**(3,852)**	**(894)**

Operating expenses by natural classification

Personnel costs	11,331	6,895	855	19,081	20,639
Supplies and services	1,113	7,812	1,662	10,587	10,432
Collaborators - Partnerships costs	-	3,823	574	4,397	5,797
Operational travel	877	2,199	529	3,605	3,592
Depreciation of fixed assets	904	301	180	1,385	1,898
Total operating expenses, net	**14,225**	**21,030**	**3,800**	**39,055**	**42,358**

See accompanying notes to the financial statements

Appendix II

List of Acronyms and Abbreviations
(May 2007)

List of Acronyms and Abbreviations

Acronyms

ACERG	Asociación de Centros Educativos del Cañón del Río Garrapatas, Colombia
ACIAR	Australian Centre for International Agricultural Research
ADB	Asian Development Bank
AfNet	African Network for Soil Biology and Fertility
AHI	African Highland Initiative
APC	Association for Progressive Communications
ARI	Agricultural Research Institute, Tanzania
ASARECA	Association for Strengthening Agricultural Research in Eastern and Central Africa
ASOBOLO	Asociación de la Cuenca del Río Bolo, Colombia
ASOCOLFLORES	Asociación Colombiana de Exportadores de Flores
AVRDC	Asian Vegetable Research and Development Center
BBA	Federal Biological Research Centre for Agriculture and Forestry, France
BCP	Biofortification Challenge Program
Bean/Cowpea CRSP	Bean/Cowpea Collaborative Research Support Program (*of the* Univ. Georgia, USA)
BOT	Board of Trustees (*of* CIAT)
CA	Département des Cultures Annuelles (*of* CIRAD)
CAAS	Chinese Academy of Agricultural Sciences
CAMBIA	Centre for the Application of Molecular Biology to International Agriculture, Australia
CAPRi	Collective Action and Property Rights
CARDER	Corporación Autónoma Regional de Risaralda, Colombia
CARE	Cooperative for American Relief Everywhere, USA
CATIE	Centro Agrónomico Tropical de Investigación y Enseñanza, Costa Rica
CBN	Cassava Biotechnology Network
CEGA	Centro de Estudios de Ganadería y Agricultura, Colombia
CENIBANANO	Centro de Investigaciones del Banano, Colombia
CENICAFE	Centro de Investigaciones del Café, Colombia
CENIPALMA	Centro de Investigación en Palma de Aceite, Colombia
CENTA	*Centro Nacional de* Tecnología Agropecuaria, El Salvador
CFP	Centro Fitogenético Pairumani, Bolivia
CIAT	Centro de Investigación Agrícola Tropical, Bolivia
CIDA	Canadian International Development Agency
CIFOR	Centre for International Forestry Research, Indonesia
CIMMYT	Centro Internacional para Mejoramiento de Maiz y Trigo, Mexico
CIP	Centro Internacional de la Papa, Peru
CIPASLA	Consorcio Interinstitucional para una Agricultura Sostenible en Laderas, Colombia
CIPAV	Fundación del Centro para la Investigación en Sistemas Sostenibles de Producción Agropecuaria, Colombia
CIRAD	Centre de Coopération Internationale en Recherche Agronomique pour le Développement, France
CLAYUCA	Consorcio Latinoamericano y del Caribe de Apoyo a la Investigación y Desarrollo de la Yuca, *based in* Colombia
CLODEST	Comité Local para el Desarrollo Sostenible de la Cuenca del Río Tascalapa, Honduras
CNPMF	Centro Nacional de Pesquisa de Mandioca e Fruticultura Tropical (*of* EMBRAPA)
CODESU	Corporación para el Desarrollo Sostenible de Ucayali, Peru
COLCIENCIAS	Instituto Colombiano para el *Desarrollo de* la Ciencia y la Tecnología "Francisco José de Caldas"
CONDESAN	Consorcio para el Desarrollo Sostenible de la Ecorregión Andina, Peru
CORPOICA	Corporación Colombiana de Investigación Agropecuaria
CRCTPP	Cooperative Research Centre for Tropical Plant Pathology, Australia
CRI	Crop Research Institute, Ghana
CRS	Catholic Relief Services, USA

CSIRO	Commonwealth Scientific and Industrial Research Organisation, Australia
CTCRI	Central Tuber Crops Research Institute, India
CURLA	Centro Universitario Regional del Litoral Atlántico, Honduras
CVC	Corporación Autónoma Regional del Valle del Cauca, Colombia
DANAC	La Fundación para la Investigación Agrícola—Danac, Venezuela
DANIDA	Danish International Development Agency, Denmark
DBT	Department for Biotechnology and Biological Control (*of the* Univ. Kiel, Germany)
DFID	Department for International Development, UK
DGIS	Directorate-General for International Co-operation, the Netherlands
DICTA	Dirección de Ciencia y Tecnología Agropecuaria, Honduras
DNP	Departamento Nacional de Planeación, Colombia
EAP-Zamorano	Escuela Agrícola Panamericana *at* Zamorano, Honduras
EARO	Ethiopian Agricultural Research Organization
EC	Economic Commission (*of the* European Union)
ECABREN	Eastern and Central Africa Bean Research Network
ECLAC	Economic Commission for Latin America and the Caribbean
EMBRAPA	Empresa Brasileira de Pesquisa Agropecuária
EPMR	External Program and Management Review (*of* CIAT)
ETH	also ETHZ; Eidgenõssische Technische Hochschule—Zürich, Switzerland
E-TIP	Ecologia's Environmental Technical Information Project (online service)
FAO	Food and Agriculture Organization of the United Nations
FCRI	Field Crop Research Institute, Thailand
FEDEARROZ	Federación Nacional de Arroceros, Colombia
FIDAR	Fundación para la Investigación y el Desarrollo Agroindustrial Rural, Colombia
FLAR	Fondo Latinoamericano y del Caribe para Arroz de Riego, *based at* CIAT
FONAIAP	Fondo Nacional de Investigaciones Agropecuarias, Venezuela
FPR-IPM	Farmer Participatory Research for IPM Project (*of the* SP-IPM *and* SP-PRGA)
GEF	Global Environment Facility (*of the* UNDP, UNEP, *and* World Bank)
GRU	Genetic Resources Unit (*of* CIAT)
GTZ	Deutsche Gesellschaft für Technische Zusammenarbeit (German Agency for Technical Cooperation)
GWG	Gender Working Group (*of the* SP-PRGA)
HAP	Hillside Agricultural Program, Haiti
IAEA	International Atomic Energy Agency, Austria
IAR&T	Institute for Agricultural Research and Training, Nigeria
IBSRAM	International Board for Soil Research and Management, Thailand
ICA	Instituto Colombiano Agropecuario
ICARDA	International Center for Agricultural Research in the Dry Areas, Syria
ICER	Internally Commissioned External Review (*of* CIAT)
ICIPE	International Centre of Insect Physiology and Ecology, Kenya
ICRAF	International Centre for Research in Agroforestry, Kenya
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics, India
ICTA	Instituto de Ciencia y Tecnología Agrícola, Guatemala
ICWG—CC	Inter-Center Working Group on Climate Change (*of the* CGIAR)
IDEAM	Instituto de Hidrología, Meteorología y Estudios Ambientales, Colombia
IDIAP	Instituto de Investigación Agropecuaria de Panamá
IDRC	International Development Research Centre, Canada
IDS	Institute for Development Studies, UK
IER	Institut d'Economie Rurale du Mali
IFDC	International Fertilizer Development Center, USA
IFPRI	International Food Policy Research Institute, USA
IGAC	Instituto Geográfico "Agustín Codazzi", Colombia
IGDN	Inter-American Geospatial Data Network
IGER	Institute of Grasslands Environment Research, UK

IIA	Instituto de Investigaciones Avícolas, Cuba
IIA	Instituto de *Investigaciones* Agropecuarias, Venezuela
IIASA	International Institute for Applied Systems Analysis, Austria
IICA	Instituto Interamericano de Cooperación para la Agricultura, Costa Rica
IILA	Instituto Italo-Latino Americano, Italy
IITA	International Institute of Tropical Agriculture, Nigeria
ILAC	Institutional Learning and Change
ILRI	International Livestock Research Institute, Kenya
INBIO	Instituto Nacional de Biodiversidad, Costa Rica
INERA	Institut de l'Environnement et de Recherches Agricoles, Burkina Faso
InforCom	Information and Communications for Rural Communities
INIA	Instituto de Investigaciones Agropecuarias, Chile
INIA	Instituto Nacional de Investigación Agraria, Peru (*now* INIAA)
INIA	Instituto Nacional de Investigación Agropecuaria, Uruguay
INIA	Instituto Nacional de Investigaciones Agrícolas de Venezuela
INIAA	Instituto Nacional de Investigación Agraria y Agroindustrial, Peru (*formerly* INIA)
INIAP	Instituto Nacional Autónomo de Investigaciones Agropecuarias, Ecuador (*formerly* Instituto Nacional de Investigaciones Agropecuarias)
INIFAP	Instituto Nacional de Investigaciones Forestales, Agrícolas y Pecuarias, Mexico
INIVIT	Instituto de Investigaciones de Viandas Tropicales, Cuba
INPA	Instituto Nacional de Pesquisas da Amazônia, Brazil
INPE	Instituto Nacional de Pesquisas Espaciais, Brazil
INRAB	Institut National des Recherches Agricoles du Bénin
INRAN	Institut National des Recherches Agronomiques du Niger
INTA	Instituto Nacional de Tecnología Agropecuaria, Argentina
INTA	Instituto Nicaragüense de Tecnología Agropecuaria
IPCA	Proyecto de Investigación Participativa en Centroamérica, *based in* Honduras
IPGRI	International Plant Genetic Resources Institute, Italy
IPP	Institute for Plant Protection, Germany
IPRA	Investigación Participativa en Agricultura/ *Participatory Research in Agriculture, based at* CIAT
IRD	Institut de Recherche pour le Développement, France (*formerly* ORSTOM)
IRRI	*International Rice* Research Institute, the Philippines
ISABU	Institut des Sciences Agronomiques du Burundi
ISAR	Institut des Sciences Agronomiques du Rwanda
ITRA	Institut Togolais de Recherche Agronomique
IVITA	Instituto Veterinario de Investigaciones Tropicales y de Altura, Peru
IWMI	International Water Management Institute, Sri Lanka (*formerly* International Irrigation Management Institute)
JIRCAS	Japan International Research Center for Agricultural Sciences
KARI	Kenya Agricultural Research Institute
KEMRI	Kenya Medical Research Institute
KSU	Kansas State University, USA
Lempira Sur	FAO project in Honduras to change slash-and-burn agriculture
LSU	Louisiana State University, USA
MADR	Ministerio de Agricultura *y Desarrollo* Rural, Colombia
MinAmbiente	Ministerio del Medio Ambiente, Colombia
MIS	*also* MIS Group; Management and Information Systems Research Group (*of the* Univ. York, UK)
MSU	Michigan State University, USA
MT	Management Team (*of* CIAT)
NARO	National Agricultural Research Organization, Uganda
NCAR	National Center for Atmospheric Research, USA
NCGR	National Center for Genome Resources, USA

NEN	North East Network
NLH	Norges Landbrukshøgskole (Agricultural University of Norway)
NRCRI	Natural Root Crops Research Institute, Nigeria
NRI	Natural Resources Institute, UK
NRMG	Natural Resource Management Group (*of the* SP-PRGA)
OFI	Oxford Forestry Institute, UK
ORE	Organization for the Rehabilitation of the Environment, Haiti
ORSTOM	L'Institut Français de Recherche Scientifique pour le Développement en Coopération (*now* IRD)
PABRA	Pan-Africa Bean Research Alliance
PASOLAC	Programa de Agricultura Sostenible de Laderas en Centro América
PBA	Corporación PBA, Colombia
PBG	Plant Breeding Group (*of the* SP-PRGA)
PhAction	Global Post-*h*arvest Forum
PRGA	Participatory Research and Gender Analysis
PRI	Plant Research International, Netherlands
PROCITROPICOS	Programa Cooperativo de Investigación y Transferencia de Tecnología para los Trópicos Suramericanos
PRODAR	Programa de Desarrollo de la Agroindustria Rural para América Latina y el Caribe, *based in* Costa Rica
PROFRIJOL	Programa Cooperativo Regional de Frijol para Centro América, México y el Caribe
PROFRIZA	Proyecto Regional de Frijol para la Zona Andina
PROINPA	Fundación Promoción e Investigación de Productos Andinos, Bolivia
PRONATTA	Programa Nacional de Transferencia de Tecnología Agropecuaria, Colombia
RDA	Rural Development Administration, Korea
REDCAPA	Red de Instituciones vinculadas a la Capacitación en Economía y Políticas Agrícolas en América Latina y el Caribe
RII	Rural Innovation Institute
RIVM	Rijksinstitut voor Volksgezondheid en Milienhygiene (National Institute of Public Health and Environmental Protection), the Netherlands
SABRN	South Africa Bean Research Network
SACCAR	Southern Africa Center for Cooperation in Agricultural Research and Training
SARNET	Southern Africa Root Crops Research Network
SDC	Swiss Agency for Development and Cooperation
SEA-CIAS	Secretaría de Estado de Agricultura – Centro de Investigaciones Agrícolas del Sureste, Dominican Republic
SEARCA	Southeast Asia Regional Center for Graduate Study and Research in Agriculture
SENA	Servicio Nacional de Aprendizaje, Colombia
SIBTA	Bolivian Agricultural Technology Development
SINCHI	Instituto Amazónico de Investigaciones Científicas, Colombia
SINGER	The CGIAR System-wide Information Network for Genetic Resources
SLU	Sveriges Lantbruksuniversitet (Swedish University of Agricultural Sciences)
SP-IPM	Systemwide Program on Integrated Pest Management (*of the* CGIAR)
SP-PRGA	The CGIAR Systemwide Programme on Participatory Research and Gender Analysis for Technology Development and Institutional Innovation
SRI	Soil Research Institute, Ghana
SWNM	The CGIAR Systemwide Program on Soil, Water & Nutrient Management
TAC	Technical Advisory Committee (*of the* CGIAR)
TCA	Tratado de Cooperación Amazónica
TIP	Traditional Irrigation Programme, Tanzania
TSBF	Tropical Soil Biology and Fertility Programme, Kenya (*now* TSBFI)
TSBFI	Tropical Soil Biology and Fertility Institute (*of* CIAT, *formerly* TSBF)
UBC	University of British Columbia, Canada
UCor	Universidad Católica de Córdoba, Argentina
UCR	Universidad de Costa Rica
UNA	Universidad Nacional Agraria, Nicaragua

UNAH	Universidad Nacional Autónoma de Honduras
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNIVALLE	Universidad del Valle, Colombia
UPWARD	Users' Perspectives With Agricultural Research and Development, *based in* the Philippines
USDA	United States Department of Agriculture
WARDA	West Africa Rice Development Association, Cote d'Ivoire
WFCP	Water for Food *Challenge Program*, Sri Lanka
WRI	World Resources Institute, USA
WV	World Vision, USA
WWF	World Wildlife Federation, USA
WWW	World Wide Web

Abbreviations

Ac/Ds	The first pair of transposons discovered (biotechnology)
ACMV	African cassava mosaic virus
AES	Agroecosystem
AFS	Agroforestry systems
Al	Aluminum
ARIs	Advanced research institutes
AROs	Advanced research organizations
AYT	Advanced yield trials
BCMV	Bean Common Mosaic Virus
BGBD	Below-ground biodiversity
BMP	Best management practices
C	Carbon
CA	Central America
CBB	Cassava bacterial blight; *also* Common bacterial blight of beans
CBWM	Community-based watershed management
CC	Climate change
CD-ROM	Compact disk—read-only memory
CFSD	Cassava frogskin disease
CH_4	Methane (a pollutant)
CIALs	Comités de Investigación Agrícola Local (Colombia)
CLOs	Comités locales (local committees)
CO_2	Carbon dioxide (a pollutant)
DCs	Developed countries
DNA	Deoxyribonucleic acid
DS	Decision support
ERI	Enabling Rural Innovation
ESTs	Expressed sequence tags (biotechnology)
FM	*Forest margins*
FPR	Farmer participatory research
FTE	Full-time equivalent
GA	Gender analysis
GCC	Global climate change
GHG	Greenhouse gases
GIS	Geographic information systems
GKP	Global Knowledge Partnership
GM	Genetically modified
GOs	Governmental organizations
GWP	Global warming potential

HS	Hillsides
IA	Impact Assessment
IAEM	Integrated agroecosystem management and conservation
IARCs	International agricultural research centers (the CGIAR system)
ICTs	Information and communication technologies
INIAs	Instituciones Nacionales de Investigación Agropecuaria (national institutions for agricultural and livestock research)
IPDM	Integrated Pest and Disease Management
IPM	Integrated pest management
IPR	Intellectual property rights
ISFM	Integrated soil-fertility management
KS	Knowledge-Sharing
LA	Latin America; Latin American
LAC	Latin America and the Caribbean
LDCs	Lesser developed countries
LIMS	Laboratory information management systems
LoRSDIs	Local rural sustainable development initiatives
M&E	Monitoring and evaluation
MAS	Marker-assisted selection
MTA	Material transfer agreement (used in germplasm exchange)
MTP	Medium-Term Plan (CIAT)
N	Nitrogen
N_2O	Nitrous oxide (a pollutant)
NARES	National agricultural research and extension systems
NARIs	National agricultural research institutes
NARS	National agricultural research systems
NGOs	Nongovernmental organizations
NRM	Natural resource management
NZ	New Zealand
OD	Organizational Development
P	Phosphorus
PB	Plant breeding
PM&E	Participatory monitoring and evaluation
PNRM	Participatory natural resources management
PPB	Participatory plant breeding
PR	Participatory research
PRR	Phytophthora Root Rot
PYT	Preliminary yield trials
QTLs	Quantitative trait loci
R&D	Research and development
RAeD	Rural Agro-enterprise Development
RHBV	Rice "hoja blanca" virus (rice white leaf virus)
RIIs	Research intensive institutions
R-to-C	Resource-to-consumption *framework*
SLM	Sustainable Land Management
SP	Systemwide program (*of the* CGIAR)
SROs	Specialized research organizations
SRT	Single row trials
SS	Senior staff (*of* CIAT)
TLA	Tropical Latin America