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PROJECT SB-2 CONSERVATION AND USE OF TROPICAL GENETIC RESOURCES

A. Project Overview

Project Description

Goal: To contribute to the sustainable increase of productivity and quality of mandated and other priority crops, and the conservation of agrobiodiversity.

Objective: To conserve and enhance the genetic diversity and ensure that characterized agrobiodiversity, improved crop genetic stocks, and modern molecular and cellular methods and tools are used by CIAT and NARS scientists, and accessed by farmers, for improving, using, and conserving crop genetic resources.

Important Assumptions: Pro-active participation of CIAT, NARS, and NGOs, agricultural scientists, biologists and development personnel.

Geographical Target: Worldwide service, but special focus in developing countries of Latin America, Sub-Saharan Africa, and South and South East Asia.

Beneficiaries and End Users: Small farmers of Latin America, Sub-Saharan Africa, and Southeast Asia will use dozens of germplasm accessions conserved by the gene bank, as such or after improvement through biotechnology tools. Sources of disease and pest resistance will be identified for current and future efforts in germplasm enhancement and plant breeding. National programs will have their national collections restored.

Collaborators:

***Africa NARS*:**
DRC: Mvuazi Research Center (INERA), **Ghana:** Crop Research Institute (CRI), Kumasi; **Kenya:** University of Nairobi, **Malawi:** Chitedze Research Station, Malawi; **Nigeria:** National Root Crops Research Institute (NRCRI), Institute for Agricultural Research and Training (IAR&T), Ibadan; **Rwanda:** ISAR; **Tanzania:** Agricultural Research Institute (ARI); **Uganda:** Namunlonge Agricultural and Animal Research Institute, Kampala; Medical Biotech Laboratories, Kampala.

Latin American NARS and Universities:

Bolivia: CFP - Centro Fitogenetico Pairumani; **Brazil:** Embrapa-Cenargen, Embrapa-CTA, Embrapa-CNPAF, Embrapa-CNPMF, University of Campinas; **Colombia:** Cenicaña, Cenicafe, Universidad Javeriana, CIB, COLCIENCIAS, Colombian Ministry Agriculture and Rural Development, Corpoica, Corporacion Biotech, Colombian National Biosafety Council, FEDARROZ, ICA, Instituto Humboldt, UniAndes, UniValle, Universidad Nacional at Palmira and Bogotá, Universidad del Tolima; **Chile:** INIA, REDBIO; **Costa Rica:** University of Costa Rica; **Cuba**: INIVIT, **Dominican Republic**: IDIAF, National Bean Programs of the (INIAF)*;* **Ecuador**: INIAP, Universidad Catolica, **Honduras***:* Zamorano*;* **Mexico:** Universidad Autonoma de Mexico, INIFAP; **Nicaragua:** Ministerio de Agricultura**;** **Peru:** INIA; **Venezuela:** Centro Tecnológico Polar, Simón Bolívar University.

Colombia NGOs*:*

CEGA, FIDAR, PBA, REDBIO-Colombia, Latin America, Small Farmers from Pescador and Tierradentro-Cauca, Cauca farmers association, Parque del Software, Cali.

Colombia private sector:

Corn product, Barranquilla; Agrobios, Bogota: LIMSYS, Cali; DATABIO, Cali; Syngenta, Cali.

Asia NARS:

China: Academy of Agricultural Sciences (CAAS), SCIB; **India:** Central Tuber Crops Research Institute (CTCRI) Thiruvananthapuram, Kerala; **Thailand:** Rayong Field Research Center.

Biodiversity Institutes:

Colombia: Instituto Humboldt; **Costa Rica:** Inbio; **Mexico:** Conabio; **US:** Smithsonian Museum of Natural History

Advanced Research Institutes:

Australia: Center for Applied Molecular Biology in International Agriculture (CAMBIA); ***Europe:*** **Belgium:** University of Ghent; **Denmark:** University of Aarhus; **France:** CIRAD, Genoplants, IRD, INRA, Universite de Perpignan; **Germany:** University of Freiburg, University of Hanover, University of Hohenheim, Federal Biological Research Centre for Agriculture and Forestry (BBA); **Netherlands:** PRI-Wageningen; **Sweden**: USLU, Uppsala**; Switzerland:** Universite de Geneve, ETH; **UK**: University of Bath; **Japan:** JIRCA-Tsukuba; **United States:** Clemson University, Cornell University, Danforth Center, Kansas Sate University, Louisiana State University, Michigan State University, National Center for Genome Research, (NCGR), Ohio State University, Penn State University, Rutgers University, Smithsonian Molecular Systematic Lab, University of Nebraska, University of Puerto Rico; University of Chicago, USDA-Plant Soils and Nutrition Lab at Cornell University, USDA at Children Hospital Baylor University, USDA-Soybean Genomics, at Beltsville, Yale University.

Regional networks:
ASARECA, SACCAR, AfNet, ECABREN and SABRN (Africa); SIGTTA (Central America); REDBIO (Latin America); CATIE and EAP-Zamorano (Central America), Cassava Biotechnology Network (CBN-LAC); FLAR, CLAYUCA.

CGIAR, and International organizations:
CIP, CIMMYT, FAO, IAEA ICARDA, ICRISAT, IFPRI, IITA, IPGRI, IRRI, TSBF, WARDA.

CGIAR Challenge Programs:
HarvestPlus; Generation Challenge Program

CGIAR system linkages: Saving Biodiversity (40%); Enhancement & Breeding (40%); Training (15%); Information (5%).

CIAT project linkages: *Inputs to SB-2:* Germplasm accessions from the gene bank project. Segregating populations from crop productivity projects. Characterized insect and pathogen strains and populations from crop protection projects. GIS services from the Land Use Project. *Outputs from SB-2:* Management of Designated Collections (gene banks); genetic and molecular techniques for the gene bank, crop productivity, and soils (microbial) projects. Identified genes and gene combinations for crop productivity and protection projects. Propagation and conservation methods and techniques for gene banks and crop productivity projects. Interspecific hybrids and transgenic stocks for crop productivity and IPM projects.

Explanation of any Project changes (with respect to previous MTPs): The project takes into account the recent changes introduced by the International Treaty on Plant Genetic Resources for Food and Agriculture. New collection efforts may now be possible for cassava and beans with agreement with the countries. Tropical forages do not, however, enjoy facilitated access status so distribution and conservation of forage genetic resources requires bilateral negotiations on a country by country basis.

B. Project Funding:

Budgeting 2004-2008

Year	2004	2005	2006	2007	2008
US Dollars (millions)	6.081	6.909	6.854	6.891	6.729

ACTUAL EXPENDITURES 2006

Project SB-2 Conservation and Use of Tropical Genetic Resources

SOURCE	AMOUNT US$	PROPORTION (%)
Unrestricted Core[1]	1,888,606	28%
Restricted Core		0%
Sub-Total	1,888,606	28%
Special Projects[2]	4,231,823	63%
Generation Challenge Program	605,425	9%
Total Project	6,725,854	100%

[1] Includes GRU expenditures
[2] Includes total CIDA LAC expenditures

ACTUAL EXPENDITURES 2006

HarvestPlus Challenge Program

SOURCE	AMOUNT US$	PROPORTION (%)
Unrestricted Core	**0**	**0%**
Restricted Core	**0**	**0%**
Sub-Total	**0**	**0%**
Restricted Projects[1]	**1,387,546**	**100%**
Total Project	**1,387,546**	**100%**

[1] Includes only funds implemented by CIAT

CIAT PROJECT SB-2: CONSERVATION AND USE OF TROPICAL GENETIC RESOURCES (2006-2008) –
STARTING 2008 THE ACTIVITES WILL BE UNDER THE PRODUCT LINES OF BEAN, CASSAVA, RICE AND FORAGE

	Outputs	Intended User	Outcome	Impact
OUTPUT 1	Genomes of wild and cultivated species of mandated and non-mandated crops and of associated organisms are characterized.	Breeders, agronomists and other crop scientists working on/ using these crops and associated organisms.	Production or breeding methods are more efficient as compared to previous years. Varieties with improved or novel traits are produced and adopted.	Farmers' livelihoods are improved by increased crop productivity, by producing new crops for niche markets, or by using varieties that require less pesticides or costly inputs.
Output Targets 2006	• Genome wide PCR base d markers (SNPs, CAPs) developed for beans and cassava. • Scaling-up of marker-assisted established for rice, bean and cassava. • Marker assisted selection for multiple traits implemented in beans, rice and cassava. Target genes for drought identified and tested in beans. • Useful genes and genes combination identified and mapped for high iron and zinc bean lines. • Introgression lines from rice interspecific crosses developed. • Places of bean domestication and races/ genepools identified.	ARIs and NARS in Latin America and Africa with capacity for marker work	Better understanding of genetic structure of diversity of specific crop gene pools. Identification of molecular markers for marker assisted selection	

	Outputs	Intended User	Outcome	Impact
	Lab Information Management System (LIMS) implemented for MAS and molecular biology activities.			
Output Targets 2007	Allele mining in *ex situ/ in situ* collections of wild relatives of beans, and cassava for genes of traits of economic importance.	Breeders and crop geneticists, and conservationists dealing with these crops and their wild relatives.	Breeders and crop geneticists, and conservationists dealing with these crops and their wild relatives are better informed about allelic richness and its possible economic significance.	
Output Targets 2008	Bioinformatics tools developed for data mining in relation to gene functions for traits of economic importance.	Breeders and crop geneticists.	Breeders and geneticists can use sequence data generated on traits of economic importance in beans, cassava, rice and *Brachiaria*.	
OUTPUT 2	Genomes modified: genes and gene combinations used to broaden the genetic base of crops (bean, rice and cassava) and forage species (*Brachiaria*)	Breeders and crop geneticists worldwide working on these crops and relatives.	Breeders and crop geneticists have access to improved lines and genetic stocks, and benefit from increased knowledge about gene function/ regulation.	Better varieties requiring less expensive inputs are made available to NARS and farmers, resulting in gains of productivity, environmental sustainability, and in social benefits.
Output Targets 2007	• Efficiencies for genetic transformation for beans and cassava improved • Genes constructs for traits related to plant disease –	Rice geneticists and breeders around the world but particularly in ARIs	Rice geneticists and breeders have a better understanding of regulation of genes responsible for yield and plant architecture.	

	Outputs	Intended User	Outcome	Impact
	insect resistance, plant stress and nutritional traits obtained for transformation in beans, rice and cassava - T-DNA rice 10,000 mutant collections characterized under field conditions.			
	Transgenic events tested under green house biosafety conditions Gene flows in rice and beans documented in farmers'fields in parts of Latin America	ARI and molecular biologists-breeders Biosafety authorities of Latin America.	Biosafety authorities have technical information about risk of gene flow (intensity, location, persistence) for better decision making.	
Output Targets 2008	Transgenic lines of mandated crops generated with different constructs against biotic (e.g. Bt) and abiotic (e.g. DREB) stresses	Cassava and rice breeders at CIAT and in partner countries.	Cassava and forage breeders at CIAT and in partner countries have access to materials with novel genetic diversity to start new breeding activities.	
OUTPUT 3	Increased efficiency of NARS breeding programmes by using biotech tools.	Breeding programs, biodiversity institutions concerned by biosafety issues, extensionists, rural health centers.	Breeding programs, biodiversity institutions concerned by biosafety issues, extensionists, rural health centers make a wider use of biotech tools developed/ improved by CIAT.	Improved varieties raise agricultural productivity and reduce environmental impacts sooner than otherwise would have occurred
Output Targets 2007	Training on MAS has been provided to several country partners in Latin America and Africa.	Breeders and breeding programs in developing countries.	Breeders and breeding programs in developing countries adopt MAS techniques used/ improved by CIAT.	
Output Targets 2008	Information package delivered to NARS in Latin America and Africa about biofortified crops.	Breeders, extensionists, rural health centers.	Breeders, extensionists and rural health centers take into account the biofortified crops produced by HarvestPlus	

	Outputs	Intended User	Outcome	Impact
OUTPUT 4	Bean, cassava and forage germplasm collections, multiplied, and thus available, restored and safely duplicated. Germplasm conservation methods improved.	CIAT commodity project and external users around the world, namely in Africa, can have access to characterized and viable samples at any time.	Partners and any other public or private institutions use CIAT designated germplasm in own research and development.	Increased and more stable agricultural productivity with less negative environmental impacts.

Output Targets 2007	25% of designated germplasm is documented at CIAT website 5% of designated germplasm included in the DNA bank	CIAT projects and external users have direct immediate access to germplasm information for use and research	Wider use of designated germplasm because of its web-based documentation.	
Output Targets 2008	Bean and forage collections safely duplicated at CIMMYT, and cassava at CIP.	(security backups are not intended for use)	Other national genebanks are also making security backups of their collections.	
OUTPUT 5	NARS strengthened in the conservation and utilization of sets of agrobiodiversity	National genebanks, botanic gardens, biodiversity institutes, university departments working in conservation/ utilization of agrobiodiversity.	NARS and national genebanks adopted new conservation methods and make greater use of genetic resources for crop improvement	Increased agricultural productivity and reduced environmental impacts
Output Targets 2007	Public awareness products for institutions working in *ex situ* conservation.	National genebanks, botanic gardens.	National genebanks, botanic gardens have material to explain their work.	

	Outputs	**Intended User**	**Outcome**	**Impact**
Output Targets 2008	Distance education, presential courses run.	NARS dealing with aspects of conservation/ utilization of germplasm collections.	Personnel trained and/ or updated in conservation methods (e.g. DNA bank)	
OUTPUT 6	Strengthening Stressed Seed Systems during Emergency and Recovery	NGOs and UN Agencies involved in crisis response	Personal involved in making assessments related to seed security assessment and interventions have clear set of tools to improve practice	Strengthening (rather than undermining) of seed systems—during crisis periods- and hence enhanced contribution to food security
Output Target 2007	Clarification of the effects on Longer-term Seed Aid Assistance—so as to guide chronic stress response (model country: Ethiopia)	NARS and UN Agencies, involved in both emergency and developmental response	Identification of better seed systems development options for most vulnerable populations (i.e. those receiving aid on repeated basis)	
Output Target 2008	Application of more effective response options in both acute and chronic stress seed system scenarios	NARS, NGOs and UN Agencies involved in Agricultural Reconstruction and Development	Matching of seed system support to problem identification in variety of stressed seed system contexts.	

C. Current SB-2 Investigators: Discipline, position and time fraction.

Name	Discipline	Time dedication%
Beebe Steve	**Bean Breeding**	30
Bellotti Anthony	Consultant	20
Blair Mathew	Bean Genetics and breeding	70
Ceballos Hernan	Cassava Breeding	40
Chavarriaga, Paul	Transgenesis, Cassava	100
Debouck Daniel	Head Genetic Resources, Botany	20
Fregene Martin	Cassava Genetics and breeding	60
Ishitani Manabu	Molecular Biologist	100
Lentini Zaida	Plant genetics, Tissue Culture and Transformation, Gene Flow (rice, cassava and tropical fruits.	80
Lorieux Mathias	Rice Genetics and Biotechnology	50
Martínez César	Breeding	49
Mejía Alvaro	Cell Biology	100
Alonso Gonzalez	Tropical fruits	100
Sperling Louise	Seed Systems	20
Tohme Joe	Genomics. Leader of the Agrobiodiversity Research for Development Challenge	100

D. Highligts of outputs

Staff Changes

Dr. Alex Garcia contract ended in Jan 2007, Dr. Garcia washired in Nov 2005 as a post doc in bioinformatics for one year to assist the team in this strategic area,

Team member received the following awards.

Jesús Beltran. 2006. Presented to the best project on agricultural research in 2006. The award was presented on the 9th of November, 2006, by Agro-Bio, in Bogotá, Colombia, to the research: “Molecular Evaluation of Cassava Transgenic Plants Using Real Time PCR”. This research was conducted, as an undergraduate thesis, by Mr. Jesús Beltrán, a former student of the University of Tolima, and currently a Research Assistant at CIAT’s Agrobiodiversity and Biotechnology Project. The research was supervised by Paul Chavarriaga and Joe Tohme.

E. Overall view of the SB-2 project

The project has continued its effort in fund raising and has lead successfully several projects in the areas of abiotic stress and biofortification. Overall the project has pursued all three outputs outlined in the MTP:

Output 1 : Genomes of wild and cultivated species of mandated and non mandated crops,
\associated organisms characterized.
Output 2 : Genes and genes combination made available for broadening the base of mandated and non mandated crops.

Output 3: Collaboration with public and private partners enhanced

Only the following achievement for 2006 are summarized. A more extensive summary is provided this year part of the seed system – reaching end users research. This area is strategic for the Agrobiodivesity team for the delivery of the product of the teams. However it usually receives less visibility due to the extensive reporting on the molecular-genomics and cellular research summaries.

Domestication events in common beans.

The study of non-coding regions of the cpDNA of wild common bean lead to the disclosure of fourteen haplotypes distributed along its range in the Americas. An output of that research enabled us to locate the few domestication events of common bean in Central and South America (Chacón et al. 2005). Another output of that research was the organization of wild common bean into three major lineages, with links with its sister taxa of the *Phaseoli* section (Freytag & Debouck 2002). The organization of the haplotypes can be explained by isolation by distance, and two major migrations: one from Mesoamerica into the Andes, and another one from northern South America into Mesoamerica. A penalized likelihood analysis applied to previously published ITS data of many legumes to estimate divergence times between *P. vulgaris* and its sister taxa, indicated a divergence of *P. vulgaris* from its sister taxa of the *Phaseoli* section from Mesoamerica at or before 1.3 Ma (Chacón et al. 2007). The results are in line with others recently published (Delgado et al. 2006; Gepts et al. 2000). Migrations and isolation events during the early Pleistocene explain the current genepools existing in the wild prior to domestication, and then into the cultivated genepools.

The section *Acutifolii* of the genus *Phaseolus* that includes the tepary bean has been shown to include one more species, apart from the cultigen and its immediate wild relative, establishing thus a secondary gene pool for that crop (Muñoz et al. 2006). It is always rewarding for the breeder to know that he/ she has a wider diversity to explore, particularly in this case for superior tolerance to drought. Recent work conducted elsewhere (Delgado et al. 2006) has confirmed the distance of this section vis-à-vis the *Phaseoli* including the common bean, strengthening further the relevance of this research.

Useful Genes and Gene Combinations Identified and Mapped for High Iron and Zinc Bean Lines.

An understanding of the basis for iron uptake, transport, and accumulation in the seeds of common bean will require a careful dissection of the entire pathway of genes involved in these processes. This knowledge will assist us as plant breeders to increase bean iron content through the careful selection of alleles and potential parents to use in the breeding program. Our approach for understanding iron accumulation in common bean has been based on candidate genes. This year we have concentrated on the analysis of three important genes for iron accumulation and tannin biosynthesis, namely ferritin, iron reductase and anthocyanin reductase. For ferritin where we have made most progress, we were interested in pursuing the intron sequences to identify polymorphisms that could be applied to the development of molecular markers. It was important to base our work on seed expressed ferritin, since Ferritin is encoded by a multi gene family in common beans as in all plants analyzed so far. Ferritin is important since it is involved in iron homeostasis and is able to sequester thousands of Fe atoms intra-cellularly in a safe form until needed for metabolic functions such as respiration and photosynthesis. Among the four genes for ferritin identified in the fully sequenced *A. thaliana* genome, up to four genes in the legumes, peas and soybeans, and two genes in maize only some are seed expressed. Sequence comparisons between plant ferritin genes has shown them to be highly conserved with variability at the nucleotide level limited to the 3'UTR region and to intronic sequences.

For common bean, we have found after alignment of mapping parent alleles, that intron 1 presented a high A-T content which was characteristic of intronic regions compared to exons in the ferritin gene and that the region between Exon 3 and Exon 8 containing introns 4, 5, 6 and 7 as well as exons 5, 6 and 7 aligned well with the soybean sequences both at the genomic and cDNA level. An early observation was that the intron sizes for common bean were different than for soybean and that variability is present in the introns especially compared to the exon sequences. In addition to the work with ferritin, we have been wrapping up lab analysis for the identification of QTLs for iron and zinc in two populations. In these studies, we added repetitions to the studies with the populations to ensure that we are identifying highly reliable QTL. Additional QTL studies that are already underway will continue to identify QTL from G14519 and G21242 as high iron parents and develop markers for iron and zinc content. Finally several new populations of recombinant inbred lines were developed with G23823E to analyze the QTL in this additional high iron genotype. Our milestones have been the analysis of ferritin intron sequences for the development of molecular markers, the full length cloning of the iron reductase gene, the partial cloning of anthocyanin reductase gene and the confirmation of QTL for iron and zinc in two populations. The deliverable of this project will be an understanding of the role of candidate genes in seed mineral and tannin accumulation as well as the identification and tracking of QTL for seed iron and zinc content in common bean.

Sequencing analysis of 20.000 full-length cDNA clones from cassava reveals lineage specific expansions in gene families related to stress response

Cassava, an allotetraploid known for its remarkable tolerance to abiotic stresses is an important source of energy for human and animal consumption and a raw material for many industrial processes. A full-length cDNA library of cassava plants under normal, heat, drought, aluminum and post harvest physiological deterioration conditions was built; 19968 clones were sequence-characterized using expressed sequence tags (ESTs). The ESTs were assembled into 6355 contigs and 9026 singletons that were further grouped into 10577 scaffolds; we found 4621 new cassava sequences and 1521 novel plant proteins. Transcripts of 7796 distinct genes were captured and we were able to assign a functional classification to 78% of them while finding more than half of the enzymes annotated in metabolic pathways in Arabidopsis. The annotation of the sequences that were not paired to transcripts of other species included many stress-related functional categories showing that our library is indeed enriched with stress-induced genes. Finally, we detected 230 recent gene duplications that include key enzymes in reactive oxygen species signaling pathways and could play a role in cassava stress response features.

The cassava full-length cDNA library contains transcripts of genes involved in stress response as well as genes important for different areas of cassava research. This library is an important resource for gene discovery, characterization and cloning; in the near future it will aid the annotation of the cassava genome.

Research progress on biological nitrification inhibition and gene technology towards improved drought tolerance in crops

The biological nitrification inhibition (BNI) phenomenon is new concept that’s existence was only recently demonstrated in laboratory environments. JIRCAS of Japan has launched a five year BNI project beginning in 2006 and their work so far has focused on developing biological and soil incubation assay systems. CIAT has been collaborating with JIRCAS on the screening of Brachiaria accessions and field experiments since JIRCAS started working on this research subject more than 5 years ago. To enhance CIAT’s research activity in the BNI project, establishment of an in-house assay system is a must. In 2006 we adapted and improved aspects of quality control for the bioassay system developed by JIRCAS. Additionally, although the current bioassay is an efficient tool for screening genetic materials for BNI activity, all the data generated by the assay is merely indirect evidence to support the BNI phenomenon. To overcome this limitation, we developed an assay system to monitor soil microbial populations using PCR techniques. This allows us to provide direct evidence of how root exudates containing BNI compounds affect soil microbial populations in the soil, especially the soil microorganisms that are responsible for nitrification. Our ultimate goal is to identify genes or genomic regions responsible for BNI which will be applied to conventional and molecular breeding for the trait. For this purpose, rice is being used as the model plant for the specific purpose because of the availability of numerous genomics tools. Based on the JIRCAS report, so far, significant BNI activity has only been found in monocot species such as wheat and sorghum. We have started screening rice genotypes and found several promising genotypes that may have high BNI activity in response to ammonium applications.

A second research topic that I would like to highlight regards gene technology for improving crop drought tolerance. Generation CP has supported us for the last two years in conducting three research projects as commissioned research. One of the projects was related to a gene technology called DREB, which is believed to be a master switch (transcription factor) that regulates many downstream genes related to abiotic stress responses. Through this project we have learned how to conduct drought screening for rice in the field, although establishment of drought screening in a specific environment, such as rainout shelter conditions, is not an easy task. Recently, MAFF of Japan asked us to participate in a new project called "Promotion of Research Targeting Stable Supply of Global Food". The aim of the project is to develop drought tolerant genotypes through transgenic approaches using genes identified by JIRCAS. The project will be launched in April of 2007.

AgroSalud achievements

The AgroSalud Project aims to reduce micronutrient deficiency and increase food and nutrition security among vulnerable populations living in Latin America and the Caribbean through biofortified crops (beans, cassava, maize, rice, sweet potato) and food products. In calendar year 2006, the consortium of institutions that make up AgroSalud enjoyed many acheivements, as summarized below.

A clean facility was built to polish and mill rice with minimal mineral contamination. This will enable increasing the throughput of rice samples that can be tested for iron and zinc levels. Thomas zum Felde from the Centro Internacional de la Papa (CIP) visited CIAT to install calibration curves to run on a Near InfraRed Spectroscopy (NIRS) machine protein, iron, zinc, calcium, potassium, phosphorus and sulfur analyses for beans and protein, total carotenoids, and beta-carotene analyses for cassava. The NIRS and the calibration curves will also allow a substantial increase in throughput to analyze samples of beans and cassava for the above nutrients.

Plant breeders made significant advances in identifying lines with high nutrient levels, in crossing them with lines containing superior agronomic characteristics, and in testing these crosses in different environmental conditions. For example, rice researchers at CIAT have identified a commercial rice variety with double the amount of iron than rice sold to consumers. Bean researchers at CIAT have identified black bean lines with 20% more iron that are drought resistant and resistant to golden yellow mosaic virus.

Post-harvest specialists advanced in selecting, adapting, and validating different processing technologies for developing food products with biofortified crops. These included extrusion and bakery process to produce foods such as pastas and breads. Impact specialists have refined cartographic models to identify suitable sites in the Latin America and Caribbean (LAC) region for agricultural and human nutrition trials, collected data to apply an economic model known as disability-adjusted life years (DALYs) to predict the potential economic impact of consuming biofortified crops in LAC, and have begun assessments in Brazil, Colombia and Nicaragua to identify food-distribution programs into which biofortified crops could be incorporated.

To keep the broader public and the Project partners informed of the Project objectives, activities and advances, the following communication measures were implemented:

- Many presentations were given in agriculture and nutrition fora. There were appearances in television and other mass media. For instance, extensive dissemination of QPM was achieved via TV and news media in Nicaragua, Guatemala, Honduras and El Salvador and Mexico. Brazilian colleagues from the Empresa Brasileira de Pesquisa Agropecuaria (EMBRAPA) were interviewed on the nationally televised TVE-Brazil (José Luiz Viana de Carvalho) and TV Bandeirantes-Brazil (Marília R. Nutti).
- Meetings with high-level government officials were organized. For example, the Honduran Minister of Agriculture visited sites where on-farm QPM testing was ongoing and introduced QPM varieties in a dissemination project. The Deputy Minister of Food Security in Guatemala attended a conference where the Project was launched and promised support.
- A preliminary website was designed (www.AgroSalud.org); it is in the process of being re-designed and updated.
- Promotional material for the Project has been developed; more will be produced once a Communications Specialist is hired in 2007.

Massive, *in vitro* Propagation Systems of Cassava Adapted to the Needs of Small Scale Farmers in Colombia

Probably the greatest limitation for the expansion of cassava as a crop is the lack of certified planting material, or clean seed, free of pathogens and diseases, especially the lack of clean seed of varieties that are preferred by small-scale farmers. The limitation becomes greater if farmers don't even have access to technology to produce clean seed in their sites of sowing, or near them, at reasonable costs. In an attempt to offer a solution, an interdisciplinary working group was set up between 2002 and 2003. The group was composed by specialists from CIAT, FIDAR, and an association of farmers, mainly women, who aimed at establishing a cheaper system for in vitro propagation of certified material, run within the land of the farmers. All farmers possessed properties located in the Department of Cauca -Colombia. The outcome of the experience was the adoption of *in vitro* propagation of cassava, fitting it into a system of rural propagation, using lower cost inputs like cheaper chemicals and fertilizers, and developed and handled by small-scale cassava producers. The methodology was developed initially with the local variety "Algodona". Later, together with the group of farmers, 6000 plants were propagated and evaluated in the field. The six most preferred local varieties were included in the trial:

HMC-1, MPer 183, CM 6740-7, Mcol 1522, Mbra 383 y CM523-7; all of them certified free of Cassava Frog Skin Disease (CFSD). These materials were later used as the initial source for faster propagation schemes (Escobar RH et al 2001, 2005).

The implementation of propagation of clean seed, at low cost, in the property of farmers, resulted in the strengthening of the *Asociación Municipal de Usuarios Campesinos* (AMUC). It also promoted the establishment of banks of local seeds (mini-gardens) and the recovery and reestablishment of 37 clones grown in the area of Dept of Cauca. Since then, the Cassava Biotechnology Network –CBN has sponsored the implementation of similar methodologies in Ecuador (province of Manabí) and Brazil (in collaboration with EMPRABA). A comparable model is being implemented for the municipalities of Ovejas, San Jacinto, Caribia and Turipaná in the Northern Coast of Colombia. In this endeavor CIAT joined efforts with CORPOICA (*Corporación Colombiana para Investigación Agropecuaria*) and the PBA (*Corporación para el Desarrollo Participativo y Sostenible de los Pequeños Agricultores*). In this case the model makes use of low-cost, temporal-immersion liquid systems for propagation of the greater yam *Dioscorea alata*.

Training African researchers for scaling up the production of cassava material through the adaptation of low-cost techniques developed By CIAT

CIAT initiated a Capacity Building Program funded by MAFF-Japan, to train four African scientists from Ghana, Tanzania, Nigeria and Uganda, in the area of cassava in-vitro propagation. One major bottleneck in the dissemination of new cassava varieties to farmers is that a time-consuming cassava propagation system using the cutting is employed once the new breeding materials are available. This project was focused on a cost efficient cassava in-vitro propagation system, developed by CIAT. CIAT has started training NARS researchers to implement this propagation system in African countries, particularly in Mozambique where cassava is an essential crop. With this project, a team of CIAT scientists and technical staff aided African trainees in learning not only the basis of the propagation system, but also hands-on skills so that they can transfer the system to their home countries.

During the project, Dr. Kadowaki and Mr. Sumita from MAFF of Japan and Dr. Asanuma from Nagoya University visited CIAT to discuss the program as well as this project in particular. The African trainees were given the opportunity to present the current status of cassava production in each of their countries at this time, and they raised two main issues related to this program. The first issue was in regard to the duration of the project, and both trainers and trainees felt that this type of training requires a minimum 3-month training period. The second issue was the complexity of implementing the new system into their home countries due to, for example, the involvement of other governmental agencies in the home country. Despite these issues, the team felt that the project was well appreciated by the African researchers. Of foremost importance is that a new cassava research network was formed among the countries using this program, which will facilitate open discussions of the relatively rapid impact that this project can make on cassava production for small cassava farmers in Africa. One means of achieving our goals is to continue this type of cassava research training for these countries and measure the implementation process for each year that this program is supported by the Ministry.

Reaching "unreachable" farmers with new bean varieties

With the CIAT support various National Bean Research Programmes and their partners are running a region-wide programme, supporting the existing seed systems through the provision of bean varieties coming from these research centres. The approach aims simultaneously to accelerate farmer access to novel types and to strengthen the existing institutional and social networks which supply seed to farmers on a continuous basis.

<u>Assessment of existing seed systems.</u> These efforts started with an assessment of the existing seed systems. This meant looking at the factors which guide farmers' preferences, at the institutions which provide access to these varieties, and at how the flow of existing and new genotypes can be continued. The advantages and disadvantages of the different seed systems were looked at by farmers and extension agents, together with a "self assessment" which focused on the roles of the various actors involved, and on the possibilities for new roles. Apart from showing the differences between the "local" and the "commercial" systems, these assessments facilitated the interaction among the various social actors, and paved the way for stronger relationships among them.

Even though both systems have advantages, the decentralized, local one, has unique aspects which make it particularly suited to small scale farmers' needs: it has a greater geographic reach, greater social reach, costs less, offers farmers more variety options, and is accountable for its product—to the community. Hence, impact-oriented strategies which try to reach lots of farmers, at an affordable price, need to build on the strengths of the local system, rather than ignoring it. Needless to say, these assessments also showed that the introduction of new varieties through the local system also presents some challenges. Among these, an inadequate supply of initial seed ("basic" or "foundation") to feed into multiple, decentralized multiplication paths; an often restricted geographic coverage of local seed providers; or diffusion rates which are relatively slow when small quantities of new varieties enter the local seed channels.

<u>A new approach.</u> Starting in 2002, CIAT decided to try a new approach to improve these shortcomings and help small-scale farmers access new bean varieties more effectively. Carried out with partners in eastern, central and southern Africa, this approach followed these steps:

1. An assessment of farmers' needs through participatory interactions;
2. A search for suitable varieties to address these needs;
3. On-farm participatory variety assessments (PVA), involving farmer groups and the local extension service providers;
4. The selection of the appropriate varieties by farmers and other users;
5. An examination of the existing seed systems; exploring the possibilities for strengthening them and for fostering new linkages;
6. The dissemination of research-derived (or "improved") varieties through these newly integrated seed channels;

7. Strengthening of farmers' skills in pre-and post harvest bean management;
8. Strengthening of local actors' capacities to sustain the intervention and improve dissemination; and
9. The promotion of a research for development alliance by focusing on the comparative advantages of each partner and supporting a co-learning process.

This new approach moved away from the standard practice which puts the full responsibility of new variety production and delivery on centralized national research programs, public extension systems and formal seed suppliers. In contrast, it moved towards a more decentralized approach, aiming to have the production of the preferred varieties in the areas where they were selected. This approach builds on the comparative advantages of different stakeholders, considering that there are many who can contribute to an effective seed chain. For instance, farmers organizations and NGOs are often locally based and have good links with the community, while traders may have special skills for moving products widely throughout a region.

Results**.** Having assessed the different seed systems and the role of the different actors within them, scientists from the national research programmes had the opportunity to present new bean varieties in response to the existing farming constraints. Common actions were planned jointly for an effective dissemination, depending on the comparative advantages of every organisation. The majority of actors decided to strengthen their interactions and initiate national or regional platforms where they meet regularly to assess the progress and look at any emerging issues.

The results of such partnerships can be clearly illustrated using a case study from Ethiopia. By building links among the different actors, the Ethiopian Bean Research Programme and its partners have expanded their outreach in many different ways. Before producing and distributing the seeds, potential varieties were evaluated by farmers in their own contexts, using their own selection criteria (considering, for example, the total yield, drought tolerance, marketability, cooking time and taste). Suitable varieties, such as Awash Melka, Awash -1 (canning beans for export) Dor 544, AFR 222 and AFR 702 (regional and food type) were taken up as the basis of the whole initiative. Working together since 2004 mainly in Central Rift Valley (CRV), east and southern highlands of Ethiopia , this collaborative group can already show a number of key results:

Scaled up production of basic seed. To respond to the growing demand for bean seeds, the production of basic seed became the focus of the Ethiopian Seed Enterprise and the Ethiopian Bean Research Programme. The annual production of basic seeds of the key improved varieties increased 50 times (from 3.3 tons to 149 tons) in three years. This occurred as both the ESE and the bean programs explicitly intensified efforts to meet enhanced requests: ESE expanded its output from 50 to 550ha (including contracting small scale farmers) and a greater number of the bean research centers became engaged in basic seed production..

Dissemination of a greater number of varieties. Instead of focusing on one or two varieties, the initiative facilitated the distribution of several ones, providing farmers with the possibility of choosing the ones they prefer. Overall, within Ethiopia , the organizations involved went from working with 6 varieties in 2004 to working with 14 in 2006. In other words, they recognized the farmers' need for a range of varieties.

A faster diffusion of varieties. The initiative also facilitated faster access to new varieties. For instance, with normal practice, *Awash Melka*, a variety which was officially released in 1999 had not really reached farmers even five years later. However, by 2006, after use of the new approach from 2004 onwards, this same variety represented about 15% of bean grains exported from Ethiopia. More recently-released varieties, such as *AR04GY* and *Dimtu*, have also reached large numbers of farmers in less than three years. A faster and wider diffusion was a result of the several assessment meetings organised locally. These were followed by seed production efforts at the local level which built on the existing social and institutional assets, such as farmers' cooperative unions.

Scaled up production. By engaging other (non-formal) interested partners, the amount of bean seeds regularly supplied to farmers increased six times in about three years. The contribution of decentralized producers (individual farmers, local organisations) represented 48.9% of the amount supplied in 2006. As examples of scale, the Loma Adama Farmers Union, extension-service supported farmer seed producers and various NGOs (e.g. Catholic Relief Services, Self-Help Development International) multiplied 250, 200 and 301 tons respectively of acceptable quality bean seeds. This clearly shows the important role which local seed producers can play.

Increased number of diffusion partners. Before this initiative started, the most important seed partners of the Ethiopian Bean Research Programme were a few collaborating farmer research groups and the Ethiopia Seed Enterprise. However, with the new approach, many other partners became engaged, including the district Bureaus of Agriculture and Rural Development across the country, large farmers' co-operative unions, NGOs, bean exporters and traders, and large and middle scale seed producers. Building on these different partnerships lead to a wider geographic coverage, facilitating the promotion of bean varieties with different objectives (for local consumption, export).

Increased number of farmers being reached. The Ethiopian National Bean Research Program estimates that more than one million Ethiopian households countrywide gained access to new bean varieties between 2004 and 2007. This does not include the farmers who received seeds directly from other farmers (non seed producers) through normal exchange networks. Engaging multiple, diverse partners helped extend the seed reach to remote and poor farmers, many of whom had not had access to new bean varieties before.

Some of the partners involved, such as the Melkassa Agricultural Research Center, Catholic Relief Services, Self-Help Development International, and the Amhara Agricultural Research Institute, have mentioned that the impacts achieved have mainly been due to (a) the process of targeting the resource poor, and not the model farmers, in traditional bean growing areas like the Central Rift Valley, and (b) the introduction of bean varieties to areas where bean production had stopped or where it had never fully developed, such as the Amhara region. In general terms, we can say that success has depended on various factors:

- the identification of farmers' preferred varieties through several decentralized assessments across the country, using farmers' groups as community entry points;
- the provision of seeds of preferred varieties through various channels, including farmer- to-farmer exchanges or local seed markets;
- the focus on local seed systems which are already providing seeds, information and localized capacity building through social networks;
- the enhancement of farmers' skills and capacities in pre- and post-harvest management, including a wide awareness-raising campaign through social networks and promotional campaigns;
- the creation of a multi-stakeholder platform to review and assess the progress;
- the active participation of traders in supporting the various seed supply procedures, and linking production to external markets.

Challenges and next steps. After four years of working together, many of the partners of this initiative are already thinking of working in similar ways with other crops such as teff (*Eragorstis tef*, fam. Gramineae) and sorghum. At the same time, development organisations like Catholic Relief Services have also taken the approach as model for accelerating the access of improved varieties to farmers in other countries. However, among the problems which concern critics, two are consistently raised. First, some worry about the quality of seed resulting from decentralized production. Our work shown shows this issue often to be based more in myth than reality: tests carried out in several countries (in Ethiopia, Rwanda, Kenya and Uganda) have shown that farmers in the region are in position to produce acceptable quality bean seed. Second, as the approach is gaining popularity among diverse partners, the demand for the first layer of seed (what is called, “foundation” or “breeder” seed) increases dramatically. This puts pressure on the formal seed sector to scale up the initial multiplication, a challenge which is already being taken up in Ethiopia.

The multi-partner seed chain approach is very versatile and gives farmers access to new varieties quickly and widely. One of its key attributes is that it builds on existing local skills and knowledge, support farmers' own organizations, and assures that even the poorest can access new variety materials, if they desire. More specifically, this approach works to create partnerships and networks with actors at different levels of the seed production and supply chain. This strategic, inclusive linking, benefits those in the formal sector desiring broad impact as well as the many local organizations which work to increase and stabilize agricultural production, even in remote and stressed zones.

F. Problems encountered and their solutions

Budget allocation and internal charges

As the results of the team efforts, SB-2 has been able to contribute significantly to the economic situation of the center. As in previous years, SB-2 teams managed to raise CIAT profile with the research community and were successful to secure funds from a wide range of donors by participating in some very competitive grants. However the high level percentage of overhead and internal charges imposed on SB-2 projects has stretched SB-2 staff capacity.

The SB2 staff are concerned that the continuous situation is affecting CIAT capacity to delivery on commitments made to donors. The high level of overhead, direct and indirect charges negatively affected the efforts of the team to improve the infrastructure of the labs or to hire needed post docs budgeted in some special projects. Discussions with management are on going to seek a solution to such problems.

Bioinformatics – a major recurrent problem that need to be addressed in 2007

The issue was raised in 2002. To respond to the need of the project, the director of research allocated from CIAT strategic resources, funds to cover part of the salary of a post doc for one year. The rest of the needed funds came from a small grant from the Generation Challenge Program. However the allocation is for one year and is a temporary measure to address an expanding need of the team for such expertise. While the team has prepared several proposals, trained junior staff in bioinformatics and established alliance both in Colombia and with ARI, the team is not getting the needed support. As stated last year "the only immediate solution is to have a post doc for an additional two years with full funding from the central strategic funds".

Lack of structured phenotypic databases

One the major strength of the international centers is the wealth of phenotypic information on germplasm and breeding lines accumulated over the years. Such unique sets of data are becoming key to gene discovery when integrated with CIAT molecular markers work. Due to historic reasons, several of the data taken on beans, cassava and forages are not completely deposited in structured databases that can be quickly queried. The only viable solution to addressed this issue is to have management imposed on the researcher a strict deadlines to incorporate the data.

Infrastructure and capital funding for equipment. The existing infrastructure is poorly maintained for properly conducting research experiments. For example, crop growth was affected due to low transparency of sun light from the roof in the greenhouse CIAT needs to direct more attention to the research environment that we are currently facing and invest its resources into solving these problems.

CIAT invested from 1998 to 2005 in major equipment and allowed the Center to position its self in key research such gene expression, SNPs and gene discovery. Such investment resulted in referee articles and the development of the first cassava microarray chip, an intial set of SNPs in beans, SSR in cassava and beans among other as well as approved proposal based on the existing infrastructure that was considered as on the of the best in the CG.

The team will be approaching Monsanto for a grant to upgrade our HPLC and NIRs facility. Part of the tissue culture facility will be remodeled using funds from a grant obtained by Manabu Ishitani. However we are now reaching a tipping point that requires a major investment in equipment to ensure that the Center remains competitive.

Recurring problems raised in 2002-2006:

- **Space:** the team needs more space for visiting researchers and lab areas.
- **Maintenance of major equipment:** the central fund allocated during the past ten years has been drastically reduced. Several of the major equipment such as the sequencer and microarray spotter are now without a proper maintenance for the past two years. The lack of preventive maintenance for other piece of equipment are also generating serious problems.
- **Salary of national recruited staff:** Some of the major issues raised in 2004 were resolved in collaboration with Human resources. However, the is an urgent need to formulate a long term strategy for promotion and salary increase and for the allocation of funds to ensure equity across the Center. Right now some of the promotion of assistants is linked availability of funds and to merit creating serious inequity among the national recruited staff.

G. Project indicators

Publication

- Refereed Journals: 40
- Book Chapters: 8
- Proceedings Scientific Meetings: 14
- Oral Presentations: 15
- Posters: 9

H. Strengthening NARS

The project concentrated its efforts this year on strengthening NARS through a series of events either at CIAT headquarters or at NARS facilities. More than 400 persons from national and national institutions visited and or received training with SB-2 Project Staff or participated in SB-2 events.

- Preparation of Final Biosafety Project GEF/WB. February 3-11. (**23 participants**).

- Detection of genes on transgenic plants and its derivates. Practiacal and Theorical Workshop for Food and Health Sectors. March 6-7 (**22 participants**).

- AgroSalud- Combating Hidden Hunger in Latin America: Biofortified Crops with Improved Vitamin A, Essential Minerals and Quality Protein. March 21-23 (**14 participants**).

- HarvestPlus Meeting. Team Working on cassava meets to share information on progess as well as unexpected problems. Activities and strategies for the next couple of years are defined based on the progress achieved. March, 27-28 (**22 participants**).

- Course/Workshop on Environmental Biosafety: Evaluation, Management and Monitoring of OGM. April 26-28 (**15 participants**).

- Final Project Review, Project Workplan and operational Manual Regional Biosafety Project. May 23-26 (**30 participants**).

- Open House. May,26 07 (5 universities and 3 institutes). **(Total: 100 participants)** and October 13, **(119 participants**

- AgroSalud Impact Meeting. November 2-3 (**9 participants**).

- Appraisal – World Bank Mission Project Latin America: Multi-Country Capacity Building in Biosafety. December 11-14 (**18 participants**).

I. List of Projects Active 2006

- A dataset on allele diversity at orthologous candidate genes in GCP crops (ADOC), GCP Commissioned grants.
- An Integrated Approach for genetic improvement of aluminium resistance of crops on low –fertility acid soils.
- Aplicacion de Microarreglos al studio de la interacción Café –Broca metabolic engineering of cyanogens metabolism in Transgenic cassava: Generation of safer more marketable cassava Food products for subsistence farmers. Ohio State University –OSU
- Bean genomics for improved drought tolerance in Latin America. BMZ-Germany. No-cost extension to Aug, 2007- Yearly contracts 2003-2006.
- Biofortified Crops for Improved Human Nutrition – Harvest Plus Challenge Program. World Bank DANIDA, Denmark Gates Foundation CIDA (AgroSalud). Developed with CIMMYT and CIP.
- Beta carotene Enhanced Mustard. USAID.
- Biotechnology RCSA. USAID.
- BMZ-Germany - “Bean genomics for improved drought tolerance in Latin America”,
- Cassava Biotechnology Network. Ministry of Foreign Affairs Netherlands.
- Coffe Genome Studies. . FEDERECAFE.

- Colciencias – “Obtención de nuevas variedades de fríjol común con atributos de rendimiento y potencial para nuevos mercados, utilizando selección convencional y asistida por marcadores moleculares” Universidad Nacional with CIAT
- Cenicafe. Technical assistance to the Coffee Genome funded by MADR.
- Crop gene expression profiles and stress-gene arrays
  Donor: Generation Challenge Program; Project number SP2-2005-013
- Development and use of inbred lines in cassava breeding. Donor: The Rockefeller Foundation
- Development of Genomics Resources for Molecular Breeding of Drought Tolerance in Cassava. GCP.
- Development of a feasibility study for the establishment of cassava plantations for the production of biofuels. NNPC, Nigeria.
- Development of an *In Vitro* Protocol for the Production of Cassava Doubled-Haploids and its Use in Breeding. CIAT – ETH (Switzerland) - SCIB (China). Donor: ZIL, Switzerland.
- Development and evaluation of drought-tolerant rice transgenic plants. GCP SB3
- Ginés Mera Fellowship Fund por Postgraduate Studies in Biodiversity. IDRC
- EcoFondo – “Manejo del germoplasma local y aumento de la agrobidodiversidad de frijol y maiz con variedades biofortificadas para mejorar la nutricion en comunidades rurales del departamento de Nariño” – FIDAR with CIAT –
- Enhancing grain legumes’ productivity, production and the incomes of poor farmers in drought-prone areas of sub-Saharan Africa and South Asia. Bill and Melinda Gates Foundation (BMGF).
- Exploring natural genetic variation: Developing genomic resources and introgression lines for four AA Genome Rice relatives. CIMMYT
- Evaluation and multiplication of 5000 lines de T-DNA mutants conservation and sustainable Use of Neotropical Native Crops and Wild Relative Crops
- Evaluation and Deployment of Transgenic Drought-Tolerant Varieties
  Donor: Generation Challenge Program; Project number SP3-19
- Fighting drought and aluminium toxicity: Integrating functional genomics, phenotypic screening and participatory research with women and small-scale farmers to develop stress-resistant common bean and Brachiaria for the tropics
  Donor: BMZ
- Fighting Drought and Aluminium Toxicity: Integrating Genomics, Phenotypic Screening and Participatory Research with Women and Small-Scale Farmers to Development Stress-Resistant Common Bean and *Brachiaria* for the Tropics. BMZ.
- Fontagro – “Mejoramiento de la nutricion humana en comunidades pobres de America Latina utilizando maiz (QPM) y frijol comun biofortificados con micronutrientes”
- Flowers, Fruits and Roots: Modification of Flowering to Improve Traits of Agricultural Importance. CIAT - Max Planck Institute, Germany. Donor: The Rockefeller Foundation.
- Generation Challenge Program - “TILLING mutagenesis and drought gene analysis”
- Gene Flow Analysis for Environmental safety in the Tropics. CIAT – University of Costa Rica – Hannover University and BBA, Germany.
- Harvest Plus Challenge Program – “Biofortified crops for human nutrition” Harvest Plust challenge program, various donors.
- High iron and zinc rice lines. AgroSalud. CIDA-Cananda US$230,000. Interspecific bridges to get full access to genetic diversity found in O. glaberrima: GCP
- Identification and Expression Analysis of Genes Important for Iron Translocation to the Rice Grain, HP.

- Impacto ambiental de la adopción del arroz resistente a las imidazolinoas en sistemas productivos contrastantes de América Latina (AL). INIA-UCV-CIAT. Donor: Fontagro.
- Improvement of the nutritional value of cassava: high storage protein content and zero cyanide cassava., DANIDA.
- Improving potato-bean-sweet potato (PBS) based rural livelihood systems through integrated soil ecosystem management (ISEM), market development and nutritional innovation in the highlands of Lake Kivu area. Sub-Saharan Africa Challenge Program. Project Rejected. 4 years.
- Introduction of inbreeding in cassava genetic improvement. Donor: The Rockefeller Foundation. Approved November 2006. January 2007-December 2009
- Japan Capacity Building Program for African Agriculture Researchers
  Donor: MAFF of Japan
- Latin America: Multi-country capacity-building for compliance with the Cartagena Protocol on biosafety (Brazil, Colombia, Costa Rica, Peru). Donor: GEF-World Bank
- Long-Term Seed Aid in Ethiopia. IDRC. Addresses chronic stress areas and extreme poverty.
- Lulo (*Solanum quitoense*, naranjilla) with added value: New alternatives for the small farmer. CIAT-CORPOICA.
- Mayze- Vit A Biofortification. USAID.
- Nutritional Genomics. USAID.
- Systematic evaluation of rice mutant collections for conditional phenotypes with emphasis on stress
  Donor: Generation Challenge Program
- Putting Seed Security at the Heart of Agricultural Relief and Recovery Response. USAID/OFDA. Focus on Seed System Security Assessment and Tool Development. January 2006-June 2007.
- Rice Functional Genomics consortium. Yale University
- Southern Africa Biotechnology Program.CGIAR.
- The Generation Challenge Program. IRD – CIAT
- Understanding the mechanism of Plant Resistante to Whitflies –USDA –
- Improving rural livelihoods in Rwanda: Promoting integrated crop, disease, and pest management (ICDPM) strategies for intensification and diversification of agricultural systems. Bilateral project for Belgium. Proposal approved pending to confirm. 3 Years.
- Tools for Cassava Breeding, Improvement, and Germplasm Exchange. Objective 5: Development of doubled Haploid and Induction of flowering.Donor: Bill and Melinda Gates Foundation.

J. Strengthening the technical capacities of CIAT-SB-2 Assistant

As part of a long term strategy, the project has managed to increase the technical capacity and expertise of the SB-2 assistants and associate. Without having access to additional funds, the project took advantage of several opportunities to achieve such training; 1) Specific courses were identified and assistants were encouraged to apply to fellowships provided by certain courses; 2) training components were build in collaborative projects; 3) targeted funding from special project to needed training in key areas. Several assistants are engaged in graduate studies at the Master or PhD level with full support of the respective supervisor.

1. Myriam C. Duque. 2006. GCP: Generation Challenge Program- subprogram in Capacity Building LD: Linkage Desequilibrium).Instituto Agronómico mediterráneo de Zaragoza, IAMZ, España, Octubre 16-20,06

2. Roosevelt Escobar. 2006. Follow-up of IIAM activities on Tissue culture, Maputo-Mozambique.Curso Internacional de Genética y Biotecnología Forestal, Marzo 27 - Abril 7 de 2006. Santiago de Chile. Con el auspicio del ICGEB, UNU-BIOLAC.

3. Roosevelt Escobar. 2006. Proceedings of the ASARECA/ECABIO Tissue Culture Workshop, 29 November-1st December 2006, Bujumbura, Burundi.`

4. Gerardo Gallego. 2006. Visited Instituto de Investigaciones Agropecuarias y Forestales- IDIAF. Dominican Republic. March 12-19.

5. Chavarriaga, Paul. Attend Meeting: “ZIL Progress Forum”, ETH Zurichen. March 25-April 3,06

6. Chavarriaga, Paul. HarvestPlus Biotechnology Meeting. Washington – USA. April 6-7,06

7. Garcia, Alexander. Lecturer in Ontology Plants Course. Merida, Venezuela. May 22-25,06

8. Moreno, Laura Tatiana. Training on Bioinformatics. Cornell University. June 21-27,06

9. Garcia, Alexander, 9th International Protégé Conference, Stanford,California. July 23-26,06

10. Garcia, Alexander, Bioinformatic National Network (NBN), SouthAfrica. August – October,06

11. Escobar, Roosevelt. Visited Witwatersrand. Cassava Projects. Johannesburg. Sept, 07-18,06

12. Beltran, Jesus. Fitophatology Congress. Cartagena, Sept 11-17,06

13. Duque Myriam Cristina. Visited Valenciano Investigation’s Institute. Dr. Emilio Carbonell. Oct. 24-2006

14. Pachón, Helena. LA Society of Nutrition, Sao Paulo, Brazil. Nov 10-26, 06

15. Garcia, Alexander, Attend Phenotype Representation Workshop in San Francisco,USA. Dec 1-2,06

16. Gallego, Gerardo. Attend “Biotic and Abiotic Stress Responses in Plants”. India. Dec. 19-06

K. **Current Graduate Students**

Students

- Undergraduate: 34
- Complete Thesis: 21