Crop and Agroecosystem Health Management

Executive Summary

Annual Report 2005
Project PE-1

CIAT
Centro Internacional de Agricultura Tropical
International Center for Tropical Agriculture

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Crop and Agroecosystem Health Management (Project PE-1)

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Cover photos: From left top row: 1) Fungal growth inhibition by antifungal protein from *Clitoria* seeds, 2) Spittlebugs in *Brachiaria* , 3) High population of whiteflies *(Bemisia tabaci)* on bean plant; middle row: 1) Field day with farmers in Pescador, Colombia, discussing the economic threshold of white grubs on maize, 2) Disease resistance conferred by the presence of an endophytic fungus in *Brachiaria,* 3) Molecular detection and differentiation of spittlebug species; bottom row: 1) Mycelium of the endophytic fungus *Acremonium implicatum*, 2) Mycelium of the endophytic fungus *Acremonium implicatum* expressing the green fluorescent protein gene, 3) Larvae of *Phyllophaga mentriesi*.

Crop and Agroecosystem Health Management (Project PE-1). 2005. Annual Report 2005, Executive Summary, Centro Internacional de Agricultura Tropical, (CIAT), Cali, Colombia, 47 p.

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1. Project Description and Log-frame

Project PE-1: Crop and agroecosystem health management

Research for Development Challenge: Improving Management of Agroecosystems in the Tropics (IMAT), CIAT. The project also contributes to the "Enhancing and Sharing the Benefits of Agrobiodiversity Biodiversity", and "Enhancing Rural Innovation" Development Challenges.

Project Manager: Segenet Kelemu

Project Description:

Goal: To enhance crop yields and quality of products, reduce pesticide use and residue, and improve agro-ecosystem health through enhancement of soil health and integrated management of major pests and diseases in the tropics.

Objective: Develop and transfer pest-and-disease knowledge and management systems for sustainable productivity and healthier agro-ecosystems in the tropics.

Gains: Increased crop yields. Judicious pesticide use promoted that result in clean harvests with little or no pesticide residues. Increased income and market access through healthier products. Microbial and predatory natural enemies of major pathogens and pests evaluated and characterized. Bio-pesticides formulated in collaboration with the private sector and producers. Comprehensive and environmentally-friendly disease and pest management strategies developed and tested on farms with the participation of producers. Increased knowledge on the biology and ecology of major pests and pathogens. Emerging pests and pathogens detected. Local knowledge on disease and pest management documented. Molecular characterization of major arthropod pests, population dynamics and evolution of pathogens, host-pathogen/pest interactions, and diagnostic tools made available for developing durable host plant resistance. Sources of disease and pest resistance identified, characterized and resistance genes molecularly tagged and cloned. Methods and strategies for enhancing soil health explored. Bio-indicators to quantify soil health developed. Molecular tools for detection, diagnosis, diversity studies as well as disease and pest management strategies extended to pests and pathogens of fruits, vegetables and other high value crops. Co-existence of transgenic and conventionally-bred lines for disease and pest resistance explored. Capacity for disease and pest management built in Africa and Latin America.

Important Assumptions: 1) Donor support to projects; 2) Active collaboration from other IARCs and other research organizations; 3) Active collaboration from CIAT's projects (e.g. TSBF); 4) Active participation from NARS.

Target Ecoregion: Humid and sub-humid tropics in eastern and southern Africa, Central America and Andes.

Beneficiaries and End Users: Information on biodiversity in tropical agroecosystems, improved IPM components and technologies and knowledge systems will benefit NARS scientists, extension workers, farmers and consumers, by increasing crop yields, crop quality, agro-ecosystem health and stabilizing production systems.

Collaborators: International Agricultural Centers through the System wide program on Integrated Disease and Pest Management, NARS Latin America (eg. ICA, CORPOICA, Colombia; EMBRAPA, Brazil; INIFAP, Mexico; DICTA, Honduras) and Africa (e.g.NARO, Uganda; EARO, Ethiopia; ISAR,

Rwanda), universities (eg. Cornell, University of Kentucky, Kansas State University, University of Florida, Universidad Nacional, Universidad Valle, Alemaya, Makerere and Nairobi Universities, U. Nacional de Costa Rica, etc.), private sector (eg. BioTropico, ASCOFLORES-CENIFLORES) NGOs (eg. Manrecur)

Project changes: The Integrated Pest and Disease Management project has made the following changes in 2005:

Previous Project Name: Integrated Disease and Pest Management

Comment: The various activities and outcomes of the project focuses not only on crop health in general through host resistance, conservation and utilization of natural resources (such as natural enemies and other biocontrol agents, plant and microbial derived biopesticides), judicious use of pesticides, and other novel strategies of disease and pest management, but also on general soil health. These measures in turn contribute to agroecosystem health (human, wildlife, soil, water, beneficial organisms, etc.) due to reduction in indiscriminate use of pesticides. Not only increased crop yields are achieved, but also enhanced quality of products (eg. products with low or no pesticide residues) that benefit producers and consumers; and healthier environment can result from development and implementation of environmentally-friendly disease and pest management strategies.

New Project Name: Crop and Agroecosystem Health Management

Previous Goal: To increase crop yields and reduce environmental contamination through the effective management of major pests and diseases.

Comment: The project will focus on strategies to enhance soil health (developing strong ties with TSBF-CIAT), host resistance, biopesticides and other novel methods of disease and pest management strategies in order to enhance crop yields and quality of products, as well as improve agro ecosystem health in general. We will seek to apply environmentally-friendly disease and pest management strategies to non-CIAT commodities in the tropics, particularly to African crops. Because we have over the years developed many tools and methods for disease and pest diagnosis, detection, control strategies mainly on CIAT commodities, great efforts would be made to apply these technologies to crops such as fruits, vegetables and other high value crops. We plan to explore ways of enhancing incomes of small producers through products with little or no pesticide residues (eg. organic farming).

New Goal: To enhance crop yields and quality of products, reduce pesticide use and residue, and improve agro-ecosystem health through enhancement of soil health and integrated management of major pests and diseases in the tropics.

Previous Output 3: NARS' capacity to design and execute IPM research and implementation strengthened.

Comment: Many of the project scientists and their support staff are well-trained molecular biologists who develop and apply various molecular tools for the detection, characterization and diagnosis of pests and diseases; clone genes from various organisms, sequence genomes of organisms, apply recombinant DNA and transgenic technologies for disease and pest management, as well as train various NARS scientists and students in molecular tools and procedures. Therefore, capacity building of NARS in these important areas of research (which are in demand particularly in Africa) is added to this output.

New Output 3: NARS' capacity to design and execute IPM research and implementation, and applications of molecular tools for pathogen and pest detection, diagnosis, diversity studies as well as novel disease and pest management strategies strengthened.

Milestones:

2005 Botanical and other traditional pesticides or control practices in beans evaluated by farmers.

Entomology

Cassava whitefly natural enemies identified.

Homopteran species (2) collected and reared and vector transmission studies initiated for cassava frog skin disease.

Complexes of soil-borne pests associated with cassava identified in Colombia.

Entomopathogens for control of selected soil-borne cassava pests identified (for white grubs and burrower bugs).

One hundred new *Brachiaria* hybrids with multiple resistance to spittlebug available.

Molecular markers for Mexican bean weevil (*Zabrotes subfasciatus*) resistance available in common bean.

Bean stem maggot tolerant bean varieties evaluated in farmers fields in Kenya, Malawi and Tanzania.

Pathology

Role of endophytic fungi in plant protection of forages defined and biocidal proteins of plant origin characterized.

Identification of sources of different known rice blast resistance genes and microsatellite markers.

Identification of rice lines with tolerance to sheath blight pathogen and development of genetic crosses.

Quantification using bioassay method for bean *Fusarium* root rot pathogen in soil.

Pythium root rot pathogens on beans in Eastern Africa characterized and distribution established.

Common bean genotypes with resistance to angular leaf spot, *Phaeoisariopis griseola* identified.

Identification of rice blast resistance genes present in 200 Latin America rice cultivars.

Candidate genes for resistance to CBB and *Phytophthora* Root Rot of cassava identified.

Novel approaches in scaling up bean IPDM technologies evaluated in Eastern and Central Africa.

Virology

Molecular marker for one resistant gene to rice hoja blanca virus available.

Cassava frog skin disease resistance identified.

2006 Participatory IPM practices for control of cassava soil borne pests evaluated at pilot sites in Colombia.

Genetic studies of sheath blight resistance in rice and identification of molecular markers associated with resistance.

Entomology

Biological pesticides identified for whitefly (*A. socialis*) control on cassava and evaluated whitefly predators and parasitoids released and evaluated in farmers fields.

At least two commercial *Brachiaria* cultivars with multiple resistance to spittlebug developed.

Molecular markers for bean pod weevil derived from crosses between Mesoamerican *Phaseolus vulgaris* genotypes available.

Botanical and other traditional pesticides for bean pest management evaluated by farmers in Eastern and Southern Africa.

Pathology

Inheritance of anthracnose (*Colletotrichum lindemuthiuanum*) resistance in Andean bean germplasm identified and elucidated.

Bacterial endophytes isolated from *Brachiaria* antifungal protein isolated from seeds of tropical forage legume.
Micro satellite markers associated with rice blast resistant genes (Pi-1, Pi-2, Pi-33, Pi-K, Pi-b, Pi-ta and Pi-ta2) identified and distributed to Latin America Rice Program.
Isolates of *Trichoderma*, a soil associated fungus; with
beneficial characteristics identified for *Phytophthora* Root Rot (PRR) control in cassava.
Quantification molecular assay method for bean *Pythium* root rot pathogens in soil validated in Uganda under field conditions.
Selection of rice blast resistant lines advanced from crosses between Latin American rice cultivars and donors of complimentary resistance genes.
Virology
Additional characterization of the Reo-like virus associated with CFSD.
Developing capacity for diagnosis of citrus viruses.

2007 Biological pesticides for cassava soil borne arthropod pests developed (for burrower bugs and specified white grub species.
Brachiaria hybrids resistant to *Rhizoctonia* foliar blight developed.
Incorporation of genes conferring stable rice blast resistance using molecular markers assisted selection into rice breeding populations.
Development of rice breeding population incorporating genes conferring tolerance to the sheath blight pathogen though marker assisted selection
Biological pesticide for Moko or Banana Bacterial Wilt (*Ralstonia solanacearum* available).
Bioassay and molecular assay methods for bean *Pythium* and *Fusarium* root rot pathogens in soil validated.
Angular leaf spot and *Pythium* root rot resistance genes characterized and deployed in improved varieties in beans in Eastern, Central and Southern Africa.
Cassava whitefly (*A. socialis*) IPM technologies implemented in farmers fields using FPR practices.
IPM of soil-borne cassava arthropod pests implemented on cassava and possibly other crops.
Whitefly IPM implemented with common bean farmers in Colombia and Ecuador.
Novel approaches in scaling up bean integrated pest and disease management technologies evaluated in Eastern and Southern Africa.
Farmer Participatory Research and technology development implemented in common bean production in Eastern and Southern Africa.
Pathology
Co-evolution of the anthracnose (*Collectotrichum lindemuthiuanum*) pathogen and common bean gene pools characterized.
Gene for antifungal protein cloned from tropical forage clitoria and characterized for use in transgenic plants.
Identification of resistance sources of phytoplasma associated with Cassava Frog Skin Disease (CFSD) using molecular markers.
Virology
Using resistance for Cassava frog skin disease more effectively.
Mild strain of Citrus tristeza virus tested for use a cross protection agent.

CIAT: PE-1 PROJECT LOG FRAME (2005-2007)

PROJECT: CROP AND AGROECOSYSTEM HEALTH MANAGEMENT
PROJECT MANAGER: SEGENET KELEMU

Narrative Summary	Measurable Indicators	Means of Verification	Important Assumptions
Goal To enhance crop yields and quality of products, reduce pesticide use and residue, and improve agro-ecosystem health through enhancement of soil health and integrated management of major pests and diseases in the tropics.	• % increased in crop yields. • % reductions in pesticide use and prevention of environmental degradation through adoption of improved technology. • % reduction of losses to several major diseases and pests.	• Production statistics. • Adoption and impact studies. • Project reports.	• National policies favorable to adoption of IPM strategies (i.e., increased support to extension, reduction of subsidies for pesticides). • National programs are active and strong in key countries.
Purpose To develop and transfer pest-and-disease knowledge and management systems for sustainable productivity and healthier agro-ecosystems.	• Number of new cultivars with resistance to pests and pathogens released and used by farmers. • Number of released and established bio-control agents. • Number of environmentally friendly control strategies adopted by farmers.	• Adoption and impact studies. • Performance of new cultivars • End-of-project reports. • Refereed publications, book chapters.	• Donor support to projects. • Active collaboration from other IARCs and other research organizations. • Active collaboration from CIAT's projects (e.g. TSBF).
Output 1 Pest and disease complexes described and analyzed.	2005 • Reduction in cassava whitefly damage. Colonies of homopteran (1 or 2) species established. • Biology determined (1 species). • Transmission studies carried out. • Taxonomic identification of white grub and burrower bug species. • Detection of endophytic fungi in *Brachiaria* and distribution determined. • A set of microsatellite markers associated with blast resistance genes identified. • A set of 20 rice lines with tolerance to sheath blight identified.	• All areas: project reports, refereed publications, book chapters. • Reports with maps, economic damage, biological information. • Analysis of experiments. • Transfer of tools to seed health facilities. • Molecular markers for pest and diseases available. • Candidate genes for resistance identified.	• NARS have the needed resources. • Adequate interaction with other disciplinary scientists. • Successful experiments. • Continued development of new varieties that are commercially acceptable. • Farmers have adequate access to extension agents, credit lines, and other factors that influence adoption. • Collaboration with NARS possible. • Evaluation, screening, and exploration sites accessible.

PE-1 Project Log Frame (cont'd)

Narrative Summary	Measurable Indicators	Means of Verification	Important Assumptions
	• Isolates of *Fusarium* and *Pythium* pathogens in beans characterized and identified to species. • Work on anthracnose diseases of tropical fruits initiated. 2006 • AFLP fingerprints for *C. lindemuthiuanum* generated. • Virulence level among isolates of *R. solani* infecting *Brachiaria* described. • Practices to control *Phytophthora* root rot (PRR) validated by selected Colombian cassava farmers. • Isolates of *Pythium* pathogens on beans characterized and identified. Data available for publication. • Biocidal proteins from tropical forages isolated and characterized. • Better diagnostic method and more information on the virus published in the annual report and journal paper. • Diagnostic tools for citrus psorosis virus and citrus leprosis virus developed and available for certification programs. • The anthracnose pathogen population of tropical fruits characterized in regions of Colombia. 2007 • RAMS and AFLP data for *C. lindemuthiauanum* available. • Antifungal protein gene identified and available in tropical forages. • DNA sequences in gene bank for resistance to cassava frog skin disease reported and published.		

PE-1 Project Log Frame (cont'd)

Narrative Summary	Measurable Indicators	Means of Verification	Important Assumptions
Output 2 Pest-and-disease management components and IPM strategies developed.	2005 • Taxonomic identification Entomopathogenic fungi, bacteria or nematodes; data from laboratory experiments available. Publications in journals. • Analysis of field and greenhouse data. • Levels of resistance confirmed in bean progenies. • Five to ten tolerant bean varieties selected in farmers' fields and greenhouse evaluation. Experimental data available; resistant bean lines identified. • Set of rice blast isolates with a virulence genes for corresponding resistance genes. • DNA sequences in cassava gene bank reported. • Extension service providers (50), and farmers (300) trained in Bean IPDM in Uganda and Rwanda. • A list of sources of CFSD resistance will be available. The work published in the annual report and a journal paper. 2006 • Agreement with commercial biopesticide industry established for product development. • Two commercial *Brachiaria* cultivars with spittlebug resistance available to farmers. • Levels of disease and insect resistance confirmed in bean genotypes • 500 common bean farmers in Malawi, 1500 in Kenya and 8000 in Tanzania evaluated botanical biopesticides and other pest management options. • Distribution of rice nurseries with 50 potential donors of blast and sheath blight resistance to Latin American countries. • Studies on enhancement of general soil health initiated.	• Analysis of experiments. • Guidelines for IPM. • Reports on field effectiveness and probability of adoption of components. • Field-oriented brochures. • Farmer participatory research implemented. • Reports available.	Funding for research and technology (IPM) practices available. Stakeholders are willing to participate.

PE-1 Project Log Frame (cont'd)

Narrative Summary	Measurable Indicators	Means of Verification	Important Assumptions
	2007 • Three to four biological pesticides commercially available for farmers. • Foliar blight resistant *Brachiaria* hybrids available. • Multiplication and distribution of Latin American rice cultivars with complementary blast resistance genes incorporated. • Implementation of marker assisted selection breeding program for sheath blight resistance in rice. • Practices to control Moko of banana validated by selected banana farmers in Colombia. • Research partners in Kenya and Rwanda trained and collaborate in *Pythium* root rot assays on beans. • Angular leaf spot and *Pythium* resistant bean varieties available to Bean Farmers. • The populations for genetic studies developed and F2 population analyzed for disease susceptibility and molecular markers. • Results of study using several CTV mild strains to determine if they provide adequate protection.		
Output 3 NARS' capacity to design and execute IPM research and implementation, and applications of molecular tools for pathogen and pest detection, diagnosis, diversity studies as well as novel disease and pest management strategies strengthened.	2005 • Five hundred farmers in Malawi, 1500 in Kenya, 8000 in Tanzania and 1000 in Uganda evaluated biopesticide and other pest management practices on common bean crop. 2006 • Cassava, maize and onion farmers trained in management of soil-borne pests (white grubs and burrowers bugs). • Molecular markers associated with resistance identified in rice. • Molecular tools for detection, diagnosis and diversity studies of a number of pathogens and pests made available.	• Reports on training courses. • Concept notes and projects prepared with partners. • IPM projects implemented	Trainees are keen to become trainers of farmer communities.

PE-1 Project Log Frame (cont'd)

Narrative Summary	Measurable Indicators	Means of Verification	Important Assumptions
	2007 • Combination of whitefly resistant cassava varieties and biological control agents available to farmers and farmers trained. • Application of biopesticides and cultural practices by farmers. • Hundred or more bean farmers and technicians trained in whitefly management. • Combination of pest resistant bean varieties and biological control agents available to farmers and farmers trained. • Awareness of IPM in beans created among policy makers and other stake holders (NGO's, private sector, schools, etc.). Farmers meetings, field days, exchange visits, publication of promotional material.		
Output 4 Global IPM networks (Integrated Whitefly Management Technology) and knowledge systems developed.	• Network of researchers established. • Preparation of Web pages and databases with relevant IPM information. • Databases of microbial and arthropod collection established.	• Electronically published Web pages and databases. • Progress reports.	

2. CGIAR Output template

MTP 2005-2008

Project PE-1

Output	Output target 2005	Category of Output Target	Achieved?
1: Pest and pathogen complexes in key crops described and analyzed.	*Pythium* root rot pathogens on beans in Eastern Africa characterized and distribution established.	Practice	Achieved
2: Pest-and-disease management components and strategies developed for key crops.	Entomopathogens for control of selected soil borne cassava pests identified (for white grubs and burrower bugs).	Strategy	Achieved
3: Strengthened capacity of NARS to design and execute IPM R&D, to apply molecular tools for pathogen and pest detection, diagnosis, diversity studies and to device novel disease and pest management strategies	Five hundred farmers in Malawi, 1500 in Kenya, 8000 in Tanzania and 1000 in Uganda evaluated biopesticide and other pest management practices on common bean crop	Capacity	Achieved
4: Global IPM networks (Integrated Whitefly Management Technology) and knowledge systems developed.	Effective network for integrated whitefly management technology established	Strategy	Achieved

3. Research Highlights

3.1. Project operations

Significant changes and improvements have been implemented in project PE-1 in 2005.

- Revised the project log-frame, milestones, objectives, goal and outputs of the project in a way that contributes to the three Research for Development Challenges (RDC) and aligned with the IMAT RDC. We have changed the name of the project from Integrated Disease and Pest Management to one that reflects the entire scope of the research we conduct: Crop and Agroecosystem Health Management (Spanish: Manejo de la Sanidad de Cultivos y Agroecosistemas). This name change has significance and it reflects the current trend and is in line with the Research for Development Challenge where the project is housed.
- Re-designed the project website and included several new features such as complete publications, CVs and pictures of principal staff, descriptions of their expertise and specific area of research, list of graduate and undergraduate students and short descriptions of their thesis, list of national staff, list of visiting scientists, funded projects and donors, list of collaborating scientists and their institutions, extensive calendar of events, popular press articles on our work, pictures and passport data of major diseases and pests that can be used by partners as quick diagnosis tools, etc. http://www.ciat.cgiar.org/ipm/index.htm. This website has been sent to many organizations and scientists world-wide in an attempt to reintroduce ourselves and raise our profiles.
- Established a consolidated database on microbial/arthropod pest collections that include pathogens, insects, entomopathogens, and other bio-control agents. There is a need for more work to make the database user friendly.
- Established a complete database on funded projects, submitted proposals, and concept notes. This database is updated and circulated among members of the project every 3-4 months. We believe that this motivates staff, removes duplication of effort, improves communications among team members, and possibly fosters team work.
- Several strategies have been implemented to build a team spirit and integration through constant communications, regular meetings, conflict resolutions, joint publications (eg. Advances in application of agricultural biotechnology to control diseases and pests of tropical crops), group proposal development, resource sharing, work-plan development and collegial feedback.
- The members of the project worked as a team and produced several proposals and concept notes, with great results. In 2005, we have received, together with partners, approval of various projects exceeding a total of US$3,300,000. This includes the whitefly project that involves multiple partners and multiple donors (DFID, NZAID, USAID and ACIAR). The whitefly project operates in SSA (with IITA and on cassava/sweet potato), Asia (with AVRDC, India, tomatoes), Mexico, Central America and Caribbean (mixed cropping systems, tomatoes, beans, pepper, cucurbits), Andean highlands (Colombia, Ecuador, Bolivia on beans, potato, tomato, pepper cucurbits). The emphasis in 2005 was to capture funds focusing within the region, and we are pleased with the success, even capturing funds, for the first time, from FONTAGRO (The Regional Fund for Agricultural Technology). We have also secured funds from the Ministry of Agriculture of our host country Colombia. We believe that this strategy not only is good for raising funds but also is key to further strengthen our relationship with our partners in the region.

- The project has strengthened its ties with CORPOICA, Colombia, and other partners by identifying joint research priority areas and successfully securing funds to execute them.

3.2. Research

Output 1: Pest and disease complexes described and analyzed.

- Primers specific to 16 microsatellite loci were identified and developed in the bean anthracnose pathogen, *Colletotrichum lindemuthianum*, and the potential of these primers to distinguish between Andean and Mesoamerican groups and to provide information on the genetic structure of the pathogen were demonstrated.
- A multiplex PCR assay was developed for simultaneous detection of six pathogenic *Pythium* species and a potential biocontrol agent.
- A competitive PCR assay was developed for *Pythium ultimum* var *ultimum*, and its utility to determine DNA concentration from unknown samples was determined.
- Three markers linked in coupling to the resistance gene in RWR 719 were identified, two were turned into SCAR markers and the potential use of these markers in MAS was demonstrated. This is the first report of tagging and developing a SCAR marker for a *Pythium* resistance gene in common bean.
- Three major intercrops of beans i.e. maize, sorghum and peas, in the bean-based system of southwestern Uganda were affected by root rots implying that they may be hosts of the pathogens. Management options effective for bean root rots are also beneficial to other crops such as sorghum and field peas in bean based cropping system. Formulating management strategies for root rots need to consider a systems approach rather than a crop's approach.
- *Mortierella* sp (strain MS10) was shown to have antagonist effects to pathogenic *Pythium* isolates with marked reduction in disease severity in screen house studies offering potential as a biocontrol agent against *Pythium* root rot.
- The rice blast resistance genes present in 211 commercially grown Latin American rice cultivars were identified and nine groups of potential sources of complementary resistance genes were defined for their use in a breeding program aiming at developing commercial rice cultivars combining desired agronomic traits and blast resistance.
- Endophytic plant growth promoting bacteria (PGPB) were isolated from *Brachiaria* hybrid (CIAT 36062) and characterized. Introduction of these bacteria into the *Brachiaria* hybrid cv. Mulato (CIAT 36061) resulted in improved growth (more leaf, stem and root biomass) relative to the control (indigenous bacteria only). A specific primer was developed that was useful to detect endophytic bacteria associated with *Brachiaria* using one step PCR instead of nested PCR.
- Methodology for mass rearing of white grub species was developed.
- Standardized protocols were developed for risk evaluations of genetically modified organisms (GMOs) on non-target soil organisms. No statistical differences were detected in abundance and diversity of soil organisms in conventional versus genetically modified cotton [Bollgard ® Bt Cry 1A ©] during the 2003-05 period in the Cauca Valley, Colombia.
- Random amplified microsatellites (RAMs) technique was employed to make an intraspecific and interspecific analysis of *Ralstonia solanacearum*, causal agent of bacterial wilt of Musaceae and of other plant species.
- Research was initiated on the molecular characterization of the anthracnose pathogen, *Colletotrichum* spp., infecting tree tomato, mango and lemon tahiti in Colombia.

Output 2: Pest-and-disease management components and IPM strategies developed.

- Resistance to the bean weevil (*Acanthoscelides obtectus*) was identified in *Phaseolus vulgaris* x *P. acutifolius* hybrids. New accessions and lines with insect resistance were identified.
- Mulching with green manures increased bean yields of susceptible bean cultivars and this increase was associated with a reduction in root-rot incidence and increased soil nutrient availability.
- Several bean lines with multiple resistance to *Pythium* root rot and angular leaf spot (ALS) diseases have been selected and will be distributed to different countries for multi-locational evaluations. Some have already been distributed to Kenya and Malawi.
- An entomoparasitic nematode, *Heterorhabditis bacteriophora*, was identified as new promising natural enemy of the soil pest *Phyllophaga menetriesi*.
- Economic threshold of white grub species *Phyllophaga menetriesi* on three crops (maize, cassava, and beans) was defined.
- A highly virulent strain of the bacterium *Paenibacillus popilliae* was identified for the control of the white grub *Phyllophaga menetriesi*.
- Numerous sexual hybrids (SX03, SX05) of *Brachiaria* with high levels of antibiosis resistance to *Aeneolamia varia*, *A. reducta*, and *Zulia carbonaria* were identified.
- High levels of antibiosis resistance to *A. varia*, *A. reducta* and *Z. carbonaria* were detected in 9 apomictic hybrids (series BR04) of *Brachiaria*.
- Six apomictic hybrids of the MX02 series, selected for resistance to *Prosapia simulans*, also showed resistance to *A. varia*, *A. reducta*, *Z. carbonaria*, and *Mahanarva trifissa*
- Six apomictic hybrids of *Brachiaria* of the series BR02 and 11 of the series MX02 were identified as resistant to *A. varia*, *Z. carbonaria*, *Z. pubescens*, and *M. trifissa* under field conditions.
- Four *Brachiaria* hybrids showed high levels of resistance to *Rhizoctonia* foliar blight under field conditions that are comparable to the resistant accession (*B. brizantha* CIAT 16320)
- A transformation protocol was developed, for the first time, for the endophytic fungus *Acremonium implicatum*.
- A biocidal protein identified from the tropical forage legume *Clitoria ternatea* was effective against diseases of tomato under field conditions.
- First occurrence of an emerging tomato strain of *Ralstonia solanacearum* race 1, a new pathotype that genetically clusters with plantain strains (race 2) was detected. Greenhouse inoculation showed that the tomato strain was pathogenic to plantain, hence, bringing into question the use of plantain–tomato rotations.

Output 3: NARS' capacity to design and execute IPM research and implementation, and applications of molecular tools for pathogen and pest detection, diagnosis, diversity studies as well as novel disease and pest management strategies strengthened.

- A collaborative mechanism has been set up to facilitate national partners to integrate application of marker assisted selection (MAS) in their breeding programs.
- Expanded diffusion of technology activities within the DFID-funded project on Sustainable Management of Whiteflies continued.
- Assistance in disease and pest diagnosis, development of molecular tools for rapid detection of pathogens provided to NARS.

- Novel approaches with potential for promoting integrated pest and disease management (IPDM) technologies were evaluated at target project sites in Africa.
- Trained modified farmer field school (MFFS) groups were effective in knowledge sharing and dissemination of IPDM technologies in Africa.
- Cohesive and dynamic farmer research groups (FRGs, over 300 groups with more than 50,000 well trained farmers) have evolved at project sites in Uganda, Kenya, Tanzania and Malawi.
- Farmer to farmer knowledge sharing enhanced technology dissemination and adoption (60-85% adoption rate) in several countries in Africa.
- Farmers used traditional (drama, songs, poems) and conventional (seminars, demonstration and learning plots, field days and visits, radio, promotional materials) pathways in technology dissemination in Africa.
- The process of learning by doing and seeing succeeded in using the psychology of development that helped to build farmers' confidence in the effectiveness of indigenous practices that they blended with improved IPDM technologies.
- The approach and processes used in the project (Evaluating novel / innovative approaches in scaling up integrated pest and disease management (IPDM) technologies) has helped to improve the skills of individual farmers and groups in the identification and management of production constraints (such as diseases, insect pests, soil fertility and markets), demand and search for information on solutions and new technologies.
- The practical sessions used in implementing IPDM project activities helped to empower men and women farmers in the management of their own resources.
- Eighteen (BSc), 18 (MSc), 7 (PhD) thesis students supervised in 2005.
- Integrated disease and pest management related courses and seminars were given to more than 1362 professionals and farmers from countries in Latin America and Africa
- More than 312 visitors from various institutions visited the PE-1 project research programs, both at CIAT headquarter and in Africa.
- Fifteen staff members (both junior and senior staff) received awards for their research work.
- Forty-three refereed journal articles, 7 book/book chapters, 59 conference papers and 3 technical manuals and booklets were published. More than 11 articles have been written on some of our interesting research results in newspapers and other outlets.

Output 4: Global IPM networks (Integrated Whitefly Management Technology) and knowledge systems developed.

- A book entitled "Whitefly and Whitefly-borne Viruses in the Tropics: Building a Knowledge Base for Global Action" was published.
- Important changes in whitefly species composition were detected in the Cauca Valley region of Colombia. These changes in whitefly species composition were accompanied by the emergence of new whitefly-borne viruses affecting snap bean, tomato, and pepper.
- Varying levels of resistance or susceptibility was detected to some of the insecticides commonly used for whitefly control in the Cauca Valley region of Colombia.
- The ovipositional rate (N_o. eggs/female) of the cassava whitefly *Aleurotrachelus socialis* on a given genotype is a good indication of the level of resistance in that genotype.
- Research results indicate that a relationship may exist between proteins in the cassava leaf and resistance to the whitefly, *Aleurotrachelus socialis*.

- Numerous resistant genotypes from interspecific crosses with *Manihot esculenta* and wild *Manihot* species were identified, indicating the possible presence of resistance to the whitefly *Aleurotrachelus socialis* in *M. flabellifolia*, *M. peruvians*, *M. tristis* and others.
- The high rate of survival and short generation time of the cassava whitefly, *Aleurotrachelus socialis*, feeding on the commercial variety Chirosa, explain its rapid population increase in cassava plantations.

4. Performance Indicators: Publications

Journal Articles in Refereed Journals (Published, In press):	43
Books and Book Chapters:	7
Conference and Workshop papers	59
Technical manuals and Bulletins	3
Newspaper and Internet articles	11

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5. Performance Indicators: Resource Mobilization

5.1. New proposals approved in 2005

Project Title	Donor	Participating Institutions	Budget US$		Total project budget US$
			CIAT (lead scientist)	Participating Institution (lead scientist)	
Precision agriculture and construction of models for tropical fruuit crops (2005 – 2007)	COLCIENCIAS Agencia Colombiana de Cooperación Internacional (ACCI) MADR Colombia	Corporación BIOTEC	19,316 (Elizabeth Alvarez)	406,248 (Myriam Sánchez)	425,564.00
Development and implementation of phytosanitary certification program for citrus. (2006 – 2008)	Ministry of Agriculture and Rural Development (MADR), Colombia	CORPOICA, ICA , Profrutales Ltda.	45,107 (Lee Calvert)	Corpoica 29,163; ICA 30,042 (Jorge Gómez, Jorge E. Angel)	118,820 (approved) 261,114.00 (total project cost)
Development and transfer of moko (*Ralstonia solanacearum*) disease management in platano in Armenia. (2005)	Alcadía de Armenia, Colombia	ICA	6,000.00 (Elizabeth Alvarez)	(Cristina Aristizábal)	6,000.00
Dynamics of sources of inoculum and análisis of the anthracnose pathogen population infecting tropical fruits (2005 – 2007)	COLCIENCIAS, Colombia	CORPOICA	90,000.00 (Segenet Kelemu)	129,046.00 (Jairo Osorio)	219,046.00

5.1. New proposals approved in 2005 (cont'd)

Project Title	Donor	Participating Institutions	Budget US$		Total project budget US$
			CIAT (lead scientist)	Participating Institution (lead scientist)	
Evaluation of cross protection as a strategy for the control of tristeza virus in citrus (2005 – 2007)	COLCIENCIAS, Colombia	CORPOICA	(Lee Calvert)	(Jorge Gómez)	35,500.00
Increasing Cassava Productivity through Integrated Pest Management (2005 – 2007)	Inter-American Institute for Cooperation on Agriculture (IICA), Colombia	Live Systems Technology (LST), S.A., Bogotá , Colombia	21,009.00 (Andreas Gaigl)	16,774.00 (Esperanza Morales)	83, 246.00
Lulo with aggregated value: New alternatives for the small holder (2006 – 2008).	Ministry of Agriculture and Rural Development (MADR), Colombia	CORPOICA La Selva, Universidad de Antioquia	(Alonso Gonzalez, Zaida Lentini, Elizabeth Alvarez)	(Mario Lobo)	240,513.00
Utilization of resistant varieties for the control of cassava frogskin disease in the Atlantic coast and Cauca zones (2005-2008)	Ministry of Agriculture and Rural Development (MADR)-IICA	Corporación para Estudios Interdisciplinarios y Accesoria Técnica (CETEC), Asociación Nacional de Productores y Procesadores de Yuca (ANPPY)	7,241.00 (Lee Calvert)	11,340.00 [Roger de Jesús Ramos (ANPPY), Alberto Rodríguez (CETEC)]	53,000.00

5.1. New proposals approved in 2005 (cont'd)

Project Title	Donor	Participating Institutions	Budget US$		Total project budget US$
			CIAT (lead scientist)	Participating Institution (lead scientist)	
Pest and Disease Resistance, Drought Tolerance and Increased Shelf Life Genes from Wild Relatives of Cassava and the Development of Low-cost Technologies to Pyramid them into Elite Progenitors (2005 – 2007)	The Generation Challenge Programme, CGIAR	EMBRAPA-CNPMF, Brazil Namulonge Agricultural and Animal Production Research Institute (NAARI) Crop Research Institute (CRI) National Root Crop Research Institute (NRCRI)	30,000.00 Elizabeth Alvarez, (Anthony Bellotti, Hernan Ceballos, Martin Fregene)	(Alfredo Alves, Anton Bua, Titus Alicia, Elizabeth Okai, Chiedozie Egesi)	894,906.00
Integrated disease management in cassava. (2005 – 2007)	Ministerio de Agricultura y Desarrollo Rural de Colombia (MADR) and Inter-American Institute for Cooperation on Agriculture (IICA), Colombia	Live Systems Technology (LST) S.A., Colombia	53,508.00 (Elizabeth Alvarez)	35,672.00 (Esperanza Morales, Jaime Jaramillo)	89,180.00
Integrated management of moko disease in Plátano (2005)	CGIAR Award	ICA, CORPOICA	10.000.00 (Elizabeth Alvarez)	(Silverio Gonzalez)	10.000.00

5.1. New proposals approved in 2005 (cont'd)

Project Title	Donor	Participating Institutions	Budget US$		Total project budget US$
			CIAT (lead scientist)	Participating Institution (lead scientist)	
Integrated management of whiteflies in the tropics – Phase III (2005 – 2008)	Department for International Development (DFID), UK	IITA AVRDC CIP CABI NRI	1,073,306.00 (Francisco Morales)	1,539,756.00 (James Legg, Peter Hanson, Isabel Carballal)	2,613,071.00
Improvement of nutrient management for the control of mildew disease in roses, caused by the fangal pathogen *Peronospora sparsa* (2006 – 2007)	COLCIENCIAS, Colombia	CENIFLORES ASOCOLFLORES	68,582.00 (Elizabeth Alvarez)	7,387.00 (Rebeca Lee)	75,969.00
Promotion of Integrated Pest Management Strategies for Major Insect Pests of Phaseolus Beans in Hillsides Systems in Eastern and Southern Africa (2005 – 2006)	DFID, United Kingdom	NARS in Uganda, Kenya, Tanzania and Malawi	(Eliaineny Minja, Robin Buruchara, Kwasi Ampofo)	(Michael Ugen, Fina Opio, John Ogecha, Felister Makini, Catherine Madata, David Kabungo, Patrick Mviha, B. Chibambo)	113,118.00
Pesticide use reduction and development of resistance to pesticides in rice and beans in Colombia, Venezuela and Ecuador (2005 – 2008)	FONTAGRO	INIA, Venezuela FEDEARROZ, Colombia INIAP, Ecuador	123,000.00 (Fernando Correa, César Cardona)	101,000.00 (Reinaldo Cardona, Miguel Diago, Sandra Garcés)	224,000.00

5.1. New proposals approved in 2005 (cont'd)

Project Title	Donor	Participating Institutions	Budget US$		Total project budget US$
			CIAT (lead scientist)	Participating Institution (lead scientist)	
Studies in epidemiology and control of the anthracnose disease of mango (2006-2008)	COLCIENCIAS	CORPOICA	35,125.00 (Segenet Kelemu)	35,125.00 (Jairo Osorio)	70,250.00
Combating the Hidden Hunger in Latin America: Biofortified crops with improved vitamin A, essential minerals and quality project (2005 - 2010)	CIDA	MADR, Universidad de Caldas Petrotesting FIDAR	70,000 (Elizabeth Alvarez) (Joe Tohme, Anthony Bellotti, Bernardo Ospina)	Jairo Castaño Jaime Jaramillo José Restrepo	
Collection, characterization, and clonal multiplication of avocado with emphasis on identification of lines tolerant to *Phytophthora* spp. (2006-2008)	Ministry of Agriculture and Rural Development (MADR), Colombia	CORPOICA, PROFRUTALES	(Elizabeth Alvarez) (Alvaro Mejia, Alonso Gonzalez, Joe Tohme)	(Juan Jaramillo, Danilo Rios)	194,705.00

5.2. List of ongoing special projects in 2005

Project Title	Donor	Participating Institutions	Amount available in 2005 US$		Total project budget US$
			CIAT (lead scientist)	**Participating Institution** (lead scientist)	
Assessing the Impact of Biotechnology on Diversity: Effect of Transgenic Maize on Non-Target Soil Organisms. (2002 – 2005)	United States Agency for International Development (USAID)	Cornell University	28,254.00 (Anthony Bellotti, Jairo Rodríguez)	71,106.00 (Daniel Peck)	99,360.00
Evaluation of Colombian isolates of tristeza virus in citrus (2003 – 2005)	COLCIENCIAS, Colombia	CORPOICA	11,949 (Lee Calvert)	60,394 (Jorge Gómez)	80,894
Evaluation of the Effectiveness of Biorationals Used in the Management of Bruchid Pests on Beans (*Phaseolus vulgaris*) by Small-Scale Farmers in the Lake Victoria Basin (2004 – 2007)	SIDA SAREC, Sweden	NARS Universities and research programs in Kenya and Tanzania	30,000.00 (Eliaineny Minja)	(Mabel Imbuga, Paul Tarus, Absolom Munyasi, John Ogecha, Phanice Namungu, Hashim Barongo, Goodluck Kimaro)	30,000.00
Integrated Control of Subterranean Pests in South America (2002 – 2005)	BMZ, Germany	University Hannover University Kiel BBA CORPOICA Univ. del Valle Univ. Nacional de Bogotá Univ. de Caldas	74,251.00 (Andreas Gaigl)	104,290.00 (Christian Borgemeister, Ralf-Udo Ehlers, Gisbert Zimmerman, Martha Londoño, Miguel Serrano, Alberto Soto, Luis F. Vallejo)	714,961.00

5.2. List of ongoing special projects in 2005 (cont´d)

Project Title	Donor	Participating Institutions	Amount available in 2005 US$		Total project budget US$
			CIAT (lead scientist)	Participating Institution (lead scientist)	
Protocol for Monitoring and Developing Resistance to the Bollgard Technology in Colombia (2004 – 2005)	COACOL, Colombia		25,141.00 (Anthony Bellotti)		30,960.00
Understanding the Mechanism of Plant Resistance to Whiteflies (2004 – 2008)	United States Department of Agriculture (USDA)	USDA	27,000.00 (Anthony Bellotti)	3,000 (Stephen Lapointe)	61,146.00

6. Performance Indicators: Capacity building

6.1. List of training courses, workshops & seminars

Event	Date	Organizer/ Place	Participants	Received by
Diagnostic and identification of bacterial and fungal pathogens	Sep 26-Oct. 7	CIAT-Cassava Pathology/ Palmira	2	Isola Robleto and Ana María Blanco, MAGFOR, Nicaragua
Training in nematodes, entomopathogenic fungi and bacteria	Jul. 18.-Nov. 2	CIAT – cassava entom. / Palmira	1	Sandra Victoria Mena
Conservation and handling of entomopathogenic fungi	Jul.13-Oct.30	CIAT cassava entom./ Palmira	1	Ifigenia Hurtado
Raising and handling of “chinche” and “galleria”	Jul. 18-28	CIAT- cassava entom. / Palmira	1	Eliécer Vivas, Technician LST S.A., Bogotá
Risk evaluation of genetically modified organisms (GMOs): Bt cotton case in the Valle del Cauca, Colombia.	June 27	ICA/Tulua	25	Agricultural and extensión specialists
Pathological, entomological problems, integrated crop management, and knowledge on nitrifying bacteria	May 20	CIAT- cassava entom / Palmira	30	Students in VIII Semester of Economic Entomology and forage protection, Agronomy program, Fac. Ciencias Agropecuarias, Universidad de Caldas, Colombia
Training in storage and conservation of entomopathogenic fungi	April 28	CIAT/Palmira	14	Students, Universidad de Córdoba, Colombia

6.1. List of training courses, (cont'd)

Event	Date	Organizer/ Place	Participants	Received by
International course of modern production, processing and utilization systems of cassava in Latin America and the Caribbean, integrated management of whitefly, horn worm and utilization of *baculovirus.* Biological control of burrower bug with nematodes	April 18-27	CIAT- Clayuca/ Palmira	34	Professionals and technicians from Latin America and the Caribbean
First workshop on "Basic Taxonomy and Overview of Collembola"	April 11-15	CIAT-Cornell University project/Palmira	11	Students from Universidad del Valle, Colombia
Biological control, soil quality indicators, molecular markers of beans	April 6	CIAT	25	Students from Universidad Nariño, Colombia
Trainning in procedures for risk evaluation of genetically modified organisms (GMOs)	Mar. 18-Apr. 8	CoaCol/Palmira	1	Luisa Fernanda Bermúdez, Universidad Nacional de Colombia
Advances in diagnosis and integrated management of bacterial wilt of banana and plantain	March 10–11, 2005	CIAT, Palmira		Martha Cecilia Castaño, Ana Lucía Bejarano, Angela María Arango, Marco Fabián Flórez, and Jefferson Rubiano, professionals and technicians from ICA–Section Quindío
First update on sustainable production of maize	Feb. 24	ICA, Corpoica, Industrias del Maiz, Casa Toro, Del Campo/ Palmira	200	Students, extensión and agricultural specialists
Advances in research for managing bacterial wilt of plantain	Oct. 26	ICA-Tulua	19	Technical personnel from ICA Tulua, Colombia

6.1. List of training courses, (cont'd)

Event	Date	Organizer/ Place	Participants	Received by
Advances in research on managing bacterial wilt in Musaceae	Sept 29	ICA- Palmira	18	Technical personnel from ICA Palmira
Workshop on integrated management of cassava pests and diseases with emphasis on biological control and production costs	Sept 9		23	23 participants from Yopal, Colombia
Managing cassava diseases	August 18, 19	CIAT, Palmira		Ana Elizabeth Diaz, CORPOICA; Juan Jose Font and Jorge Fuentes, Guatemala
Seminar on "Advances in the Search for Alternatives in Managing Bacterial Wilt of Musaceae	Aug 18	Sevilla, Valle del Cauca	30	Farmers and technicians
Advances in the search for alternatives in managing bacterial wilt of plantain: national seminar on plantain pests and diseases	July 18-19		300	Farmers, technicians, and students from Armenia, Colombia
Workshop on the management of cassava diseases, using clean strategies	5 July	CIAT, Palmira	11	Farmers form Piendamó, Cauca
Training on the agronomic management of snap and dry beans and integrated disease management.	17-19 November	Bogota	65	Technicians
Symptoms and management of cassava frogskin disease	28 March	CIAT	43	Farmers form Armenia
Detecting phytoplasmas associated with frogskin disease of cassava	Nov 2004-Nov 2005	CIAT, Palmira	2	Adriana Arenas and Diana López, students, Universidad del Valle, Colombia
Managing bacterial wilt of plantain in Quindio, Colombia	1-31 July	CIAT, Palmira	2	Marcelo Vargas and Omar Zuluaga, Universidad de Caldas, Colombia

6.1. List of training courses, (cont'd)

Event	Date	Organizer/ Place	Participants	Received by
Innovation histories of the adoption of bean varieties		CIAT, Kampala, Uganda	16	
Strengthening capacity for participatory monitoring and evaluation for the national bean programs in ECABREN partner countries, Nairobi, Kenya	14 - 18 March	CIAT	35	
Biofortification project planning meeting	19 March	Nairobi, Kenya	13	
Planning of bean research	30-31 March	Cameroon	15	
Participatory plant breeding monitoring tour	1-12 April	CIAT/ Ethiopia	12	
Ninth annual meeting of the PABRA steering committee	16 - 18 May	Arusha, Tanzania	17	
Ouru masawa farmer field day	18 May	Kenya	107	Farmers
Ethiopia bean seed impacts partner meeting	20 - 21 April			
Workshop on strengthening common bean seed system in Eastern Ethiopia	May 30	Jima, Ethiopia	15	
Breeder's course and field visits	June 7 - 18,	Uganda/ Rwanda/ Kenya	17	
Training of enumerators at Oyugis for IPDM uptake surveys in Kisii site	25 -26 August	Kenya	16	
Marker assisted selection in plant breeding: principles and practices	3 - 7 October	Kawanda, Uganda	13	

6.1. List of training courses, (cont'd)

Event	Date	Organizer/ Place	Participants	Received by
To facilitate a farmer exchange visit and conduct IPM farmer group participatory training workshop at Tarime for VicRes Project participants	22-26 Nov	Tarime, Tanzania and Kisii, Kenya	25	
Tarime farmers' learning visit to Ouru Masawa	24 Nov	Tanzania	26	Farmers
Training of Tarime farmers on bean IPDM and participatory group research approach	25 Nov	Tanzania	27	Farmers
How to measure parasitism in whiteflies	Feb. – Mar.	CIAT	120	Farmers
Biology and ecology of whiteflies	23 Feb.	CIAT	30	Technical assistants and farmers
Training in sampling methods	22 April	CIAT	8	Students, Univ. Nacional /Palmira
Biology and ecology of whiteflies	4 May	CIAT	20	MSc. students, Univ. Nacional / Medellín
Biology and ecology of whiteflies	19 May	CIAT	35	Students, Univ. de Caldas- Manizales
Biology and ecology of whiteflies	Sept.	CIAT	2	Students, Univ. de Caldas- Manizales
Management of whiteflies	12 October	CIAT	19	Students, Univ. Nacional /Palmira
Management of whiteflies	10 –22 Oct.	CIAT	1	Vladimir Lino Collaborator from PROINPA
Sampling insects, biology of whiteflies	8 Nov.	CIAT	27	Students, Univ. Nacional /Palmira
Viral Diseases of High Value Crops	23-25 Nov.	CIAT	20	Personnel from Semillas Arroyave

6.2. List of visiting scientists-2005

Name	Institution	Subject	Date
Mónica Ramirez	Universidad del Valle, Colombia	Evaluation of the ant community in conventional and Bt-modified cotton in the Cauca Valley, Colombia	01 February - 31 December
Claudia L, Guzman	Universidad del Tolima, Colombia	Biodiversity of collembolas in silvo pastoral and agricultural production systems in the tropical dry forest	7-11 February
Luisa F. Bermudez	Universidad nacional de Colombia, Bogotá	Procedures for risk evaluation of genetically modified organisms (GMOs)	18 March - 8 April
Jose C. Rodríguez	Univ. Chapingo, México	Effect of genetically modified organisims on non-target organisms	30 July-02 August
Sandra Milena Rodríguez	CORPOICA, Villavicencio	PCR methods to detect *Ralstonia solanacearum* in soil samples collected from a commercial plot of plantain in the Ariari Region; identifying isolates of *Ralstonia solanacearum* through specific PCR, using primers	18 April- 13 May
Mathilde Ouevrard	Institut National d'Horticulture, France	Application of biofungicides in grape disease control: evaluation of the inhibitory minimum concentration of several products on *Ralstonia solanacearum*	23 May-21 July
Juan Pablo Castillo	Universidad de Caldas, Colombia	Development of strategies for managing bacterial wilt of plantain	15 July-15 December
Carlos A. Ortega-Ojeda	Escuela Politécnica del Ejército, Ecuador	Estimating grade damage caused by the soil pests *Phyllophaga* spp (Coleoptera: Melolonthidae) in maize, cassava and beans.	January 2004-February 2006

6.3. List of students

BSc Thesis

Name	Supervisor	University	Title
Javier Francisco Abello C. (Feb. 2004 – Aug. 2005)	Segenet Kelemu (CIAT) Celsa García (Universidad Nacional)	Universidad Nacional de Colombia, Bogotá	*Agrobacterium tumefaciens* – mediated transformation of the endophytic fungus *Acremonium implicatum* (J. Gilma & E.V. Abbott) W. Gams, with the green fluorescent protein gene (*gfp*).
Jorge Alejandro Corredor (Aug 2004 – Mar 2005)	Elizabeth Álvarez (CIAT) Gerardo Martínez (Universidad de Caldas)	Universidad de Caldas	Evaluation of the association of morphological and biochemical characteristics of cassava (*Manihot esculenta* Crantz) roots with resistance to root caused by *Phytophthora tropicalis* and postharvest physiological deterioration.
Luz Elena Romero (Jan 2006 –Jan 2007)	Lee Calvert (CIAT) Eiver Cardenas (Universidad del Valle)	Universidad del Valle, Colombia	Identification of microsatellite molecular markers associated with resistance to the *Tagosodes Oryzicolus M. (Homóptera; delphacidae)* in rice.
Eduardo Gómez (Aug 2004 – Sept.2005)	Elizabeth Álvarez (CIAT) Clemencia Forero de La Rotta (Universidad Javeriana)	Universidad Pontificia Javeriana, Bogotá	Identifying and characterizing isolates of *Ralstonia solanacearum* obtained from areas affected by bacterial wilt of plantain in Colombia
Carolina Buitrago Aya (Mar 2004 – Oct. 2005)	Andreas Gaigl (CIAT) James Montoya (Universidad del Valle)	Universidad del Valle, Colombia	Evaluation of pathogenicity and virulence of *Bacillus popilliae* Dutky on second instar *Phyllophaga menetriesi* Blanchard (Coleoptera: Melolonthinae)
Anyimilehidi Mazo Vargas	Anthony Bellotti (CIAT) James Montoya (Univalle)	Universidad del Valle, Colombia	Effect of cotton Bollgard® (Bt) on the diversity and abundante of soil arthropods in Cauca Valley.
Monica Carvajal. 2000-2005	Lee Calvert (CIAT)	Universidad de Los Andes, Bogotá	Characterization of leprosis critics virus in Colombia

6.3 List of students (cont'd)

Name	Supervisor	University	Title
Luz Adriana Mesa Becerra (Oct. 2005 – Oct. 2006)	Elizabeth Alvarez (CIAT) Julio C. Torres (Universidad del Quindío)	Universidad del Quindío, Colombia	Moko disease management alternatives in platano (Finca La Florida)
Andrés Rincón (Jul. 2005 – Dec. 2005)	Elizabeth Alvarez (CIAT) Andreas Gaigl (CIAT) Inés María Ulloa (Universidad del Valle)	Universidad del Valle, Colombia	Economic evaluation of intergated nutrient, disease and pest management in cassava in Cauca and Eastern plains of Colombia.
Lorena Cortes (March 2004- May 2005)	George Mahuku (CIAT)	Universidad del Valle	Effect of different sources of green manure on soil-borne diseases of beans (*Phaseolus vulgaris*, L. Fabaceae).
Eliana del Pilar Macea (Aug. 2005-Aug 2006)	Anthony Bellotti (CIAT) Jaime Montoya Lerma (Universidad del Valle)	Universidad del Valle	Identification of molecular markers associated with resistance to green mites in cassava.
Gabriel A. Torres Londoño (Oct. 2005 – Oct. 2006)	Anthony Bellotti (CIAT) Gerardo Martínez López (Universidad de Caldas)	Universidad de Caldas, Colombia	Evaluation of *Sogatella kolophon* (Kirkaldy) and *Empohasca bispinata* (Davidson & Delong) as posible vectors of cassava frogskin disease.
Víctor Hugo Treviño Henao (Oct. 2005 – Oct. 2006)	Elizabeth Alvarez (CIAT) Julio César Torres Arbeláez (Universidad del Quindío)	Universidad del Quindío, Colombia	Moko disease management alternatives in platano (Finca La Manigua)
Marcelo Vargas (Feb. 2005 – Feb. 2006)	Elizabeth Alvarez (CIAT) Henry Toro (Universidad de Caldas)	Universidad de Caldas, Colombia	Evaluation of ecological practices of soil management and its effect on moko disease of Platano caused by *Ralstonia solanacearum* (Finca La Guaira, Dep. Quindío)
Omar Zuluaga (Feb. 2005 – Feb. 2006)	Elizabeth Alvarez (CIAT) Henry Toro (Universidad de Caldas)	Universidad de Caldas, Colombia	Evaluation of ecological practices of soil management and its effect on moko disease of Platano caused by *Ralstonia solanacearum* (Finca La Cataluña, Dep. Quindío)

6.3 List of students (cont'd)

Name	Supervisor	University	Title
Sandra Jimena Valencia (Completed)	Cesar Cardona (CIAT) Magnolia Cano (Univ. Nacional Palmira)	Universidad Nacional Palmira, Colombia	Sub-lethal effects of antibiosis on the demography of *Zabrotes subfasciatus* and *Acanthoscelides obtectus*, storage pests of beans.
David Pulgarin	Fernando Correa (CIAT) Gustavo Adolfo Garcia Henao (Univ. de Antioquia)	Univ. de Antioquia, Medellín, Colombia	Characterization of rice blast resistance genes in Latin American and Carribean rice varieties.

MSc Thesis

Name	Supervisor	University	Title
María Elena Cuellar Jiménez (Feb. 2004 – March 2006)	Francisco Morales (CIAT) James Montoya (Universidad del Valle)	Universidad del Valle, Colombia	Bean leaf crumple virus: Transmission by whiteflies (Gennadius) (Homoptera: Aleyrodidae), search for sources of resistance in *Phaseolus vulgaris* L. and epidemiology.
Miriam Karlsson (Dec. 2004 – Aug. 2005)	Anthony Bellotti, Claudia Holguín (CIAT) James Montoya (Universidad del Valle) Sven Axel Svensson (Swedish Univ. of Agric. Science)	Swedish University of Agricultural Science	Control of whitefly (*Aleurotrachelus socialis* Bondar) with organic insecticidas in cassava (*Manihot esculenta* Crantz)
Sophia Komba (Jun. 2003 – Dec. 2005)	Susan Kaaria, Eli Minja (CIAT) Felician Mutasa (Open University of Tanzania)	Open University of Tanzania and New Hampshire University (USA)	Social economic benefits of IPDM technologies to bean farming communities in Hai district, northern Tanzania
Juan Fernando Mejía (Oct. 2005 – Oct. 2007)	Elizabeth Alvarez (CIAT) Martín Fregene (CIAT) Jaime E. Muñoz (Universidad Nacional)	Universidad Nacional, Palmira, Colombia	Identification of resistance gene analogs associated with superelongation disease of cassava.

6.3 List of students (cont'd)

Name	Supervisor	University	Title
José Luis Claros (Feb. 2005 – Sept. 2005)	Elizabeth Álvarez (CIAT) Martín Fregene (CIAT) Jaime Eduardo Muñoz (Universidad Nacional)	Universidad Nacional de Colombia, Palmira	Identifying resistance gene analogs associated with bacterial wilt in the ACR cassava family
Maria Antonia Henriquez (Jan.2003 – Aug.2005)	George Mahuku (CIAT) Hernando Ramirez (Universidad Nacional de Colombia, Palmira)	Universidad Nacional de Colombia, Palmira	ESTs for understanding the interaction between common bean (*Phaseolus vulgaris*) and *Phaeoisariopsis griseola*, the causal agent of angular leaf spot disease
Walter Ocimati (Sep. 2004 – Dec. 2005)	Robin Buruchara (CIAT) Geoffrey Tusiime (Makerere University)	Makerere University, Uganda	Effects of different management practices against root rots on major crops in the bean-based cropping system of south-western Uganda
Augustine Musoni	Robin Buruchara (CIAT)	University of Nairobi	Inheritance of fusarium wilt (*F. oxysporum* f.sp. *phaseoli*) and selection for multiple disease resistant and marketable climbing bean varieties
Carlos Alberto Ortega-Ojeda (Jan. 2004 –December 2005)	Andreas Gaigl (CIAT) César Falconi (Escuela Politécnica del Ejército)	Escuela Politécnica del Ejército; Centro de Posgrado, Ecuador	Estimating grade damage caused by the soil pests *Phyllophaga* spp (Coleoptera: Melolonthidae) in tropical crops
Leopoldo Serrano	Francisco Morales (CIAT)	Universidad de El Salvador	Characterization of whitefly biotypes.
Ana Karina Martinez	Francisco Morales (CIAT) F. Alirio Vallejo (Univ. Nacional, Palmira)	Universidad Nacional, Palmira, Colombia	Characterization of *begomovirus* and evaluation of tomato lines for resistance to *begomovirus* in the Cauca Valley.

6.3 List of students (cont'd)

Name	Supervisor	University	Title
Maritza Cuervo	Lee Calvert (CIAT) Edgar Ivan Estrada (Univ. Nacional Palmira)	Universidad Nacional Palmira, Colombia	Molecular characterization of isolates of the virus associated with cassava frogskin disease collected from production zones in Colombia.
Fernando Lopez	Cesar Cardona (CIAT) James Montoya (Univ. del Valle)	Universidad del Valle, Cali, Colombia	Tolerance to adult feeding damage as a component of resistance to *Aeneolamia varia* in *Brachiaria* spp.
Ulises Castro	Cesar Cardona (CIAT) Jorge Vera graciano (Universidad of Chapingo, Mexico) Ramón Garza García (INIFAP)	Universidad of Chapingo, Mexico	Mechanisms of resistance to *Aeneolamia Albofasciata* and *Prosapia simulans* in *Brachiaria* spp.
Natalia Labrin (Jan 18 to Oct 20 2006)	Lee Calvert (CIAT) . Andrea Ebert. (CATIE)	CATIE, Costa Rica	Ecological Agriculture in the area of genetics to resistance in Venezuelan rice varieties (*Orytza Sativa*) to the white leaf virus.
Edgar Corredor (Jan 2005- Jan 2007).	Lee Calvert (CIAT)	Universidad Nacional Palmira, Colombia	Inheritance of resistance to the insect *tagosedes oriziculus homoptera* in rice varieties.
Alejandro Pabón	Cesar Cardona (CIAT) Evaldo Ferreira Vilela (Departamento de Biologia Animal/UFV)	Universidad of Viçosa, Brazil	Mechanisms of resistance to *Deois incompleta, D. Schah* and *Notozulia entreriana* in *Brachiaria* spp.
Paola Sotelo	Cesar Cardona (CIAT) Ariel Gutierrez (Univ. Nacional Palmira, Colombia)	Universidad Nacional Palmira, Colombia	Inheritance of crumpled leaf virus in snap beans

6.3 List of students (cont'd)

Ph.D. Thesis

Name	Supervisor	University	Title
Clare Mukankusi (Sep. 2003 – Aug. 2007)	Robin Buruchara (CIAT) Rob Melis (University of KwaZulu-Natal)	University of Kwazulu-Natal, Pietermaritzburg, RSA	Breeding beans (*Phaseolus vulgaris* L.) for resistance to Fusarium root rot (*Fusarium solani* f.sp. *phaseoli*) and large seed size in Uganda
Virginia Gichuru (Sept. 2005 – Aug. 2006)	Robin Buruchara (CIAT) Patrick Okori (Makerere University)	Makerere University, Uganda	Symptomatology and characterization of *Pythium* spp. of major crops in a bean based cropping system in south-western Uganda
Enrique Bravo	Francisco Morales (CIAT)	Universidad del Valle, Cali, Colombia	
Helena Reichel	Francisco Morales (CIAT)	University of Gembloux, Belgium	Characterization of filamentous virus of platano in Colombia, the Philippines and Africa.
Gloria Santana	Francisco Morales (CIAT)	Universidad Nacional Palmira, Colombia	Resistance to bean common mosaic virus

7.0 Staff list

Principal Staff

Alvarez, Elizabeth (0.25), Pathologist, headquarters
Bellotti, Anthony (0.0), Entomologist, headquarters
Buruchara, Robin A. (0.35), Pathologist, outposted, Uganda
Calvert, Lee, (0.30), Virologist, headquarters
Cardona, César (0.0), Entomologist, headquarters
Correa, Fernando (0.10), Pathologist, headquarters
Gaigl, Andreas (1.0), Entomologist, headquarters
Kelemu, Segenet (0.50), Pathologist and Project Manager, headquarters
Mahuku, George (0.20), Pathologist, headquarters
Minja, Eliaineny (0.80), IPM Specialist, outposted, Tanzania
Morales, Francisco (0.70), Virologist and Whitefly Project Coordinator

Research Associates

Arias, Bernardo (0.32), Agronomist, headquarters
Mukankusi, Clare, Biologist, outposted, Africa

Visiting Scientists

Ortega-Ojeda, Carlos Alberto, Agronomist
Ramirez, Mónica, Biologist
Guzman, Claudia Lisana (Biologist)
Bermudez, Luisa Fernanda
Rodríguez, Jose Concepción

Research Support Staff

Bohórquez, Adriana (1.0), Biologist, headquarters
Buah, Stephen, Pathology/Biotechnology Lab., Africa
Cadavid, Marcela (1.0), Biologist, headquarters
Calberto, Germán A.
Cuervo, Maritza (1.0), Agronomist/Biotechnology, headquarters
Guerrero, José María (0.5), Agricultural Technologist (Acarologist), headquarters
Hernández, María del Pilar (1.0), Biologist-Entomologist, headquarters
Holguín, Claudia María, Agronomist, headquarters
Kananura, Patrick, Research Assistant, Africa
Male, Allan, Research Assistant, Biotechnology Lab., Africa
Martínez, Ana Karine, Biologist
Mejía, Juan Fernando (0.43), Agronomist, headquarters
Melo, Elsa L. (1.0), Biologist, headquarters
Mziray, Hendry A., Agronomy - Africa
Ospina, Claudia M., Agronomist (Springtails Taxonomy)
Rodríguez, Jairo, Agronomist
Llano, Germán Alberto (0.18), Agronomist, headquarters
Loke, John Bernard (0.5), Agronomist, headquarters

Office Staff

Baguma, Athanasio, Administrative Assistant, Africa
Escobar B., Oscar, Social Communicator
García, Melissa. Administrative Assistant
Nassozi, Sarah, A.C.I.S., Regional Finance and Administration Officer, Africa
Tibalikwana, Mabel, Administrative Secretary, Africa
Zamora, Zulma Lorena C., Secretary

Technicians

Acam, Catherine, Africa
Mendoza, Carmen, headquarters
Tobón, Rosalba, headquarters
Zuñiga, Rodrigo, headquarters
Nanez, C., headquarters

Field Workers

Munoz, Adriano
Musoke, Steven, Screen House, Africa
Suleiman, Ssebuliba, Breeding, Africa
Riascos Buenaventura, Rómulo
Rodriguez, Cesar
Perez, Gerardino
Rengifo, Herney, headquarters
Yela Oscar

8.0 Summary 2005 budget

Source	Amount US$	Proportion (%)
Unrestricted Core	233,701	19%
Restricted Core: Colombia	74,140	6%
Sub-total	**307,841**	25%
Special Projects	901,231	75%
Total Project	**1,209,072**	100%