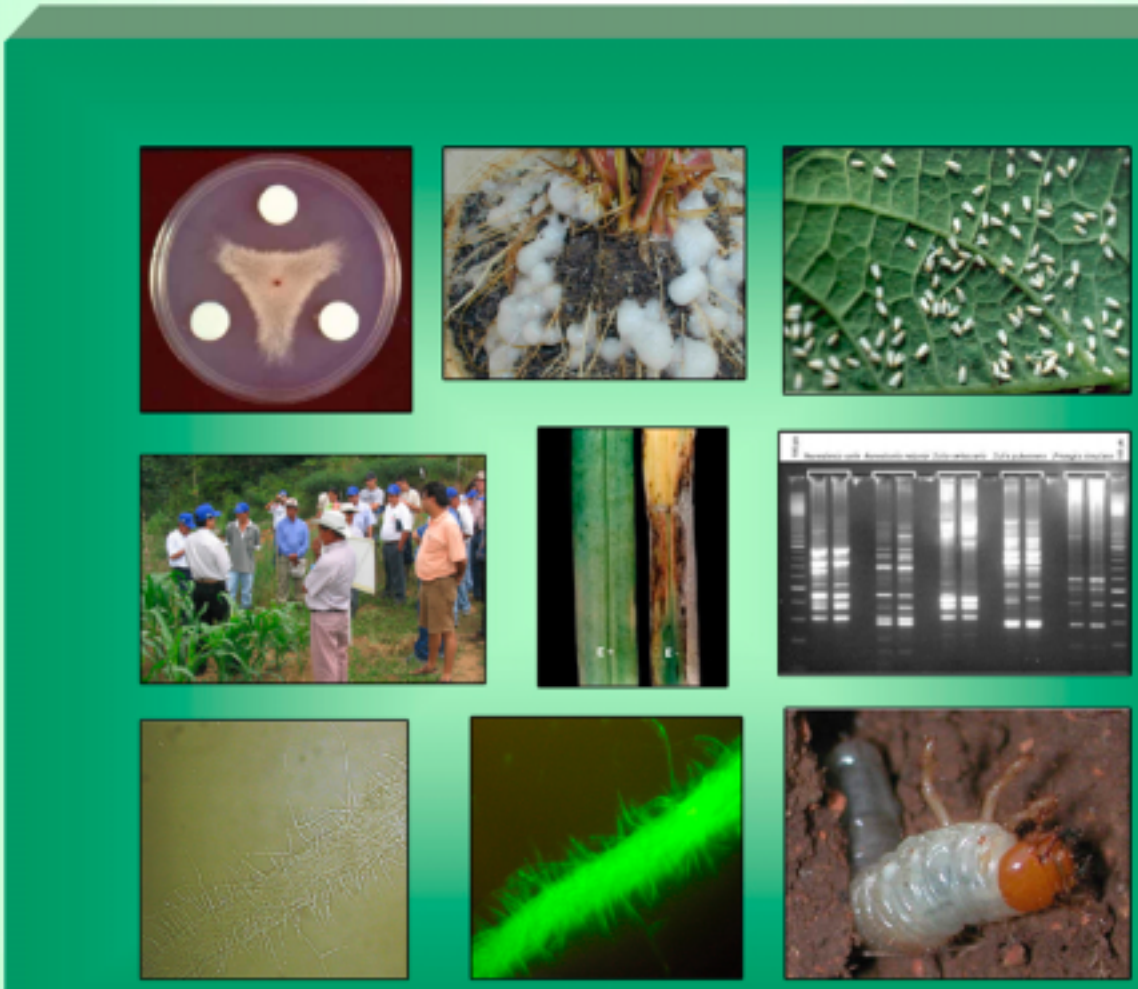
# Crop and Agroecosystem Health Management

## Project PE-I

## Annual Report 2005

CIAT
Centro Internacional de Agricultura Tropical
International Center for Tropical Agriculture



# Crop and Agroecosystem Health Management

## Project PE-1

## Annual Report 2005

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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 endophytic fungus in *Brachiaria,* 3) Molecular detection and differentiation of spittlebug species; bottom row: 1) Mycelium of the endophytic fungus *Aremonium implicatum,* 2) Mycelium of the endophytic fungus *Aremonium implicatum* expressing the green fluorescent protein gene, 3) Larvae of *Phyllophaga mentriesi*.

Crop and Agroecosystem Health Management (Project PE-1). 2005. Annual Report 2005. Centro Internacional de Agricultura Tropical, (CIAT), Cali, Colombia, 345 p.

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# Project overview: PE-1: Crop and agroecosystem health management 2005-2008

**Project Manager: Segenet Kelemu**

**Project Description:**

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

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

**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. 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) 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.

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

| Narrative Summary | Measurable Indicators | Means of Verification | Important Assumptions |
|---|---|---|---|
| ***Output 2***<br>Pest-and-disease management components and IPM strategies developed. | 2005<br>∉ Taxonomic identification entomopathogenic fungi, bacteria or nematodes; data from laboratory experiments available. Publications in journals.<br>∉ Analysis of field and greenhouse data.<br>∉ Levels of resistance confirmed in bean progenies.<br>∉ Five to ten tolerant bean varieties selected in farmers' fields and greenhouse evaluation. Experimental data available; resistant bean lines identified.<br>∉ Set of rice blast isolates with a virulence genes for corresponding resistance genes.<br>∉ Extension service providers (50), and farmers (300) trained in Bean IPDM in Uganda and Rwanda.<br>∉ A list of sources of CFSD resistance will be available. The work published in the annual report and a journal paper.<br>2006<br>∉ Agreement with commercial biopesticide industry established for product development.<br>∉ Two commercial *Brachiaria* cultivars with spittlebug resistance available to farmers.<br>∉ Levels of disease and insect resistance confirmed in bean genotypes<br>∉ 500 common bean farmers in Malawi, 1500 in Kenya and 8000 in Tanzania evaluated botanical biopesticides and other pest management options.<br>∉ Distribution of rice nurseries with 50 potential donors of blast and sheath blight resistance to Latin American countries.<br>∉ Studies on enhancement of general soil health initiated.<br>2007<br>∉ Three to four biological pesticides commercially available for farmers.<br>∉ Foliar blight resistant *Brachiaria* hybrids available. | ∉ Analysis of experiments.<br>∉ Guidelines for IPM.<br>∉ Reports on field effectiveness and probability of adoption of components.<br>∉ Field-oriented brochures.<br>∉ Farmer participatory research implemented.<br>∉ Reports available. | Funding for research and technology (IPM) practices available.<br>Stakeholders are willing to participate. |

| Narrative Summary | Measurable Indicators | Means of Verification | Important Assumptions |
|---|---|---|---|
| | ∉ Multiplication and distribution of Latin American rice cultivars with complementary blast resistance genes incorporated.<br>∉ Implementation of marker assisted selection breeding program for sheath blight resistance in rice.<br>∉ Practices to control Moko of banana validated by selected banana farmers in Colombia.<br>∉ Research partners in Kenya and Rwanda trained and collaborate in *Pythium* root rot assays on beans.<br>∉ Angular leaf spot and *Pythium* resistant bean varieties available to Bean Farmers.<br>∉ The populations for genetic studies developed and F2 population analyzed for disease susceptibility and molecular markers.<br>∉ Results of study using several CTV mild strains to determine if they provide adequate protection. | | |
| ***Output 3***<br>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<br>∉ 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.<br>2006<br>∉ Cassava, maize and onion farmers trained in management of soil-borne pests (white grubs and burrowers bugs).<br>∉ Molecular markers associated with resistance identified in rice.<br>∉ Molecular tools for detection, diagnosis and diversity studies of a number of pathogens and pests made available. | ∉ Reports on training courses.<br>∉ Concept notes and projects prepared with partners.<br>∉ IPM projects implemented | Trainees are keen to become trainers of farmer communities. |

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

| Narrative Summary | Measurable Indicators | Means of Verification | Important Assumptions |
|---|---|---|---|
| | 2007<br>≤ Combination of whitefly resistant cassava varieties and biological control agents available to farmers and farmers trained.<br>≤ Application of biopesticides and cultural practices by farmers.<br>≤ Hundred or more bean farmers and technicians trained in whitefly management.<br>≤ Combination of pest resistant bean varieties and biological control agents available to farmers and farmers trained.<br>≤ 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***<br>Global IPM networks (Integrated Whitefly Management Technology) and knowledge systems developed. | ≤ Network of researchers established.<br>≤ Preparation of Web pages and databases with relevant IPM information.<br>≤ Databases of microbial and arthropod collection established. | ≤ Electronically published Web pages and databases.<br>≤ Progress reports. | |

**MTP 2006-2008**
**Project Logframe**
**PE-1**

| | Outputs | Intended User | Outcome | Impact |
|---|---|---|---|---|
| **Output 1** | Pest and pathogen complexes described and analyzed. | NARS and university researchers, extension workers, students, CIAT scientists | Molecular and conventional tools for disease and pest diagnosis, detection and characterization developed, and applied to better understand insect pest and pathogen complexes | Improved stable crop productivity from better disease and insect pest management strategies. |
| **Output 1 Targets 2006** | ∉ Taxonomic identification of invasive pest species and white grub and burrower bug species on CIAT commodities and related agroecosystems.<br>∉ Taxonomic identification entomopathogenic fungi, bacteria or nematodes; and cassava whitefly natural enemies in key regions determined.<br>∉ *Fusarium* and *Pythium* pathogens of beans and five natural enemies of soil pests identified and characterized | NARS researchers in LAC, Asia and Africa, CIAT scientists | Microbial and insect pest characterization tools developed. | Improved disease and insect pest management strategies. |
| **Output 1 Targets 2007** | ∉ Anthracnose pathogens of beans and tropical fruits from Colombia characterized and the virulence level of *R. solani* isolates from *Brachiaria* and rice determined.<br>∉ Diagnostic tools for two citrus viruses (psorosis and citrus leprosies) and cassava frogskin disease developed and made available.<br>∉ Molecular tools for detection, diagnosis and diversity studies of a number of pathogens and pests made available. | Researchers in LAC, Asia and Africa, CIAT scientists | Adoption of disease and pest characterization tools. | More efficient and accurate tools for disease and pest diagnosis; improved understanding of disease and pest complexes |
| **Output 1 Targets 2008** | ∉ Two plant growth promoting bacteria and one biological control agent characterized. | Researchers in LAC, Asia and Africa | New options for disease and pest management and plant health enhancement; tools for disease and pest characterization. | Diversity of options for enhancing plant health. |

PE-1 Project logframe MTP 2006-2006 (cont'd)

| | Outputs | Intended User | Outcome | Impact |
|---|---|---|---|---|
| **Output 2** | Pest-and-disease management components and strategies developed. | Researchers in LAC, Asia and Africa | Disease and pest resistant lines; disease and pest management strategies | Increased crop yields and enhanced quality of products; increased and stable income. |
| **Output 2 Targets 2006** | ∉ A set of microsatellite markers associated with rice blast resistance genes identified.<br>∉ Bean, cassava, rice and tropical forage lines resistant to major diseases and pests identified.<br>∉ Biocidal proteins from tropical forages isolated and characterized.<br>∉ Cultural practices that enhance soil health and control soil pests validated by selected farmers in Colombia.<br>∉ Biopesticide for cassava whiteflies evaluated. | Researchers in LAC, Asia and Africa; CIAT scientists | Disease and insect pest resistant bean, cassava, rice and tropical forage lines. | Increased and stable yields. |
| **Output 2 Targets 2007** | ∉ Two commercial *Brachiaria* cultivars with spittlebug resistance available to farmers; Whitefly resistant cassava variety available to farmers; 50 blast and sheath blight resistant rice lines distributed to Latin American countries and marker assisted selection implemented for 3 diseases.<br>∉ Efficacy of cassava whitefly parasitoids determined. | Researchers in LAC, Asia and Africa; CIAT scientists; farmers | Disease and pest resistant genotypes made available | Enhanced and stable productivity |
| **Output 2 Targets 2008** | ∉ Three biological pesticides commercially available; an antifungal protein gene from tropical forages available and used in other crops. | Researchers in LAC, Asia and Africa; farmers | Disease /pest resistant crops made available; biopesticides made available | Enhanced and stable productivity, healthier environment. |
| | ∉ Foliar blight resistant *Brachiaria* hybrids available. | | | |
| | ∉ Multiplication and distribution of Latin American rice cultivars with complementary blast resistance genes | | | |

PE-1 Project logframe MTP 2006-2006 (cont'd)

| | Outputs | Intended User | Outcome | Impact |
|---|---|---|---|---|
| | ∉ Cultural practices to control Moko of banana validated by selected banana farmers in Colombia | | | |
| | ∉ Angular leaf spot and *Pythium* resistant bean varieties available to bean farmers. | | | |
| **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. | NARS in LAC, Asia and Africa; farmers | Improved capacity for disease and pest management strategies and knowledge on new molecular tools. | Efficient tools for disease and pest diagnosis; environmentally-friendly disease and pest management strategies. |
| **Output 3 Targets 2006** | ∉ Facilitate partners with a goal to train five hundred farmers in Malawi, 1500 in Kenya, 8000 in Tanzania and 1000 in Uganda, for evaluation of biopesticide and other pest management practices on common bean crop.<br>∉ Extension service providers (50), and farmers (300) trained in Bean integrated pest and disease management in Uganda and Rwanda.<br>∉ Research partners in Kenya and Rwanda trained and collaborate in *Pythium* root rot assays on beans.<br>∉ Whitefly IPM components validated with cassava producers. | NARS and farmers in Africa | Options for disease and pest management strategies | |
| **Output 3 Targets 2007** | ∉ Cassava, maize and onion farmers trained in management of soil-borne pests (white grubs and burrowers bugs).<br>∉ Cassava farmers trained in whitefly IPM tactics. | NARS and farmers in LAC, Africa | | |
| **Output 3 Targets 2008** | ∉ Combination of whitefly resistant cassava varieties and biological control agents available to farmers and farmers trained.<br>∉ Hundred or more bean farmers and technicians trained in whitefly management. | NARS, NGOs and farmers | Improved disease and pest management practices. | Stable and increased yield and quality. |

PE-1 Project logframe MTP 2006-2006 (cont'd)

| | Outputs | Intended User | Outcome | Impact |
|---|---|---|---|---|
| | ∉ Cassava whitefly IPM introduced to countries in LA. | | | |
| **Output 4** | Global IPM networks and knowledge systems developed. | NARS, NGOs, universities, and farmers | Improved communications and exchange of information and materials | Improved access to information; sharing of natural resources such as beneficial organisms |
| **Output 4 Targets 2006** | ∉ Network of researchers established.<br>∉ Databases of microbial and arthropod collection established. | | | |
| **Output 4 Targets 2007** | ∉ Preparation of Web pages and databases with relevant IPM information. | | | |
| **Output 4 Targets 2008** | ∉ Preparation of laboratory manuals | | | |