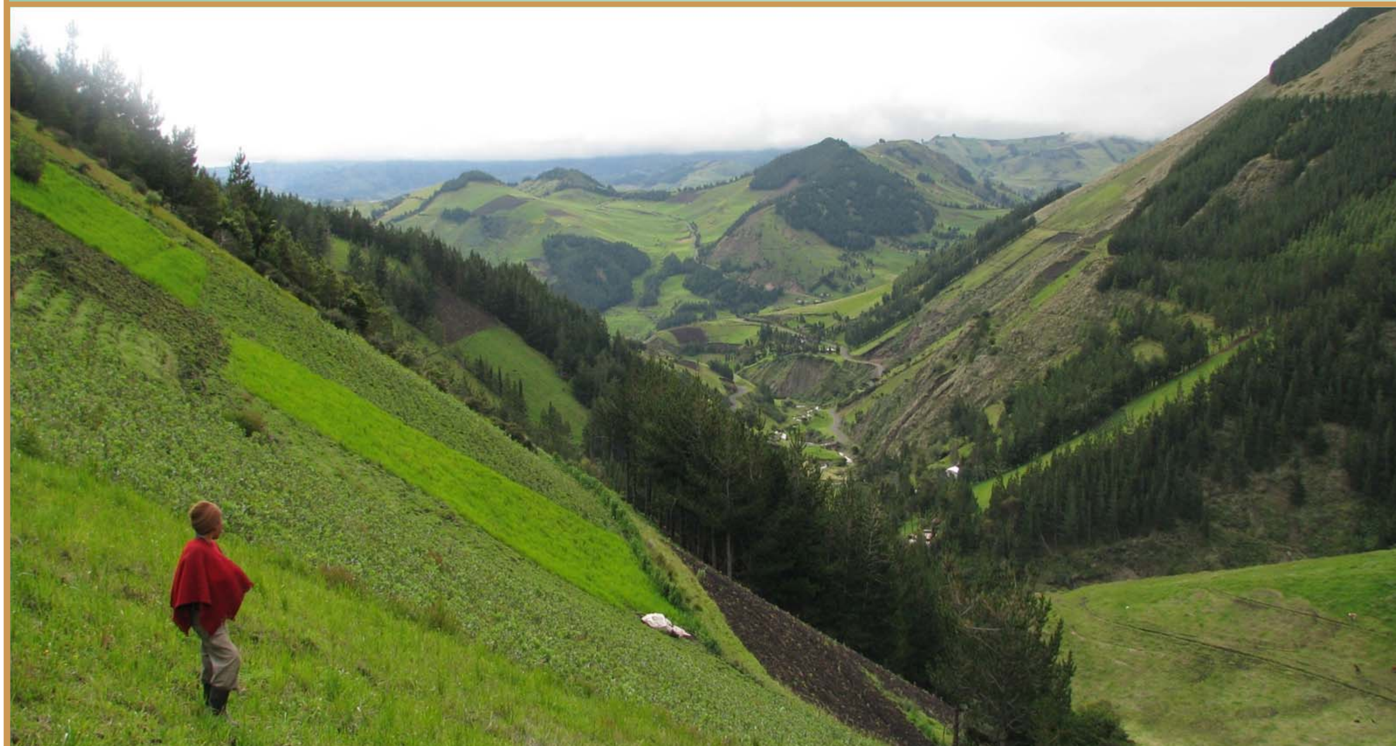
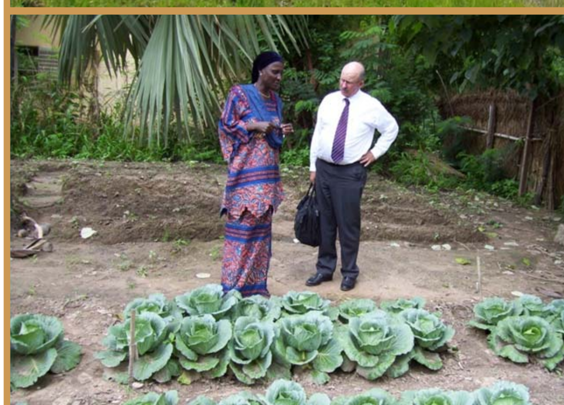
Integrated Pest Management Collaborative Research Support Program

Annual Report

Phase IV – Year One: 2009-2010





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Integrated Pest Management
Collaborative Research Support Program

FY 2010 Annual Report
October 1, 2009 – September 30, 2010

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Introduction and Program Review

This annual report presents the progress and achievements made during the period from October 1, 2009 to September 30, 2010, the first year of the fourth phase of the Integrated Pest Management Collaborative Research Support Program (IPM CRSP). Upon receiving communication from USAID for the renewal of the IPM CRSP, Virginia Tech released an RFA on July 6, 2009. It requested the submission of proposals from U.S. universities for six regional and five global theme projects. An external evaluation panel consisting of a plant pathologist, an entomologist, a weed scientist and a gender specialist was set up to evaluate the proposals. The following proposals were selected:

1. Development and Delivery of Ecologically-based IPM Packages for Field and Vegetable Cropping Systems in Central Asia. Principal Investigator - Karim Maredia, Michigan State University.
2. Integrated Pest Management: Science for Agricultural Growth in Latin America and the Caribbean. Principal Investigator – Jeffrey Alwang, Virginia Tech.
3. Regional IPM Programs in East Africa: Kenya, Tanzania and Uganda. Principal Investigator – Mark Erbaugh, Ohio State University.
4. West African Regional Consortium for IPM Excellence. Principal Investigator – Donald Mullins, Virginia Tech.
5. IPM CRSP South Asia Regional Program. Principal Investigator – Edwin Rajotte, Penn State University and George Norton, Virginia Tech.
6. Ecologically-Based Participatory IPM for Southeast Asia. Principal Investigator – Michael Hammig, Clemson University.
7. Abating the Weed Parthenium (*Parthenium hysterophorus* L.) Damage in Eastern Africa Using Integrated Cultural and Biological Control Measures. Principal Investigator – Wondi Mersie, Virginia State University.
8. The International Plant Diagnostic Network: Gateway to IPM Implementation and Enhanced Trade. Principal Investigator – Sally Miller, Ohio State University.
9. Toward the Effective Integrated Pest Management of Plant Disease Caused by Viruses in Developing Countries: Detection and Diagnosis, Capacity Building and Training, and Formulation of IPM Packages. Principal Investigator – Sue Tolin, Virginia Tech.
10. IPM Impact Assessment for the IPM CRSP. Principal Investigator – George Norton, Virginia Tech.
11. Gender Equity, Knowledge, and Capacity Building. Principal Investigator – Maria Elisa Christie, Virginia Tech.

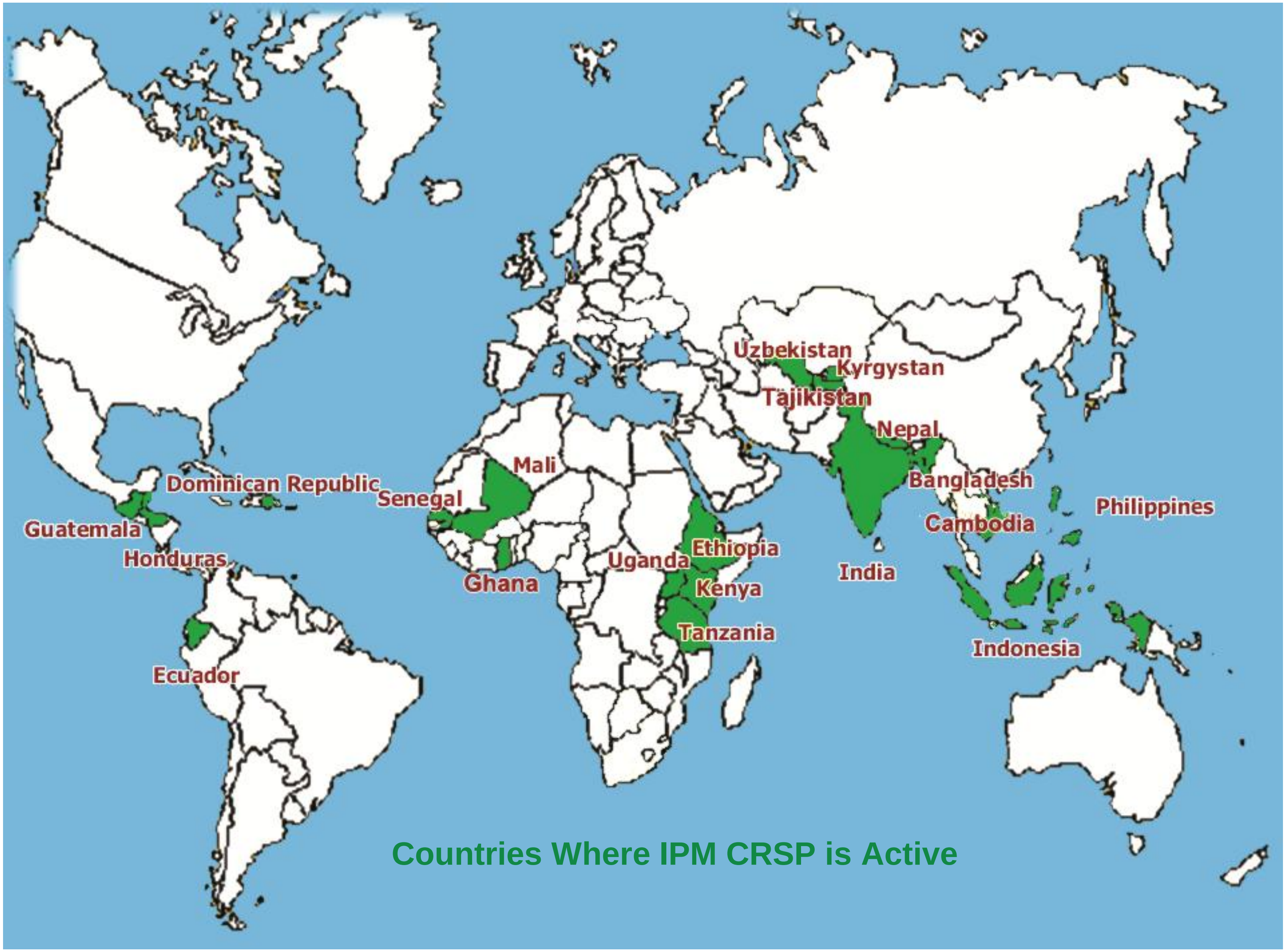
Losses due to pests, concerns about environmental and health risks associated with pesticides, and problems with pest resistance to pesticides have stimulated the search for alternative pest management strategies. Horticultural crops in particular rely heavily on pesticides, but concerns for human health and the environment, and the need to comply with export market regulations for pesticide use for some crops continue to constrain production of these crops. Worldwide interest in IPM continues to grow as programs such as the IPM CRSP demonstrate that IPM can reduce losses due to pests, minimize reliance on chemical pest control, and, therefore foster food security and long-term sustainability of agricultural systems. IPM is a management philosophy and decision support system that emphasizes increased information to make pest control decisions. Those decisions are then integrated into sustainable, ecologically-based farming systems. Components of IPM systems include biological, environmental, and economic monitoring; biological control; host plant resistance; grafting; and habitat management through crop rotations, intercropping, antagonistic plants or other organisms, trap crops, refugia, cover crops, and sanitation, among other practices. Ecologically-based IPM involves various combinations of these management tools, with chemical inputs applied only when absolutely needed to restrict pests from reaching economically damaging densities.

IPM is needed throughout the developing world. Insects, diseases, weeds, and other pests respect no borders and spread through plant and animal products. Concerns over biosecurity, invasive species, and food security are global issues that require IPM attention in developed and developing countries.

The mission of the IPM CRSP is to implement participatory, farmer-focused, innovative, interdisciplinary research, training, and information exchange programs in IPM that will be adopted in horticultural and other food production systems. The IPM CRSP has been developing a large set of IPM practices for vegetable and other crops in developing countries. While each country has its own specific mix of pests and agro-climatic conditions, many pest problems are similar around the world. Several techniques developed in one country have been transferred to other countries with efforts to adapt to the local conditions. In some cases, they have been applied singly or in partial packages.

The new phase of the IPM CRSP is implementing an ecologically-based, participatory Integrated Pest Management (EP-IPM) program designed around regional IPM Centers of Excellence (regional programs) and critical cross-cutting global IPM themes. The focus is on maximizing the impact of IPM packages as well as scaling up local successes to national, regional (Africa, Asia, and Latin America/Caribbean) and global stakeholders.

Crops selected for development of IPM packages are tomato, wheat and potato in Central Asia; tomato, okra, onions, crucifers and cucurbits in South Asia; tomato, onion and crucifers in Southeast Asia; tomato, sweet potato, peppers, naranjilla and tree tomato in Latin America and the Caribbean; tomato, pepper, onion, passion fruit and coffee in East Africa; and tomato, cabbage and potato in West Africa. Some of the basic components of the IPM packages addressed are: soil preparation, seed selection, seed treatment, screening of seedlings, seedling selection, physical/mechanical tactics, grafting, trapping, and use of biopesticides and natural enemies. Emphasis has been placed on gender equity, capacity building and technology transfer.



Countries Where IPM CRSP is Active

Integrated Pest Management: Science for Agricultural Growth in Latin America and the Caribbean

Principal Investigator

Jeffrey Alwang, Professor, Department of Agricultural and Applied Economics, Virginia Tech (alwangj@vt.edu)

Co-Principal Investigators

George W. Norton; Department of Agricultural and Applied Economics, Virginia Tech

Stephen Weller; Department of Horticulture and Landscape Architecture, Purdue University

Sue Tolin; Department of Plant Pathology, Physiology, and Weed Science, Virginia Tech

Paul Backman; Department of Plant Pathology, Penn State University

Beth Gugino, Department of Plant Pathology, Penn State University

Sarah Hamilton, Associate Professor and Director, M.A. Program in International Development, University of Denver

Ricky E. Foster, Department of Entomology, Purdue University

Judith K. Brown, Department of Plant Sciences, The University of Arizona

Host Country Collaborators:

Ecuador

Instituto Nacional Autónomo de Investigaciones Agropecuarias (INIAP). Victor Barrera, Jose Ochoa, Patricio Gallegos, and Elena Cruz.

Honduras

Fundación Hondureña de Investigación Agropecuaria (FHIA). Jose C. Melgar, Hernan Espinoza, J. Mauricio Rivera C. and F. Javier Diaz.

Escuela Panamericana de Agricultura (Zamorano). Alfredo Rueda.

Dominican Republic

Instituto Dominicana de Investigacion Agropecuara y Forestria (IDIAF). Reina Teresa Martinez.

Guatemala

Universidad del Valle de Guatemala. Margarita Palmieri

AGROEXPERTOS. Marco Arévalo

Summary

The LAC IPM CRSP research is being conducted in laboratories, on station, and in farmer fields in several sites in Dominican Republic, Ecuador, Guatemala and Honduras. The focus is on solanaceous crops in the Central American and Caribbean region and in several important Andean fruits in Ecuador. The current research is exploiting a long track record of research accomplishments by the IPM CRSP and combining successful practices into IPM packages for key crops. Currently, some of these packages in Ecuador and Honduras are being validated. In Dominican Republic and Guatemala, the research is beginning to produce results and we are exploring means of transferring technologies from our more mature country sites to these. This project is notable in its high degree of integration with the global themes. As viruses are an overwhelmingly important pest constraint in the region, we are closely coordinating our activities with the virus global themes, and several of our researchers also have direct involvement in that project.

Honduras

Solanaceous crops

Management of the complex Zebra chip disease-psyllid of potatoes

The potato psyllid *Bactericera* (*Paratrioza*) *cockerelli* (Šulc) (Hemiptera: Triozidae), is the vector of *Candidatus liberibacter solanacearum,* the causal agent of the Zebra chip disease. Starting in March 2010 observations have been completed on seven plots, and there are currently ongoing observations on two additional plots, all of them established in growers' fields located in the two main potato growing regions of Honduras, La Esperanza (Intibuca) and San Marcos de Ocotepeque (Ocotepeque). In each plot, adult psyllids were collected weekly using cylindrical sticky card-board yellow traps for examination in the laboratory. Field observations were made for the presence and number of eggs and nymphs in the leaves, and of the incidence of the Zebra chip disease.

Results of laboratory PCR tests revealed that most of the potato samples were negative for *Liberibacter* (16sRNA gene) despite foliar symptoms reminiscent of the zebra chip disease. One potato sample (10.18.10) and a symptomatic *Datura* sp. (MAL-F01) near that same field were found positive in this assay, confirming the presence of the bacterium in symptomatic potato and also that wild *Datura* is a host of *Liberibacter* in Honduras. Additional testing is being carried out to improve the sensitivity of the test for potato samples, which vary greatly in concentration of the bacterium depending on time of year, in relation to age of infection and plant part collected when sampling.

In 2009-2010, *Bactericera* numbers increased in potato crops and caused the same level of damage as does zebra chip disease in tuber production. An extension brochure was prepared with 27 IPM alternatives to illustrate management of this new pest. A national committee was formed to work on the *Bactericera* problem in potatoes, peppers and tomatoes.

Management of whitefly-transmitted begomoviruses

Results of laboratory tests for begomovirus detection using the core Cp PCR primers for symptomatic tomato and pepper plants collected in Honduras revealed that most pepper and tomato plants (Comayagua and eastern Honduras) were positive for whitefly-transmitted geminiviruses. Samples have been prepared for DNA sequencing to determine the specific virus identification (four tomato, two bell pepper, and two potato samples were sent for DNA sequencing). Some of the same tomato samples (1-4) sequenced at a commercial testing lab (AGDIA) using PCR primers (different primers) that amplify a non-coding with coding region fragment of begomoviruses matched most closely to *Tomato severe leaf curl virus* (~93%) and *Tomato mosaic Havana virus* (~91%).

Golden nematode species detection using PCR

108 samples suspected of being afflicted by gold nematodes were received from different parts of the country. DNA from the cysts was extracted using the CTAB and Proteinase K method. The Proteinase K method works better for DNA extractions. Samples were tested using PCR for the identification of *Globodera*. So far we have not been able to obtain the desired product amplification.

White grub control by *Heterorhabditis bacteriofora* in tomato.

During July and August 2010, a trial to evaluate white grubs control by *Heterorhabditis bacteriofora* in tomato was conducted in a farmer field in Tatumbla. Nematodes were applied by the drip irrigation system during 5 weeks using a total 1.25 dosages / ha (250 million nematodes). The farmer applied Carbofuran to the soil by a single furrow application. The chemical control reduced 49% and the nematodes 78% of the white grub population. The number of white grubs/per soil sample /day in the nematode treatment was 0.5 compared to 1.5 grubs in the chemical control.

Tetranychus spp. control by the predatory mite *Neoseiulus longisnosus* in eggplant

In February 2010, a trial was conducted in a farmer field in Cantarranas, to control *Tetranychus* spp. by the predatory mite *Neoseiulus longisnosus* in eggplant. The predatory mite was used at doses of 4, 5 and 6 predators / m^2 and compared to a farmer control with Abamectina. Before the trial, two applications of chemicals were made to the whole crop to reduce the large incidence of spider mites. The predatory mite and the chemical control were applied weekly for four weeks. The initial infestation of spider mites was 0.2 mites/ leaf. At the end of the trial spider mite population in the chemical control was 8.4/leaf as compared to the 0.3, 1.5 and 2.8 / leaf using 6, 5 and 4 predatory mites/ m^2.

Management of thrips and mites in horticultural crops

In Honduras, several types of eggplants are grown for export to ethnic markets in the U.S. In these crops, fruit culling due to cosmetic imperfections, caused mainly by thrips and mites, is a major aspect of crop losses. An experiment was conducted to determine the efficacy of low-density inter-planting of sunflower (*Helianthus annuus*) and long bean (*Vigna unguiculata*) that promote the development of populations of the predatory pirate bug *Orius insidiosus* and other predators for management of the pests *Thrips palmi* and *Polyphagotarsonemus latus*. These treatments were compared against the standard grower practice of applying insecticides. In the diversified plot the average number of *Orius* per leaf 0.31, was significantly higher than the 0.15 recorded in the conventional plot. Conversely, the number of *T. palmi* per leaf of 0.7 and 1.5 individuals in the diversified plot was significantly lower than in the conventional plot, respectively. By means of regression analyses of current mite counts over fruits harvested after two weeks, it has been calculated that a count of one mite per leaf is equivalent to 1.09% of damaged fruit. If these figures prove to be consistent through time, they could be the basis for the development of threshold levels of economic damage.

Onions

Thrips tabaci control by the pirate bug (*Orius insidiosus*) and *Beauveria bassiana* in onions

During July and August 2010, a trial to control *Thrips tabaci* in onions with the pirate bug (*Orius insidiosus*) and *Bauveria bassiana* was conducted in a commercial farmer field in Guinope. Weekly alternate applications of *Orius insidiosus* and *Beauveria bassiana* were compared to a farmer weekly application of chemical control (Sun fire). The incidence of thrips in both treatments was below economic threshold of 1 thrips/ leaf given that the trial was conducted during the rainy season. The number of thrips/plant/day during the trial was 1.3 in the biological control plots compared to 2.1 in the chemical control.

Sweet potatoes

Investigation on damage to sweet potato tubers

In Honduras, blemishes in the skin of tubers are responsible for culling of significant amounts of sweet potato produced. Research initiated in the previous phase of the project demonstrated that the damage to the skin caused by the root-knot nematode (*Meloidogyne* spp.) significantly reduced productivity. However, growers claimed that larvae of insects were also causing similar damage. UV light traps were set up in a grower's field for night capture of adults of the suspected insects, namely wire worms (Elateridae) and white grubs (Scarabaeidae). In seven months of trapping, no adults of the Elateridae have been caught and only in a few occasions individuals of the Scarabaeidae were captured. The number of scarabdeid adults captured was so small, that they could hardly be responsible for damage. It is apparent that, in this location, nematode and no insects are the main cause of injury to the sweet potato roots.

Management of plant virus diseases

Preliminary results of commercial lab PCR-testing (AGDIA) of sweet potato samples showing virus-like symptoms indicated the presence of a closterovirus giving a weak positive response using the 'group test'. One of those two plants (1) also was weakly positive for potyvirus using the 'potyvirus group test'. No significant shared identity was found for the PCR product amplified from sample 4 suggesting that the amplicon was possibly not viral in origin. Sample 1 shared 73% identity with *Sweet potato chlorotic stunt virus*, while sample 2 shared 92% identity with *Sweet potato chlorotic stunt virus*. 'Beauregard' (orange) variety contained both viruses and 'Bushbock' (red) variety was infected with SCStV only (2 samples each were tested). We looked into the Sanitary Certificates that accompany sweet potato germplasm purchased as seed potatoes for planting in Honduras and found that the certificate did not indicate which if any plant viruses were tested for.

Production of virus-free sweet potato propagative material through the use of tissue culture techniques

Mother plants were established from material donated by a grower. Preliminary trials to culture sweet potato meristems in tissue culture were successful. In July 2010, samples from mother plants and lab microplants were sent to the US for virus diagnostics. One mother plant resulted positive to Closterovirus. At this time, we have under culture 194 plants from the negative virus diagnostic plants. In about six months, plants will be given to the growers after the acclimation process. The growers will use them to reproduce virus free vegetative material.

White grub control by *Heterorhabditis bacteriophora* in sweet potatoes

A trial in farmer field was conducted in la Venta. Six applications of 200 million nematodes are compared with Fipromil and Bifentrina applications used by the grower for control. The chemical treatment had 0.5 white grubs per sample and 0.3 wire worms per sample, while the biological treatment had no pests. The estimated commercial production was 52,571 pounds per hectare in the chemical treatment and 69,285 pounds per hectare in the biological treatment.

Technology Transfer

The dissemination of information on integrated management of pests of crops in general, and of vegetable crops in particular, has been promoted via different means, including publications, workshops, technology transfer events, seminars, etc. Members of FHIA's staff participated locally as instructors/lecturers in 37 group events of different nature addressed to a total of 1,205 persons (122 female and 1083 male), including growers (845 persons) and also extension agents, technicians of agrichemical firms, students, and others (360 persons). More than 90% of the events were focused on plant pathological problems; insect and nematode problems were the main or concurrent focus in the rest of the events.

Ecuador

Naranjilla

Commercial cultivation of naranjilla in Ecuador is mostly found in the Pastaza valley and in Yunguilla. Cultivation of this crop faces a number of challenges, and the IPM CRSP has identified a number of feasible technologies for naranjilla pest and disease management.

Bacterial canker: The most severe incidence is found in highly humid areas. Plants with symptoms in Saloya and Tandapi (Pichincha) and Baeza (Napo) were cataloged. Infected plants start with necrosis and thinning of leaves, followed by cracks in the stems. For culturing this bacterium, small pieces of infected plant material were wetted in a sodium hyper chloride solution (1%) for 3 minutes and then rinsed 3 times with sterile water. Culture was started on Agar Nutritive and after 4 days of incubation verified colonization. The diameters of the bacterial colonies were between 3 and 5 mm and they yellow colored. Thirty five colonies from the center of the culture were used for ELISA testing for *Clavibacter michiganensis* subsp. *michiganensis*. The ELISA test results were positive.

Bacterial canker management in naranjilla: In the village of Nuevo Machachi, canton Mejía (Pichincha), at an elevation of 1400 masl, bacterial canker management practices were validated. The trial consisted of 130 common naranjilla plants grafted onto *Solanum hirtum*. Alternate applications of antibiotics Kasugamicina and Oxitetraciclina have given encouraging results.

In naranjilla, bacterial canker is seed transmitted. To start with, the seeds were disinfected with one of the following chemicals: Sodium hypochlorite, Kasugamicina and Oxitetraciclina. During the development of the plant in the seedbed (for the first 45 days), Oxitetracliclina was applied every 15 days. After 45 days, the plants were transplanted in individual containers where they remained for an additional 60 days. During this period, foliar application of Kasugamicina and Oxitetraciclina in rotation was carried out every 21 days. The plants were then grafted onto *Fusarium* resistant rootstock *Solanum hirtum* and were transplanted the fields. This treatment has produced bacterial canker free plants.

Inter-specific crosses of *Solanum* spp. for *Fusarium* and *Phytophthora* resistance

The practice of grafting common naranjilla onto *Fusarium* resistant rootstock is an important innovation resulting from IPM CRSP research. Common naranjilla is the highest yield variety and its fruit receives a price premium of approximately 50% in most Ecuadorean markets. It is also highly susceptible to losses from *Fusarium*. The challenge with the grafting technology is economics: a grafted plant costs $.60- $.70 compared to $.20-$.30 for non-grafted varieties. Few people have been trained in grafting, and the prospects for wider training are also constrained by lack of resources. As a result, grafted plants are not widely available, and poor producers are constrained from adopting them. In addition, late blight (*Phytophthora infestans*), which is increasingly affecting naranjilla production, can be controlled with fungicides, but this control is environmentally damaging and inputs are scarce and prohibitively expensive for remote and poor producers. As a result, development of resistant varieties is a high priority during this phase of the CRSP. In prior studies, resistance to *Fusarium oxysporum* f. sp. *quitoense* has been identified in all members of the *Lasicarpa* section.

We need to understand the different types of resistance and their patterns of heredity. For this reason, we are examining resistance to *F. oxysporum* f. sp. *quitoense* and *Phytophthora infestans* in F4 crosses between *Solanum quitoense* with *Solanum hyporhodium, Solanum vestissimun* and *Solanum felinum*. The objectives are: 1) study the expression of resistance in the greenhouse to *F. oxysporum* and *P. infestans* present in *S. hyporodium, S. vestissimun* and *S. felinum,* and 2) select genotypes with resistance to *F.oxysporum* f. sp. *quitoense* and *P. infestans*.

Table1. Resistance and susceptibility to the isolate INIAP-SC-Fo 008 of *F. oxysporum f. sp. quitoense* of seven population of two crosses with *Lasiocarpa*

	RC(3)3[1]	C2(5)67[2]	RC3(3)29[1]	C4(5)12[2]	C4(5)13[2]	C5(1)16[2]	C5(4)69[2]
Resistant	77	74	82	70	84	89	69
Susceptible	23	10	18	30	16	11	31

[1] *S. felinum* x *S. quitoense* var. Dulce x *S. quitoense* var Dulce
[2] *S. quitoense* var. Dulce x *S. vestissimun*.

We have evaluated seven segregates for the two diseases. All populations exhibited a high proportion of resistance (Table 1).

Resistance to *P. infestans* is expressed quantitatively, with high proportions of resistant plants with crosses of *S. quitoense* with *S. felinum* compared to low proportions of resistant plants in crosses of S. *quitoense* with *S. vestissimun*. Nevertheless, there is marked variation in the proportions of plants with different types of reaction.

To manage bacterial canker, good seed selection and subsequent disinfection with Kasugamicina, 1% sodium hypochlorite is the best means of prevention. Application of Oxitetraciclina and Kasugamicina in the seed bed can complement these preventative measures, especially since the disease can be leaf-transmitted. These procedures are both effective and economical and help to avoid more expensive control methods. Close monitoring of disease progress in the field is also important. We recommend quick removal of infected stems and plants; a copper hydroxide paste can repair any remaining injuries. Application of Oxitetraciclina and Kasugamicina helps reduce the severity of the disease in the field if it is not very well advanced. We recommend disinfecting tools with Oxitetraciclina and copper prior to their use in fields. Use of crop rotations is also recommended.

With the information on genetic resistance to *F. oxysporum* f. sp. *quitoense* and *P. infestans* a method for more sustainable production of common naranjilla is being explored.

Validation of technology package for naranjilla

INIAP and the IPM CRSP have developed several technologies for controlling naranjilla vascular wilt (*Fusarium oxysporum*), anthracnose (*Colletotricum gloesporoides*), late blight (*Phythopthora infestans*) and fruit borer (*Neoleucinodes elegantalis*). Following several years of research it was necessary to integrate the most successful technologies into an IPM package to be recommended to farmers. The general objective of this research is to validate components in farmer fields in Río Negro, and Tandapi.

An experimental area, with 200 common naranjillas grafted onto resistant rootstock (*S. hirtum),* has been planted. Grafting is known to control *Fusarium* and root knot nematode. Control of late blight requires judicious use of tested low-toxicity fungicides. Observations include agronomic information on plant growth and yield, phytosanitary conditions such as incidence of *Fusarium*, latency period for *Fusarium*, incidence of anthracnose, percent of undamaged fruits, fruit lesions and number of fruits affected by the borer. We are also evaluating control costs.

Validation of low-toxicity products for naranjilla fruit borer

This study of chemical alternatives was conducted with common naranjilla (INIAP-

Quitoense). We tested the effectiveness of three insecticides Spinosad 3cc/l; Bulldock 1.5cc/l and Alsystin 1.5cc/l, applied in over 10 opportunities every 15 days. In addition, we applied cultivation and sanitation practices consistent with good farming. Results indicate that Spinosad application yielded 90% healthy fruits, followed by Bulldock (80%), and Alsystin (70%), while the control had only 30%. In another study, the rotation of Bulldock with Alsystin produced 98 fruits per plant compared to individual Bulldock (56 fruits) and Alsystin (48fruits).

Tree tomato

The important pests and diseases affecting tree tomato are anthracnose (*Colletotrichum* sp), late blight (*Phytophthora infestans*) and leaf insects. Of these, anthracnose is by far the most serious disease. Late blight is also wide spread, and is serious in humid climates and during periods of high rainfall.

Blackberry

The most important pests and diseases in blackberry production are botrytis (*Botrytis cinérea*), mildew (*Peronospora* sp) and the scarabeid larvae. Widespread application of fungicides is the primary farmer control measure; however, it is generally not effective and leads to potential environmental problems. INIAP has identified and tested a number of alternative control measures such as controlled thinning, removal of plant waste, and better fertilization to improve plant health and reduce diseases.

The IPM CRSP with Fontagro is generating additional technologies such as use of chemical control in rotation, improved cultural practices, and the use of entomopathogenic nematodes of the genera *Steinernema* sp. and *Heterorhabditis* sp. for control of scarabaeid larvae.

Artisanal multiplication of entomopathogenic nematodes for the control of *scarabaeid* grubs in blackberry

From prior IPM CRSP studies, we have at our disposal a broad collection of entomopathogenic nematodes that can potentially be used to control larvae of insects. A stock of the nematode, E.C.Cu Het 01 (H*eterorhabditis*) is multiplied at EESC-INIAP, in larvae of *Galleria mellonella* under controlled conditions. For artisanal multiplication, a composter of 2.5 x 1.25 x 0.20 m dimension was built and loaded it with 3:1 mixture of organic matter and soil. In this mix, 80 grubs of scarabaeid and 20 larvae of *Galleria mellonella* infested with the nematode were inoculated. The compost was mixed every 15 days. In the four experimental composters, mortality of scarabaeid grubs was 78.3%, and the population per infested grub was 21,000 juvenile nematodes.

Gender network

Conducted a gender training workshop (April 7-10) in Guaranda. Participants from other LAC sites also attended this workshop. In addition, 25 local stakeholders (13 men, 12 women) participated in it. A notable finding was that in the upper part of Bolivar, it is important to have bilingual technicians, as many of the women in this area do not speak Spanish.

Impact assessment

A LAC-wide protocol for measuring impacts was established during the LAC meeting held in Honduras during May 2010. In Ecuador, a baseline survey was undertaken in the Chimbo, Bolivar area. We field-tested the proposed instrument and then interviewed 418 people in various parts of the watershed. This information has been entered into a database.

Data was also collected for an assessment of the naranjilla technologies. Andrew Sowell conducted interviews with more than 60 naranjilla producers and collected cost information from experimental trials and other sources. This analysis will be completed in the coming year.

Guatemala

Potato

The most important diseases in potato in Guatemala are: *Ralstonia solanacearum* (bacterial wilt), zebra chip *(Paratrioza)*, *Phytophthora infestans* (late blight), *Rhizoctonia* (basal rot) and *Fusarium* spp.

Tomato

Bacterial canker is caused by *Clavibacter michiganensis michiganensis*. This disease has caused severe losses among tomato growers and has become a major threat for tomato and pepper production in Guatemala.

Dominican Republic

Pests and natural enemies of tomato and pepper

The major pests of tomato are whitefly, leaf miners, and thrips. Major pests of peppers were pepper weevil, mites, whitefly and thrips. Parasitoid population was low in areas where insecticide usage was heavy.

Traps for monitoring pests in the field

This experiment was conducted at the IDIAF Agricultural Experimental Station in Sabana Larga, in San Jose de Ocoa Province. A completely randomized block design with four treatments and three replications was laid out. The treatments were setting up yellow, blue and white chromatic traps and hand picking. Yellow traps collected more whiteflies and aphids, and the blue traps collected thrips and leafminers. The white traps collected very few insects.

Diseases of tomato and pepper

Fusarium is serious disease of these crops in Dominican Republic. The incidence of necrotic symptoms and wilting of tomato and pepper plants caused by *Fusarium* represented 90%. *Sclerotium* and *Rhizoctonia* pathogens were also found less frequently.

Distribution of *Ralstonia solanacearum* on pepper and tomato

Bacterial wilt in Dominican Republic is caused by *Ralstonia solanacearum* race 3 biovar II.

Surveys were conducted to determine the distribution and incidence of *R. solanacearum* and other bacteria of importance in the main producing zones of San José de Ocoa. Samples of symptomatic and asymptomatic plants were taken to the Laboratory of Bacteriology of the Center for Agricultural Technologies and processed. Isolation was done in Nutrient Agar. Samples were disinfected with alcohol flamed 70% and, small cut pieces of stems were macerated within plastic bags with 5 ml of distilled sterile water. Plates were incubated by 72 h to 30°C. Colonies were transferred three times for purification.

About 70% of the plantations of tomato and peppers in Sabana Larga, Nizao, Rancho Arriba, San Jose de Ocoa were sampled. Affected plants were observed both in greenhouses and open fields. The incidence of diseases in pepper was less than in tomato.

Distribution of Tomato Spotted Wilt Virus (TSWV)

Tomato Spotted Wilt Virus was reported only under protected crop cultivation of tomato and pepper, in Jarabacoa and Constanza. In 2010, a survey was conducted for TSWV in Ocoa Valley in Nizao, Las Auyamas, Sabana Larga, Rancho Arriba, Las Caobas, Carretera Ocoa-Azua, and Carretera Palenque San Cristobal. TSWV was only found in Sabana Larga with an incidence of about 10%.

Regional IPM Programs in East Africa: Kenya, Tanzania and Uganda

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Summary

The East Africa project is conducting research on development of IPM packages for tomato, pepper, passion fruit and coffee in Uganda; tomato, passion fruit and onion in Kenya; and tomato, coffee and onion in Tanzania. Several components of the IPM packages developed were transferred to farmers by organizing farmers' field days, workshops and meetings. Some of the notable achievements are identification of bacterial wilt tolerant varieties, introduction of grafting and high tunnel cultivation, and screen house production of seedlings to reduce virus disease incidence in tomatoes, screening for virus disease resistance in passion fruit, and use of arbuscular mycorrhiza fungus, *Trichoderma* sp. and *Bacillus* sp. for control fungal and bacterial diseases fruit and vegetable crops. East Africa project has been closely working the global theme projects on Gender, Impact Assessment and International Plant Diagnostic Network.

Uganda

Tomato

Evaluation of Improved Tomato Germplasm for the Management of Pests of Tomato

Jeninah Karungi, Joe Kovach, Sally Miller, Kyamanywa, Tusiime

In collaboration with AVRDC improved tomato germplasm was acquired and selected the following for screening against key pests and diseases of tomato in Uganda:

- CLN3022C (resistant to viruses)
- CLN3008A (resistant to bacterial wilt, Ty1 and Ty2)
- CLN3022H (resistant to bacterial wilt, Ty1 and Ty3, TMV, fusarium wilt)
- LBR16 (resistant to blight, fusarium wilt, gray leaf spot)
- LBR17 (resistant to blight, fusarium wilt, gray leaf spot (GLS))
- CLN1466EA (resistant to bacterial wilt, TMV, fusarium wilt, GLS)
- CLN2413L (resistant to bacterial wilt, TMV, fusarium wilt)
- MT56 (local, resistant to bacterial wilt)

The germplasm was screened in pot and field trials. Pot trial results indicated that all the lines have succumbed to viral infection with 3008A and LBR 17 being the most severely affected and MT56 the least affected. Line

3008A still had the highest fungal infection while lines 2413L and MT56 were least affected. Scores of bacterial wilt severity indicated that line 1466E was most affected, followed by LBR 16 and 3008A. The remaining lines did not show symptoms. With regards to insect pest infestation, MT56 sustained the highest aphid counts whereas 3008A had the least. Thrips were highest on LBR 16 whereas 1466EA did not have any thrips. 3008A and 3022C had the highest counts of white flies whereas 3022H had the least. Analysis of field trial data is on-going.

Variety MT56 for Management of Bacterial Wilt in Uganda

Didas Asiimwe, Sally Miller, P.R. Rubaihayo, Tusiime, Steven Guwa, Francis Okello

Studies were carried out to determine the mode of inheritance of bacterial wilt resistance in MT56, interaction of its resistance genes with characterized *Ralstonia solanacearum* biotype(s), and evaluation of its performance in six different agro-ecological zones. BW tolerant varieties, MT56 and Tengeru 97; and susceptible varieties, Moneymaker, Marglobe and Roma were planted and the scoring for disease load is on-going. To identify *R. solanacearum* biovars currently existing in major tomato growing areas of Uganda, bacterial suspensions were collected from infested tomato plants from hotspots for BW disease in the country (central: Wakiso, Masaka, & Mukono; Eastern: Jinja; Western: Mbarara & Kasese; Northern: Lira). Bacterial isolation and biochemical identification of biovars of R. *solanacearum* were done using specific carbohydrates. Results indicated that all the isolates (except one of the three from Jinja and one of the three from Mbarara) were characterized as biovar 3. This study showed that there is little variation in the *R. solanacearum* affecting tomato in Uganda.

Development of Techniques for Management of Arthropod Pests of Tomato

Michael Otim, S. Kyamanywa, Matt Kleinhenz, J. Kovach, Z. Muwanga

Two experiments, one on-station and one on-farm (Wakiso district), were conducted to evaluate the effect of reduced pesticide application on the incidence of bollworm, spider mites, aphids, thrips, whiteflies, and natural enemies. The treatments included: i) spraying once a week [a tank mix of dimethoate (insecticide) and agrolaxyl (fungicide)]; ii) spraying once in vegetative growth and once during flowering; iii) spraying twice during flowering and twice during fruiting; iv) weekly sprays with agrolaxyl (fungicide); and v) an untreated control. Results indicated that pesticide application reduced bollworm infestation levels as well as the number of natural enemies (spiders). The results showed no differences in bollworm infestation in plots that were sprayed weekly and those that were sprayed once at the vegetative stage and once at flowering, and those sprayed twice at flowering and twice at fruiting. Analysis of the data for other parameters is still on-going.

Seed/Soil Treatments with Biological Preparations in the Management of Fungal, Bacterial and Nematode Problems of Tomato

Mary Silver Rwakikara, Samuel Muwanga, Peter Senyonga

Arbuscular mycorrhiza fungi (AMF) are among the most abundant soil organisms and form symbiotic (often obligate) associations with over 80% of terrestrial plants. Subsequently, they confer a number of advantages to the hosts, including increased nutrient uptake especially for relatively immobile nutrients, e.g. phosphorus and some micronutrients, improved water uptake and use efficiency, and improved disease resistance. The research was set out to develop and evaluate AMF as an IPM component to be used alongside already developed technologies. Soil was collected from Central Uganda from a tea plantation that was formerly part of the equatorial forest of Mabira, a site previously characterized as highly mycorrhizal. Soil samples were analyzed in the laboratory and found to have high levels of AMF. After that, screen house trials with sorghum and onions plants (documented trap/multiplication hosts for the AMF) were planted in pots inoculated with the fungus. Colonization measures are on-going to establish the colonization capacity of AMF after which further multiplication of the AMF will be carried out to get enough inocula to use in screening on MT56 and other varieties. Samples of the isolated AMF were sent to colleagues in Brazil for identification, and we are waiting for feedback.

Hot Pepper cv. Scotch Bonnet

Exploiting Host Resistance to Manage Hot Pepper Root Rot/Wilt Disease in Mubuku Irrigation and Settlement Scheme

G. Tusiime, S. Miller, J. Karungi, J. Bonabana, S. Kyamanywa, D. Munyazikwiye

Establishment of the range of fungal root rot and wilt pathogens on scotch bonnet in Mubuku irrigation scheme. Pepper production in Mubuku Irrigation is constrained by the root rot and wilt disease. It is known that pepper rot and wilt could be incited by a complex of pathogens. Of the pathogens in the complex, it is only *Phytophthora capsici* that has been isolated from infected pepper. However, it is important to determine all possible pathogens involved in this disease. Effective management approaches are those that target the whole range of pathogens in the complex. The objective of this component of the study is to survey pepper for the root/wilt causing pathogens. Pepper samples with root rot/wilt disease were brought to the laboratory at Makerere University. Root and crown sections were obtained from the samples and plated on isolation media targeting *Phytophthora*, *Fusarium* and *Verticillium* spp. So far, only *Phytophthora capsici* has been isolated from the samples. It appears likely that it is the most significant pathogen responsible for the root rot/wilt disease in Mubuku irrigation Scheme.

Screening hot pepper germplasm for resistance to root rot/wilt disease: Host resistance is known to be the most reliable means to manage plant diseases. In Mubuku irrigation scheme, the two hot pepper varieties grown are all susceptible to the root rot/wilt disease. In an effort to find and deploy root rot resistant pepper varieties, we obtained One hundred ten (110) F3 lines from Habanero - IP 59234 (said to be resistant to root rot/wilt disease) cross and planted them in Mubuku Irrigation Scheme to evaluate them against the disease. From these, it is hoped that lines with good levels of resistance can be identified and deployed in our efforts to develop hot pepper varieties resistant to the rot/wilt disease. Fifty (50) F3 lines of a cross between Habanero and IP 159234 (were established in a field trial in Mubuku on 20th July 2010). These materials have currently not wilted (about 2 months after transplanting), although they seem to be susceptible to viruses. For this reason, about 110 F3 lines (including the 50 planted in Mubuku) have been planted in a field at the Makerere University Agricultural Research Institute (Kabanyolo) to increase seed and reduce the risk of losing seed to unforeseen pests such as the viruses in Mubuku, as we do more evaluations.

Establishment of the Optimum Irrigation Frequency and Ridge Size on Hot Pepper Wilt Incidence and Severity in Mubuku Irrigation Scheme

G. Tusiime, Sally Miller, Karungi J., Bonabana J., Kyamanywa S., Munyazikwiye D., Mubuku

Optimum irrigation frequency to manage pepper root rot/wilt diseas: It is established that pepper production in Mubuku Irrigation is constrained by the root rot and wilt disease predominantly caused by the oomycete *Phytophthora capsici*. This pathogen, like all oomycetes, is favored by water logged conditions in the field. Pepper in Mubuku is produced under irrigation. Our interaction with farmers indicates that they apply unnecessarily too much water in their fields. This favors the growth of the pathogen and hence the damage it causes on the crop. The objective of this component of the study is to demonstrate that reduced water in the field by reducing the frequency of irrigation lowers disease severity. A trial to investigate the effects of irrigation frequency on occurrence of root rot/wilt disease on pepper was established in June 2010 in Mubuku Irrigation Scheme. Three irrigation frequencies are being investigated: (i) after every 8 days, (ii) after every 6 days, and (iii) after every 4 days. The farmers' usual ridge size (i.e., 6 cm high ridges) was adopted for this trial. To date, no wilt has developed in the trial.

Optimum ridge size for managing pepper root rot/wilt disease. In order to limit the amount of water in the root zone of the pepper crop, ridges on which pepper is planted can be manipulated which in turn limits damage caused to the crop by *Phytophthora capsici*. Farmers currently employ ridges of up to 6cm high. These are too small; they get over logged with water even with a slight irrigation. This encourages development of the disease. The objective of this component of the study is to evaluate different ridge sizes on occurrence and severity of root rot/wilt disease on pepper. A trial to evaluate the effect of ridge size on occurrence and severity of hot pepper root rot/wilt disease was conducted with three ridge heights of (i) 30 cm, (ii) 20 cm, and (iii) 15 cm. Hot pepper was transplanted onto these ridges at a spacing of 1 x 1 m for the 30cm and 20 cm ridges, and 1 x 0.8 m for the 15 cm high ridges. These ridges were irrigated following the farmers' usual practice. The trial is being monitored for disease development. To date, no wilt has developed yet in the trial.

Diversity of Hot Pepper Seed-borne Viruses and Development of a System for Small-holder Virus-free Seed Production

P. Sseruwagi, S. B. Mukasa, Sally Miller, J.Karungi, J. Bonabana, S. Kyamanywa, D. Munyazikwiye

The damage caused by viral infections is, among others, dependent on the age when the crop is infected. It is therefore desirable that the crop remains virus free for as long as possible. One of the strategies to ensure this is the provision of virus-free seed. Outdoor pepper seed production is constrained by not being able to keep away the viruses from seed. Seedlings from such seed are transplanted with disease and are weakened so early in their growth. The objective of this component of the study is to evaluate the suitability of a tunnel to produce virus-free pepper seed. A tunnel for in-door establishment of the crop has been constructed at the Makerere University Agricultural Research Institute, Kabanyolo.

Passion fruit

Grafting, Soil Amendments and Host Resistance for the Management of Key Diseases of Passion Fruit

P. Sseruwagi, M. Ochwo-Ssemakula, M. Otim, S. Kyamanywa, D. Kirunda, S. Miller, S. Nyanzi

Two passion fruit species namely, sweet calabash (*Passiflora maliformis*) and yellow (*P. edulis* fsp. *flavicarpa*), were previously reported as tolerant to diseases. Physiologically mature fruits of these two species were collected from eight major passion fruit growing districts including: Mbale, Mubende, Mityana, Nakasongola, Lira, Tororo Kaberamaido and Masaka for propagation as root stock in the screen house at the National Agricultural Research Laboratories Institute. Seedlings were then artificially-inoculated with isolates of the virulent collar rot pathogen (*Fusarium solani*) accessed from the disease hot spot in Wakiso district. These fungal isolates were cultured from single spores in chepadox nutrient media after plating of diseased stem tissue on Potato Dextrose Agar (PDA) media. Data on disease incidence and severity would be collected, starting two weeks after inoculation, for a period of four months. Resistant accessions would be selected for grafting to scions of commercial varieties such as the Kawanda hybrid and the small purple. These seedlings will be raised in the screen house and evaluated in field trials for agronomic performance and tolerance to prevalent pests/diseases at the National Crops Resources Research Institute in Namulonge for 2 years.

Promising passion fruit lines KPF4, KPF11 and KPF12 from Kenya will be evaluated alongside the local root stock in Uganda for tolerance to collar rot and *Fusarium* wilt. In addition, different soil fertility amendments (cow manure and NPK fertilizer) as well as antagonistic *Trichoderma* species found effective in Kenya will be used as a potential IPM strategy. The process for acquisition of the promising lines and *Trichoderma* from Kenya has been initiated.

Environmentally-Friendly Management Options for Viral Diseases of Passion Fruit

M. Otim, M. Ochwo-Ssemakula, P. Sseruwagi, S. Kyamanywa, R. Natukunda, J. Kovach

Potential vectors of passion fruit viruses were determined in earlier trials. Subsequent trials will investigate potential environment friendly options, notably bio-control agents and cultural practices, such as use of cover crops/intercrops in management of the vectors and associated viral diseases. An on-station field trial has been completed that determined the temporal and spatial spread patterns of the viral disease.

Coffee

Effect of Conventional vs. IPM Management Systems on Priority Insect Pests of Coffee

S. Kyamanywa, P. Kucel, J. Kovach, I. Rwomushana, M. Erbaugh

Key pests and diseases: The key pests are: Antestia bugs (*Antestiopsis* spp.), Stem borers (*Bixadus sierricola*), Root mealybugs (*Planococcus ireneus*), Leaf miners (*Leucoptera* spp.), Coffee berry borer (*Hypothenemus hampei*), Coffee lacebugs (*Habrochila* spp.), tailed caterpillars (*Epicampoptera andersoni*), Leaf skeletoniser (*Leucoplema dohertyi*.), Common coffee mealybug (*Planococcus kenyae*) and Soft green scales (*Coccus alpinus*). The key diseases are: Coffee leaf rust (*Hemileia vastatrix*) and Coffee berry disease (*Colletitrichum kahawae*).

On-farm demonstration trials were set up to verify management options that had been found effective against key pests of coffee on station. These included utilisation of organic manure, mineral fertilizer, and/or bean intercrop on coffee root mealybug infestation; stem wrapping and stem smoothening were the options found effective against the coffee stem borers. Farmers groups were mobilized and three demonstration sites were set up in Bugusege, Sironko district for the period May to September, 2010. Farmer participatory data collection was conducted monthly. This activity hosted a Field Trip to Bugusege Mt. Elgon region to visit on-farm trials and interact with coffee farmers. The trip was for IPM CRSP East Africa Region members (14) and American collaborators (3) who were holding a regional meeting in Mbale, Uganda (10F : 7M). The trip was to two on-farm sites where IPM packages for coffee are being demonstrated after which there was a session with farmers (10F : 4M). The farmers expressed gratitude that Makerere University, through IPM CRSP, was coming out to the communities to assist in improving coffee yields. Amongst their key problems with coffee production were stem borers, coffee rust, poor quality seedlings, and soil nutrient depletion.

Action Threshold and Disease Curves for Major Insect Pests and Diseases of Arabica Coffee

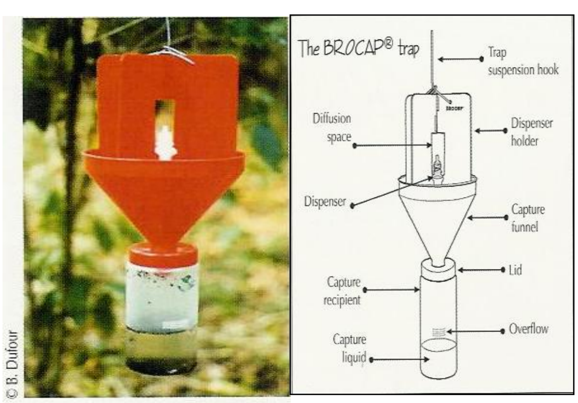
I. Rwomushana, P. Kucel, J. Kovach, S. Kyamanywa, M. Erbaugh, C. Ssemwogerere

To reduce pesticide usage while improving coffee yields, studies to determine action thresholds and disease curves as decision tools in IPM on coffee are undergoing in the Mt. Elgon region and on-station in Mukono district. Data on the key insect pest of coffee has been collected for one coffee growth cycle and is being analysed.

Evaluation of IPM Options for Managing the Coffee Twig Borer in Uganda

S. Kyamanywa, P. Kucel, J. Kovach, I. Rwomushana, M. Erbaugh

The study was initiated on-farm at two sites in Ntenjeru and Nakanyonyi Sub-Counties in Mukono district in May, 2010. Community based participatory implementation of the test phyto-sanitary control measures (pruning, stumping and burning) are being carried-out. On-station trials assessing the effect of (BROCARP) traps that use ethyl-alcohol as single attractant are also on-going. Farmer participatory search for alternate hosts has also been initiated. Data collection is on-going.



Brocap® trap

The BROCARP® Trap (Picture and sketch above) was jointly developed by CIRAD and PROCAFE. Details are available at CIRAD-CP Export service (brocarp@cirad.fr). They were imported in Uganda by Kaweri Coffee Ltd for coffee berry borer control.

Kenya

Tomato

Grafting and High Tunnel Tomato IPM Workshop

Waiganjo, M, R. Amata, Z. Kinyua, S, Kuria, M. Menza, C.M. Kambo, C. Njeru, M. Erbaugh, J. Kovach, S. Miller, S. Kyamanywa, R. Ssonko

A two-day workshop was conducted at KARI/Thika and KARI/Mwea on grafting and using high tunnels as integrated pest management (IPM) strategies for tomato production on April 12 and 13, 2010. In addition, the workshop participants were updated on pest identification and various IPM options to address the major tomato production constraints. There were a total of 44 participants of which 26 were men and 18 were women. The lead trainers were Drs. Waiganjo, Amata, Kinyua, Ssonko, Kyamanywa, Kleinhenz, Miller and Erbaugh, all of whom are PIs with the IPM CRSP Regional Program in East Africa. The training involved presentations, participatory discussions, and practical grafting exercises at KARI-Thika during the first day. On the second day, presentations and discussions were conducted on pesticide handling, pests' natural enemies and beneficial arthropods, and high tunnel technology benefits. The participants were thereafter taken through a demonstration of screen house seedlings protection at the KARI-Mwea centre and a field visit at a smallholder high tunnel structure for tomato production. Use of affordable clear polythene soil solarization was demonstrated.

Table 1. The effects of treatments on virus disease incidence, insect pests and yield of tomato crop grown at KARI-Mwea

Treatment	Virus (TYLCV)	Whiteflies	Aphids	Leaf miner	Yield in tons/ha
Screenhouse-IPM	0.13±0.03a	0.95±0.03c	0.21±0.04a	0.27±0.04a	3.01±1.80a
Farmer practice	0.14±0.03a	1.97±0.02bc	0.25±0.04a	0.23±0.04a	1.06±0.20a
Screenhouse +no insecticide	0.14±0.03a	2.99±0.03ab	0.19±0.03a	0.29±0.05a	1.43±0.36a
Outdoor +no insecticide	0.22±0.04a	3.99±0.02a	0.25±0.04a	0.25±0.04a	1.02±0.19a
Cv	23.52	10.30	25.08	22.32	36.15
p-value	0.29	0.0162	0.63	0.73	0.29

Means within a column marked with the same letter are not significantly different at p=0.05 by SAS SNK test.

Evaluation of effects of screen-house produced seedlings to insect transmitted viruses

Waiganjo, M., S. Kuria, C.M. Kambo, C.Njeru, M. Erbaugh, J. Kovach, S.Miller

The second season tomato screen house trials were conducted on-station at KARI-Mwea to test IPM practice involving nursery protection using insect proof screen house and need based pesticide application of bio-pesticides. The IPM option was compared with farmer practice using outdoor nursery and routine insecticide application and untreated control. A commercial variety (Onyx) was used. The treatments included:

1. Screenhouse-IPM- Pest scouting and need based pesticide application of Bio-pesticides namely, B.t, Dipel® alternated with neem, Nimbecidine®
2. Outdoor-Farmer practice involving weekly application of fungicide (Mancozeb®) and fortnightly insecticide application (Dimethoate alternated with Deltamethrin (Decis®)
3. Screenhouse alone-No insecticide application
4. Outdoor -no insecticide application (control)

Data sampling was conducted fortnightly from five plants per plot to assess arthropod pests and disease (tomato yellow leaf curl virus) incidence. Yield/hectare was assessed during harvest.

Tomato seedlings production in the screen house followed by need based pesticide application resulted in significantly lowest whitefly infestation and the highest yield, but the yield was not significantly higher than other treatments (Table 1). The incidence of the viral disease (tomato yellow leaf curl), however, was low in all the plots with no significant difference among the treatments.

Tomato varietal testing for resistance/tolerance to bacterial wilt (Ralstonia solanacearum):

The objective of this study was to test the developed and introduced tomato lines for resistance/tolerance to bacterial wilt on-station at KARI-Mwea and validate the trial on-farm at the farmers' fields in Kirinyaga District.

Table 2: Effect of introduced and conventional tomato varieties on bacterial wilt incidence and fruit yield

Season one field trial			Season two field trial		
Tomato Varieties	**Mean ± s.e Bacterial wilt infected plants**	**Mean±s.e yield in tons /ha**	**Tomato Variety**	**Mean ± s.e Bacterial wilt infected plants**	**Mean±s.e yield in tons /ha**
155-18	1.14±0.22ab	1.6±0.15a	155-18	0.83±0.12a	1.3±0.14a
193-2	1.64±0.30ab	1.5±0.12a	193-2	0.83±0.12a	1.3 ±0.13a
193-31	1.39±0.22ab	1.7±0.16a	193-31	1.50±0.42a	1.1±0.19a
81-1	1.14±0.21ab	1.6±0.17a	81-1	1.09±0.52a	1.1±0.25a
MT56	0.79±0.08b	1.7±0.19a	MT56	0.94±0.16a	1.3±0.16a
Onyx	1.79±0.25ab	1.6±0.17a	Onyx	1.06±0.19a	1.0±0.11a
CALJ	1.76±0.29a	1.7±0.17a	Valoria	1.13±0.23a	1.2±0.22a
%CV	72	32.59	CV	86.59	33.07
P Value	0.043	0.96	P Value	0.228	0.341

Means within a column marked with the same letter are not significantly different at p=0.05 by SAS SNK test.

During the first season, five KARI-Thika developed tomato lines (TKA 155-18, TKA 193-2, TKA 155-82, TKA 81-1, TKA 193-31), and one introduced line MT56 (UG) and two commercial varieties, Cal J and Onyx, were planted on-station at a spacing of 50cm within the rows and 100cm between the rows in 5x3m plots. The experiment was laid out in a Randomized Complete Block Design (RCBD) consisting of seven treatments, replicated three times. Weekly observation of the plants to assess the plant growth in all the treatments was done, and the wilted plants were taken as a percentage of the total number of plants per replicate (25 plants). The trial was repeated on-station for a second crop season and variety Calj replaced with var. Valoria.

There was significant difference between the treatments (P=0.043) for bacterial wilt with the introduced line MT56 having the lowest mean number of wilted plants (0.79). The variety CALJ had the highest mean number of wilted plants (1.76). The developed lines 155-18, 81-1 and 193-31 performed better than the commercial variety, Onyx with a mean of wilted plants of 1.14 and 1.39, though there was no significant difference between them (Table 2). During the second season, two of the developed lines (TKA 155-18 and TKA 193-2) proved superior with the least mean number of wilted plants (0.83) lower than the introduced line MT56 (0.94), while 193-31 and 81-1 had the highest mean number of wilted plants (1.50 and 1.69) higher than the commercial varieties, Valoria (1.13) and Onyx (1.06) though they were not significantly different from one another.

During the first tomato crop season, the yields ranged from 1.5 to 1.7 tons. The developed line 193-31, CALJ and the introduced variety MT56 had the highest yields but not significantly different from the others. During the second season, yields ranged from 1.0 to 1.3tons/ha. Developed lines155-18 and 193-2, and the introduced MT56 had the highest yields (1.3

tons) but not significantly different from each other.

- KARI-Thika lines (TKA155-18, 193-2, 193-31 81-1) showed a high degree of tolerance to bacterial wilt and maintained the preferred market oval shape during both trials.
- The introduced line MT56 was the most bacterial wilt tolerant among the test varieties and recorded high yields. However, the variety was not preferred for marketing due to its poor shelf life.
- The variety MT56 is therefore recommended as root stock for the tomato grafting program.

High tunnel and grafting of tomato plant development and crop yield, fruit quality and shelf life

Menza, M; Waiganjo, M; Sylvia K; Gitonga, J; Amata, R; Erbaugh, M. Miller, M. Kleinhenz, M..Kovach, J. Pauline Mueke, Charity Gathambiri

Grafting susceptible varieties onto resistant ones is an effective approach to control of bacterial wilt in tomato. This technology has been employed successfully in various countries including Uganda. The technology has not been explored in tomato production in Kenya. High tunnel production is rapidly gaining importance among smallholder tomato growers in Kenya owing to its many benefits. The technology enables continuous or prolonged higher and better quality yield in a relatively small area regardless of weather changes and enables better pest management. However, limited technical knowledge on high tunnel production among resource poor small holder farmers is a major challenge.

Trials involving high tunnel and open field production were set up at a farmers' field in Mwea. The trial involved use of seedlings from the training workshop. Onyx variety grafted onto MT56 rootstock un-grafted Onyx and Anna F1 varieties were used in randomized complete blocks replicated 4 times in both high tunnel and open field production system. Seedlings were planted at 30 x 60cm spacing in the high tunnel and 50 x 100 cm in the open field respectively. Fertilizer application, pruning, weeding, irrigation and other cultural practices were carried out by the farmer under his management practices.

Three (3) weeks old scion and root stock seedlings raised under a protected screen house at KARI-Thika were used. Proper hygiene and sanitation was observed in the work. Grafting blades (surgical blades) mounted on stainless steel handles, clips, grafting tapes, gloves, disinfectant (Jik®) and clean water was used. The work was carried out in a grafting shed at KARI-Thika. Wedge grafting method was employed. After grafting, seedlings were kept under acclimatization tunnels properly covered with clear polythene for the grafts to take.

Data collection was carried out biweekly on growth and yield parameters, and pests and diseases infection. Yield data was taken by harvesting from all plants per plot and calculated per hectare basis. Data on growth rate (mean height increase in cm) was taken. Heights of a random sample of four plants per plot were measured biweekly and averaged. Data was analyzed using Genstat and separated by Student-Newman-Keuls test at $p \leq 0.05$.

Anna F1 is an indeterminate hybrid variety bred for high tunnel production out yielded Onyx, an open pollinated variety adapted for open field production.

Results of yield from 6 harvests obtained in two months show the following:

- Grafting had no significant reduction on yields in both production systems.
- Both varieties gave higher yields under high tunnel than under open field production.
- Anna F1 out-yielded Onyx in total yield under high tunnel, while under open

field production Onyx gave higher yields than Anna F1.

- There was a sharper decrease in Onyx yield after peak harvest than for Anna F1
- Grafting did not reduce the growth rate in both production systems.
- There were no significant differences in crop growth rate except by the 12th week where Anna F1's growth in the open field was significantly higher (66.5 cm) with onyx having the lowest (28.19 cm)

Passion Fruit

Diagnostic protocols for passion fruit virus population

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The presence of passion fruit woodiness virus in Kenyan passion fruit samples with virus symptoms is under determination using primers that were designed from the Australian and East Asian strains of passion fruit woodiness viruses. Rt PCR primers are being developed from the Kenyan strains with the help of the Australian, East Asian and Kenyan strains. Molecular Variability of virus strains from diseased passion fruit samples from Kenya will be done through DNA sequencing of the Kenyan strains.

From the preliminary sequence data, it is understood that for one of the new viruses at least two different strains exist. These two strains can be differentiated by using restriction enzymes that digest the cDNA of one strain but not the other. We used the partial sequence information to design a pair of primers that are expected to amplify a PCR product from the cDNAs of both strains. The primers were used to amplify the expected PCR product from RNA samples collected from different fields. The PCR fragments were digested with two different enzymes (MluI and EcoRV) to classify the strains of the virus in each field. Currently 25 samples were analyzed, 8 samples belong to one strain, and 6 to the other.

Sequences of Initial Kenya passion fruit virus (KPFV) particle, sequences of the 3'-End, first and second sequences of the 5'-End of the KPFWV have been determined. Two KPFV different sequences were identified and it is suspected that there are 2 viral strains. Fourteen out of the 25 diseased Kenyan passion fruit isolates tested positive to KPFV virus.

Fifty percent of the genome of one strain of the KPFV has been sequenced. Two additional strains of viruses have also been characterized to a lesser extent (30%). Sequences of eight strains of the KPFV particles have been determined. Sequencing of more samples is ongoing. Primers are being designed based on the information being generated. These primers will be useful in diagnostics of viruses affecting passion fruit in Kenya.

The data collected indicates similarities between KPFV and the virus infecting passion fruit plants in Uganda. The results also indicate that in most of the infected trees, KPFV is present as a mixed population of multiple strains, and is likely to be part of a virus complex.

Screening and grafting germplasm and rootstocks for passion fruit disease resistance

Passion fruit lines KPF11, KPF4, MKY2 and KPF12 were evaluated for rootstock scion compatibility with the following scion material lines: Purple, MKY2, KPF4, and KPF12. Fifteen plants of each line were grafted with the different scion materials and time taken for shoot development on the scions recorded. Data on yield and vegetative characteristics were taken and analyzed using general linear model in SAS and mean separated by student Newman Keuls test. Virulent strains of *F. oxysporum* fsp. *passiflorae* and *F. solani* were

Table 3. Effect of *Fusarium oxysporum* on mean growth rate (mean height increase in cm) of passion fruit lines

Line	June 2009	July 2009	August 2009	Sept. 2009	October 2009
KPF11	9.333 a	8.833 a	17.33 a	19.83 a	21.42 a
KPF12	7.667 ab	10.917 a	13.50 ab	17.17 a	17.83 a
KW	7.417 ab	13.667 a	22.42 a	26.83 a	24.17 a
KPF4	7.083 ab	10.800 a	16.00 a	18.75 a	19.33 a
PURPLE	2.667 b	2.500 a	2.92 b	6.00 b	3.58 b
P	0.05	0.140	0.017	0.007	0.015
Cv	52.5	78.1	61.1	46.3	55.7

Means followed by the same letter in one column are not significantly different. Mean separation by Student-Newman-Keuls test at $p \leq 0.05$

grown on separate plates of carnation leaf agar and spores harvested at 14 days of growth. Fifty milliliters of water with an inoculum concentration level of 10^6 per ml each for the two species was introduced to the sterilized soil of each of the four lines (KPF12, KPF11, KW, and KPF4). The lines were replicated four times. The lines were monitored for wilt and stem canker symptoms and growth characteristics recorded. The lines used in production characteristics trial were KPF12, MKY2, C5, KPF4 and purple (as the control). The plants were spaced at 3 meters X 2 meters. Each line was replicated six times. Data on yield and vegetative characteristics were taken and analyzed using general linear model in SAS and mean separated by student Newman Keuls test.

Under the insect proof screen house environment, KPF4, KPF12, and purple passion fruit exhibited self-compatibility. Line KPF12 fruited heavily, followed by KPF4, and purple. MKY2, C-5 and KPF21 performed poorly yield-wise**.** MKY2 was ever green and vigorous.

Evaluation of passion fruit lines for tolerance to major diseases (*Fusarium* wilt and collar rot

Table 4. Effect of *Fusarium solani* on mean growth rate (mean height increase in cm) of passion fruit lines

Line	July 2009	August 2009	Sept. 2009	October 2009	January 2010
KPF11	22.00 a	23.50 b	13.917 a	1.417 a	40.17 a
KPF12	8.75 ab	14.33 b	11.083 a	1.500 a	23.00 b
KW	17.65 a	34.17 a	12.000 a	3.333 a	23.00 b
KPF4	14.58 a	16.33 b	9.667 a	2.083 a	20.00 b
PURPLE	0.50 b	0.25 c	1.333 b	0.417 a	9.83 b
p	0.003	<.001	0.002	0.299	0.001
cv %	65.6	47.6	48.7	130.0	42.9

Means followed by the same letter in one column are not significantly different. Mean separation by Student-Newman-Keuls test at $p \leq 0.05$

disease) and yield performance is illustrated in Tables below. Lines KPF4, KPF11, and KPF12 did not show any signs of collar rot and grew normally compared to their controls, while the purple showed stunted growth, yellowing and collar rot compared to the controlled and the other cultivarsalso badly damaged by collar rot in the *F. solani* and *F. oxysporum var.passiflorae* trials (Table 3).

Passion fruit lines KPF4, KPF11, and KPF12 tolerated the pathogens well at KARI Thika and could be recommended for straight sowing in the soil. There was no significant difference in mean growth rate between KPF 4, KPF11, KPF12, and KW. There was a significant difference between the purple passion fruit variety and all the rest of the passion fruit lines. There was no significant difference in mean growth rate between KPF 4, KPF12, KW and purple when planted in soil infested with the collar rot pathogen (Table 4).

IPM technologies for managing leafminer, *Liriomyza* spp, new pest of passion fruit and spider mites, *Tetranychus* spp

Evaluation of passion fruit breeding lines for spider mite tolerance: Seven breeding lines: KPF4, C5, KPF11, KPF12, PURPLE, MKY2 and KW1 were evaluated for mite infestation. The treatments were replicated three times. Each replicate had four plants. Fifty yellow mite cultures were collected from susceptible species and introduced to the fifth leaf, from the growing tip of the eight plants of each line. There were no introductions on the controls. Data on yield and vegetative characteristics were taken and analyzed using general linear model in SAS and mean separated by student Newman Keuls test.

While the purple passion fruit was completely destroyed by the spider mites by the sixth month, KW1 appeared to be untouched by the pest. Lines C5 and MKY2 showed slight damage, while KPF4, KPF11, and KPF12 outgrew the slight damage and performed normally.

Evaluation of biologicals, *Trichoderma* spp and *Bacillus* spp, chemical fungicides and cultural practices to manage major fungal diseases of passion fruit

Management of Fusarium Wilt: There was a significant difference between biological control agents and fungicide treatments applied for the control of Fusarium wilt disease when applied after disease set in or curatively. *Trichoderma asperellum* was significantly different from the control and fungicide treatments when applied as curatively but was not significantly different to *T. harzianum*. The two bio control agents (*T. asperellum* and *T. harzianum)* were not significantly different from fungicidal drenches including carbendazim, ridomil and ortiva, when used as protectant treatments.

Management of Die-back Disease: There was a significant difference between control and all fungicides and biocontrol agents used irrespective of application method. Carbendazim and Cotaf were effective in controlling dieback irrespective of the application method (i.e., spray, paste, pruning coupled with sprays, and pruning coupled with the paste).

Onion

Baseline survey of farmer production practices and marketing of onion

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To carry out the onion baseline survey, two structured questionnaires were developed including one for market survey of onion traders and a farmer production practices questionnaire. The dry onions market survey questionnaire had five sections, including general information, background information included trader, supply and demand of onions, gender aggregated control over resources, and other useful information concerning the trader perceived profitability of onion marketing, business and its constraints.

The questionnaire was pre-tested using four (4) respondents at Nyeri market and adjustments made accordingly. The final adjusted questionnaire administration was initiated to onion traders at Karatina market (Plate 4), and will be continued at Nairobi (Wakulima market), Nakuru, and Bungoma as proposed. In addition, disease infected onion bulbs were collected from Karatina market to KARI-NARL for determination of the disease in the laboratory.

The biological and production baseline survey questionnaire was pre-tested to onion farmers in Kirinyaga District. The questionnaire consisted of basic data, respondents personal data, land details, labor on production, inputs used in onion production and output got from the farm, management experience, knowledge of pests, their control practices, pesticide handling and storage, and required information by the onion farmer and farmer income. Four respondents were interviewed, after which review of the responses and adjustments were carried out and a final questionnaire developed.

Technology Transfer

Tomato grafting and high tunnel demonstration

Farmer follow-up tomato grafting and high tunnel training was carried out at Mwea on 2nd July, 2010. The field day was attended by 56 farmers (41M, 15F), some of whom had attended the tomato grafting and IPM workshop on April 12th &13th, 2010. The one day field day took place at Simon Ndambiris farm, the contact farmer for tomato grafting and high tunnel activities. The objectives of the field day were to demonstrate tomato grafting and use of high tunnel farming in the area, its benefits and importance of good seed selection, and proper crop nutrition as a component of integrated pest management. The resource persons included research officers from KARI and two production managers from Scotts Limited.

Transfer IPM knowledge and packages to growers of passion fruit

Members of the Juja farmers group, comprising 15 members (8 women and 7 men), participated in evaluation of passion fruit lines for tolerance to Fusarium wilt and brown spot diseases and evaluation of biocontrol agents for their effectiveness in controlling the 2 diseases.

Tanzania

Tomato

Dissemination of IPM Pacakges

A.P. Maerere, K.P. Sibuga, E.R. Mgembe, M.W. Mwatawala, D. Mamiro

The objective of the activity was to demonstrate to farmers the effect of IPM practices on tomato insect pests and diseases. IPM practices that were validated and farmers trained on were seed treatment + mulch + pesticide application based on pest scouting. Mulch was applied at a thickness of 10 and 15 cm using dry rice straws and dry grasses (predominatly *Panicum* spp.). An un-mulched plot was used for comparison. The tomato variety used in the demonstration was Tanya VF. The demonstration plots were established at Mlali village. Farmers from Mlali, Kipera, Misegese were invited to visit the plot for training on seed treatment, nursery establishment, transplanting, mulching, fertilizer application, scouting for insects and diseases as basis for deciding whether to apply pesticide or not, and on appropriate methods/practices of pesticide application.

As was undertaken during phase 1, the Ward Agricultural Extension worker met with the farmers on site on a designated day, once a week for pest scouting and pesticide application, as needed. Researchers visited demonstration plots and interacted with farmers at least once every two weeks to monitor and evaluate, conduct training, and discuss the development of the crop.

A total of 40 farmers were trained (18F:22M) on farm using the demonstration plot. Observations/comments made by farmers were:

(a) Application of mulch reduced the effect of drought that was experienced this year on the tomato crop. This was demonstrated by the fact that plants in the mulched plots were more vigorous and had remained green without signs of wilting at 4 weeks from when irrigation had been stopped. Thus mulch had positive effect on soil moisture conservation.
(b) Mulch reduced weed populations and therefore the need for frequent weeding that is usually done up to 3 times per crop cycle.
(c) The thicker mulch of 15 cm using rice straws was most effective both on weed suppression and soil moisture conservation.
(d) Tomato fruits in the mulched plots were more colorful and with lower incidence of blossom end rot.
(e) Farmers recognized the need to stop the practice of burning rice straws, and instead to collect them for use in tomato mulching.

The final training session for the season was recorded on video. This is being processed to produce a video film that will be used for training other farmers.

Impact of Management Practices on Post-Harvest Physiology and shelf Life

A.P. Maerere and H.D. Mtui, M. Bennett

On station field experiments to test the impact of management practices on postharvest physiology and shelf life of tomato were conducted at SUA. Treatments consisted of two tomato cultivars (Tanya VF (Ta) and Tengeru 97 (T)), two mulch ((M) at 15 cm thickness) and no mulch (M0)) and four spray regimes (No spray (F0 =control)), spray with pesticides (fungicide and insecticide) according to recommended dosage rates and intervals (Fs)), spray weekly (Fp) and spray as needed (Fi).

The two cultivars used showed difference in time to maturity. Cultivar Tanya VF was early maturing by producing fruits which ripened a week earlier compared to cultivar Tengeru 97. The last harvest for Tengeru 97 was also one week later. This phenomenon has positive implication on marketing. Since the two varieties are grown concurrently, it means that the season is extended.

On the overall, there was a higher incidence of fruits with blossom end rot and sunscald (SS) disorders as well as higher rates of fruit rot on non-mulched plots. The incidence of fruit decay was minimal in mulched plots compared to non-mulched plots. BER occurred at a lower rate in Tanya VF than in Tengeru 97. Cultivar wise, mulching seems not to have effect on BER fruit disorder as well as fruit rot in Tengeru 97, while it had pronounced effect in preventing fruit rot in Tanya VF (Table 5)

Observed fruit damages were mainly due to Blossom End Rot, American boll worm and birds. Tengeru 97 was highly susceptible to bird attack and to damage by American bollworm compared to Tanya VF (Table 5). Birds seemed to prefer Tengeru 97 which is semi-indeterminate (growing upright) as the fruits were more exposed, compared to Tanya VF which is determinate with relatively dense canopy. The fruits lying on the ground were possibly more protected from the birds. Other important pests observed included aphids and whiteflies.

There were yield differences between the different treatments. Tanya VF was found to be higher yielding than Tengeru 97. Pesticide sprays at recommended dosage rates and intervals (Fs), Weekly Pesticide sprays (Fp) and spray as needed (Fi) gave higher yields

Table 5: Yield and yield components obtained from different treatments

TREATMENT	Average marketable Fruit number plant^{-1}		Average fruit weight (g)		Yield (t/acre)	
	Tengeru 97	Tanya VF	Tengeru 97	Tanya VF	Tengeru 97	Tanya VF
M-F0	12	25	94	51	10.9	12.5
MF0	11	30	113	59	11.8	17.4
M-Fi	12	39	130	87	15.5	35.8
MFi	10	52	140	91	14.4	45.0
M-Fp	12	31	130	78	15.8	24.4
MFp	13	43	139	88	18.5	37.6
M-Fs	11	35	123	77	13.6	26.9
MFs	12	42	150	94	17.8	39.3

compared to the control (F0) (Table 1). Mulched plots gave higher yields compared to non-mulched plots. For Tanya VF cultivar, the highest marketable yield was obtained when spraying was done as needed (IPM) and mulched (MFi) though may not be statistically different from those using mulch and sprayed weekly (MFp) and using recommended dosage rates and intervals (MFs).

The average fruit number per plant and fruit weight was higher in sprayed treatments than control. In all treatments, the average marketable fruit number per plant, average fruit weight and consequently yields obtained from mulched plots were high compared to non-mulched plots. Although Tengeru 97 had higher fruit weight, it had fewer marketable fruits per plant which resulted into lower yield compared to Tanya VF.

Coffee

Effect of Existing Shade and Open-Grown Coffee on Key Pests

J.M. Teri, G. Maro, F. Magina

The objective was to conduct comparative study of effects of shaded and open grown coffee on the behavior of key coffee pests and the damage levels, yield and quality of coffee under natural shade or open field.

Preliminary results show that white coffee stem borer (*Anthores leuconotus*) is more prevalent in sparse than in dense shade. Rains or high humidity has the effect of increasing the pest population. However, the Antestia bug (*Antestiopsis* spp) was more abundant in dense shade and increased in the field during the flowering and fruiting period. The Coffee Berry Borer *(Hypothenemus hampei)* is slightly more prevalent under dense shade and observed in the field particularly during the period of fruiting (young cherries to ripe fruits).

These initial results tend to indicate that management strategies for WCSB should encourage proper shading by planting more shade trees in sparsely shaded farms to attain a light intensity of between 20 to 40 lux. For Antestia bug, the proper management would be to prune the coffee and trees so as to improve the aeration within the plant canopy. Proper pruning will deny the *Antestia* bug and CBB hiding sites.

Coffee Berry Borer Management Using Traps

J.M. Teri, G. Maro, F. Magina

Traps based on the use of attractants identified during the baseline survey as being used by farmers were set in a trial. These included alcohols/spirits (wine, methanol, ethanol and methylated spirit). Local brews made from fermented ripe banana juice mixed with porridge of malted finger millet is considered to be a cheap alternative to industrial alcohols, which is readily available in coffee growing areas. Local made recipient materials have also been identified. Alcohol based attractants have appears to be effective in trapping the CBB.

Onion

Baseline Socio-Economic Survey on Onion Production

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The survey questionnaire was developed and pre-tested during the month of August 2010, in 4 villages (Msosa, Nyanzwa (in Kilolo district), in Iringa region, Malolo B and Chabi (in Kilosa district) Morogoro region). Out of the four villages, three namely - Msosa, Malolo B, and Chabi - were selected for the actual survey. A total of 100 farmers (46 Female, 54 Male) were interviewed. The survey was completed in September 2010.

Farmers in the study area grow maize, rice, beans and onion as major crops. Onion is the major cash crop. Production system is based on both rainy fed and irrigation. Due to the possibility to irrigate, onion is grown almost throughout the year, although the main production season is March – July. Seed sowing in nursery is done in December – January, followed by transplanting in the field from February to April. Thus harvesting is mainly from July to August. The same plots are used for all crops, and therefore, most farmers practice mixed cropping and crop rotation. Crop rotations are, however, of relatively short period of time before the same crop comes again on the same piece of land.

Although many farmers in the study area consider onion production to be under a monoculture cropping system, most plots planted with onion were observed to be intercropped with maize. Onion is always grown at a very close spacing ($\underset{\sim}{}$10cm), while maize is grown at a very wide spacing and mainly on the edges of beds as is indicated.

At least three varieties of onion were found to be grown in the villages. The varieties are Red Bombay, Khaki, and Red Creole Khaki (Texas Grano type). Red Bombay is the most important. It is considered to be the most high yielding and very attractive to buyers due to its bright red color. Red Creole is preferred by farmers on grounds that it has good market and produces fewer splits. Khaki variety was said to have relatively better storage shelf life compared to other varieties, however, it is less cultivated due to low yield and poor market attributes.

Weeds and insect pests were considered to be more problematic in all surveyed areas. The most common troublesome weed species is Mexican poppy (*Argemone mexicana).* Other weeds are Blackjack (*Bidens pilosa*), wild amaranth, annual and perennial grasses. Weed control in onion production is done by using herbicide followed by hand pulling. The most common herbicides used are Volmethalin® (Pendimethalin 500) and Galigan® (Oxyfluorfen 240 EC). The very close spacing used in onion production does not allow the use of the hand hoe in weeding, and therefore use of herbicide has become more popular.

Insect pests known to be important in the area include; onion thrips (*Thrips tabaci*), elegant grass hopper and onion grub. Onion thrips was mentioned to be an important pest in all study areas, while white or Onion grubs (*Phyllophaga* spp.) are said to be new and is more serious in Chabi village. Farmers use insecticides such as selecron® to control onion thrips and the elegant grass hopper. Currently, there is no known method for the control of grubs. Farmers practice hand picking of the grubs when observed (unearthed), but found that the method is laborious and not effective enough.

Gender Distribution of Labor: All tasks of onion production from nursery preparation to harvesting are done by all. However, land preparation activities are considered as men's activities. After harvesting, men are also responsible for the transportation of the produce, i.e., carrying of onions from the field to the homestead. Grading is done by men, while drying, threshing and winnowing of seeds are tasks reserved to women.

Gender Baseline Survey for Scotch Bonnet in Mubuku Irrigation Scheme, Uganda

Margaret Najjingo Mangheni (Gender), Jackline Bonabana (Impact Assessment)

M. E. Christie, (GK), M. Erbaugh, (GK), G. Norton (IA), D. Taylor, (IA), D. Kraybill (IA), Justar Gitonga

Hot Pepper (Scotch bonnet) production in Mubuku Irrigation scheme is constrained by the root rot and wilt disease. IPM is implementing 3 studies aimed at testing various tactics for managing these diseases, namely, resistant varieties, optimum irrigation frequency and ridge size. A survey was conducted to collect gender disaggregated baseline information on the socio economic characteristics, production, and prevalence of insect pests and diseases affecting pepper, current pest and disease control measures, enterprise characteristics, operational constraints, and the current application level of the code of practices.

The baseline survey questionnaire was developed in June 2010 with input from a multidisciplinary team of social scientists including a gender specialist. It was pre-tested in the field in the first week of July 2010. Data was collected in July by five enumerators assisted by the District Agricultural Officer, the Sub-county Extension officer attached to Mubuku Irrigation Scheme, and the Scheme's records officer. The data was entered and preliminary analysis done using SPSS computer program.

The basic demographic profile of the respondents is as follows: Responses were obtained from a total of 112 farmers (73 males, 39 females). Sixty-six percent of the respondents were married, while the rest were single, widowed, or divorced. The major occupation of respondents was farming (94%). A small number of respondents were people in private service and business (<1% each). Labor for farm operations was mainly provided by family members. About 30% of the respondents employed mainly hired labor on the farms. The average amount of land owned was 11 acres of which about 7.5% was under pepper production. About 60% of the respondents considered Hot Pepper a family crop (grown by both husband and wife), while <4% considered it a wife's crop. Ninety-nine percent of farmers grew hot pepper on raised land (ridges). Access to credit was generally not considered a constraint. Ninety-one percent had easy access although only about 51% had actually obtained credit ranging from fifteen thousand to seven million shillings. The major source of credit was a local bank in the district.

Economic Impacts of Integrated Pest Management in Tomato production in Kenya

Muthoka, N.M., M.M. Waiganjo, and S. Kuria

Evaluation of Tomato Pest Management Options – on station experiment 1

Tomato trials were conducted at KARI-Thika to assess the comparative efficacy of various tomato pest management options and their economic benefits. Five treatments included grass mulch application without insecticide application, untreated control without insecticide application, gass mulch application at two weeks from transplanting and need-based pest control using bio-pesticides, farmers' practice involving staking and bi-weekly insecticide application, and fifth option was tomato staking and need-based insecticide application using bio-pesticides. Using a commonly grown tomato variety Cal J, the five treatments were laid out in randomized complete blocks, replicated four times.

Evaluation of Tomato Pest Management Options – on station experiment 2

Trials were conducted on-station at KARI-Thika to test IPM practice involving nursery protection using insect proof screen house and need based pesticide application of bio-pesticides. Four reportedly wilt tolerant tomato varieties developed at KARI-Thika (TKA 81-1, TKA 193-31, TKA 155-18, TKA 193-2) were compared with a commercial variety Cal.J as the sub-plots and three pest management options as the main plots.

The three treatments included:

1. IPM practice-Pest scouting and need based pesticide application of Bio-pesticides namely, B.t, Dipel® alternated with neem, Nimbecidine®
2. Farmer practice involving weekly application of fungicide (Mancozeb®) and fortnightly insecticide application (Dimethoate alternated with Deltamethrin (Decis®)
3. An untreated control with no insecticide application.

The IPM practice with need-based pest control using bio pesticides had highest mean marketable yield (3,137.20kg/ha and 2,988.12kg/ha respectively) while the untreated control had the lowest mean marketable yield (1,667.23kg/ha). The highest economic benefits were recorded from the IPM practice while the farmer practice incurred highest costs attributed to routine pesticide use.

Aggregate economic benefits of the project

The economic surplus approach is used in measuring the aggregate economic benefits of agricultural research and calculates two measures of project worth, the net present value (NPV) and the internal rate of return (IRR). The focus is primarily on the research-induced supply shift. The NPV and IRR values are estimated for the period 1995-2016. Research costs have been estimated using the IPM-CRSP tomato allocation for KARI-THIKA and are assumed to continue to 2016. Data on price and quantity was obtained from Ministry of Agriculture annual reports.

Table 6: Economic benefits of the management options evaluated in the tomato trial at KARI-Thika, Kenya

Treatment	Marketable yield (kg/ha)	Yield value (Ksh/ha)	Other costs	Pest management cost (Ksh/ha)	Economic benefit (Ksh)
Untreated control	258	15,480.00	20,150	0	-4,670
Mulching and no insecticide	850.00	51,000.00	20,150	25,000	5,850
Mulching, need-based pest control using bio-pesticides	1,379.73	82,783.80	20,150	42,000	20,634
Farmers' practice	2,527.69	151,66	20,150	116,000	15,511
Staking, need-based pest control using bio-pesticides	1,993.32	119,599.20	20,150	78,000	21,449

1. Need based bio-pesticide application and stalking yielded higher returns, though not significantly different from need based bio-pesticide application and mulching.
2. Mulching although not usually applied by tomato farmers greatly reduced occurrence of weeds and pest infestation in the tomato plots.

The scientists involved in the project gave responses to a scientist questionnaire for the different IPM practices, (stalking, need based use of bio-pesticides, solarization, scouting and use of suitable varieties). Then a focus group was held with 11 farmers who were trained and grow tomatoes in Kirinyaga south District, in addition, statistical data was used from the Ministry of Agriculture.

According to the scientists, a yield improvement of 50-100% occurs with IPM use compared to the untreated control, with a 50% yield change assumed in the economic surplus analysis. The cost change was estimated to be –0.40%. The scientists suggested that maximum adoption rate of 70-100% will be achieved by year 2016. The elasticity of supply was assumed to be 1, due to the fact that producers are able to alternate their production between french bean, sweet corn, water melon, and butter nut with relative ease. An elasticity of demand for tomatoes was estimated of 0.5.

The consumer and producer surplus analysis yielded positive values for all years. For the conservative scenario (maximum adoption 25%), the benefits and costs of the IPM practice were discounted at 15% giving a net present value (NPV) of approximately Ksh 268,475,172 the IRR was 106% over 20years. For the robust scenario (maximum adoption 70%), the benefits and costs of the IPM practice were discounted at 15% giving a net present value (NPV) of approximately Ksh 2,113,384,505 the IRR was 517% over 20years. (Tables 6 & 7)

Table 7: Summary of the results from the economics surplus analysis

	NPV	IRR
Conservative scenario, max adoption rate = 25%	Ksh 268,475,172	106%
Robust scenario, Max adoption rate= 70%	Ksh 2,113,384,505	517%

Gender: According to the focus group discussion, men are involved in more activities than their female counterparts in tomato production activities, a factor that could be explained by the fact that tomato production is a commercial activity. Resources from the sales of tomatoes are mainly controlled by men.

Review of All Project Work Plans for Integration of Gender and Impact Assessment Components

Integration of gender and impact assessment into IPM research projects is feasible when they are on farm interfacing with male and female farmers. Therefore, the work plans of projects in all countries were reviewed so as to determine the time when gender and impact assessment integration would be done. It was found in Uganda that only 3 projects (hot pepper and coffee) were on farm in year 1, and in Kenya, only 1 project on passion fruit. All other projects were still on station in year 1 and would go on farm in year 2. Based on these findings, it was decided that a gender disaggregated baseline survey be conducted for hot pepper in Uganda in year 1. A similar study was also planned for coffee.

Presentations: A presentation on the status and progress of the impact assessment activities was made at the IPM Annual Technical Committee meeting held in Mbale, Uganda, June 2010. The meeting was attended by country coordinators and scientists from Kenya, Uganda, Tanzania; collaborators from US partner institutions; and a regional collaborator from KARI, Kenya. At the planning meeting, Year II activity plans were drawn. 7 male and 9 female scientists attended the meeting.

Another presentation titled "How, why, and when to assess impact of an introduced technology" was delivered to undergraduate students taking the course ABM 1205 Farm management and accounts at Makerere University. In this presentation, students were exposed to methodologies for impact assessment being used by the IPM team. 20 female and 39 male students attended this presentation.

Under the Millenium Science Initiative project, a tour of potato farmers in Muko, Rubaya and Hamurwa subcounties (Kabale district) and Kambuga Subcounty (Kanungu district) was done during the 4th week of May 2010. During this tour, informal presentations were made on the benefits of reducing pesticides, and on alternative methods of controlling major pests in potato production in the two southwestern districts of Uganda. 151 male and 94 female farmers benefited from the presentations.

IPDN in East Africa

Assessment of Tomato, Onion and Passion Fruit Diseases (Kenya)

Kinyua, Z.M., R.L. Amata, B.C. Langat, S.M. Ndirangu, S. Miller, Waiganjo M. and M. Erbaugh

Field appraisal and sampling was carried out to assess the range of diseases affecting tomato, onion and passion fruit. Field visits were undertaken in selected parts of Kirinyaga and Murang'a. Samples were also taken for analysis to the Plant Pathology Laboratories at KARI NARL-Kabete, where fungal, bacterial, viral and nematode diseases and their causal agents were determined. Laboratory work involved direct visual examination, direct microscopy or culturing/isolation followed by microscopy or biochemical analyses, depending on the nature of the sample and the anticipated pest problem.

A wide range of diseases was recorded in the assessed crop fields (Table 8). Viral infections on tomatoes appeared to be combinations of at least two viruses, which were not resolved as symptoms of many virus diseases are known to over-lap. On the other hand, analysis of soil and root samples where nematode infestation was suspected revealed a number of nematode species, particularly in tomatoes.

Table 8. Diseases and pests identified in selected crop fields in central Kenya during the period July to September 2010

Area/Locality	Crop name	Problem description/disease	Causal agent and other pests	Disease severity indication*
Kariguini	Tomato	Leaf spots & blighting	*Alternaria solani*	Moderate
		Bacterial wilt	*Ralstonia solanacearum*	Very low
		Bacterial specks	*Pseudomonas* sp.	Very low
		Insect damage	*Thrips*	Moderate
Makuyu	Tomato	Powdery mildew	*Leveillula taurica*	Low
		Leaf spots & blighting	*Alternaria* sp.	Very low
		Late blight	*Phytophthora infestans*	Very low
	Onions	Insect infestation	*Thrips*	Very severe
		White tip	*Alternaria* sp.	Very low
	Passion fruit	Fruit stalk rot	*Alternaria* sp.	Very low
		Dieback, viral symptoms	*Colletotrichum* sp. Woodiness virus	Very severe
Punda milia Bombo	Tomato	Wilting	*Ralstonia solanacearum*	Mild
		Leaf Mosaic	*viral infection*	Mild
	Onions	Insect damage	*Thrips*	Very severe
		White tip	*Alternaria* sp & *Botrytis* sp	Very low
Mungania/Kandara	Passion fruit	Stem necrosis	*Ascochyta* sp.	Low
Rukenya Kutus	Tomato	Wilting & bacterial speck	*Ralstonia solanacearum* *Pseudomonas* sp.	Low
		Early blight	*Alternaria* sp	Low
		Bacterial specks	*Pseudomonas* sp.	Low
		Wilting	*Ralstonia solanacearum* *Pratylenchus* sp.	Low

Kagumo/Kerugoya	Tomato	Stunting/nematode infestation	*Tylenchorynchus* sp	Low
		Crown rot	*Phoma* sp	Low
	Passion fruit	Brown necrotic spots	*Colletotrichum* sp	Moderate
		Woodiness	Woodiness virus	Low
		Dieback of twigs	*Colletotrichum* sp., *Meloidogyne* sp, *Helicotylenchus* sp. & viral infections	Very low
Kagio	Tomato	Bacterial specks	*Pseudomonas* sp.	Low
		Stem rot	*Erwinia carotovora*; presence of *Helicotylenchus* sp., *Pratylenchus* sp., *Hemicycliophora* sp.	Low
		Viral symptom	Viral infection, presence of *Meloidogyne* sp. & *Pratylenchus* sp.	Low
Ritaya Kakuzi	Passion fruit	Woodiness of fruits & wrinkled leaves	Woodiness virus	Very severe

***Severity indications**

- ***Very severe*** if 76 to 100% portions of most symptomatic plants in the crop field are affected;
- ***Severe*** if 51 to 75% portions of most symptomatic plants in the crop field are affected;
- ***Moderate*** if 26 to 50% portions of most symptomatic plants in the crop field are affected;
- ***Mild*** if 11 to 25% portions of most symptomatic plants in the crop field are affected;
- ***Low*** if 5 to 10% portions of most symptomatic plants in the crop field are affected;
- ***Very low*** if less than 5% portions of most symptomatic plants in the crop field are affected.

West African Regional Consortium for IPM Excellence

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- INSAH- W. Africa
- ISRA- Senegal
- IER- Mali
- ANCAR - Senegal
- ETQCL - Mali
- CERES-Locustox-Senegal
- OHVN-Mali
- CRI-Ghana

Summary

The first year activities of the West Africa Regional Consortium for IPM Excellence project focused on research planning and organizing the US-based and host country scientists for development of three vegetable IPM packages in three West African countries. These packages include: 1) tomato in Ghana, Mali and Senegal, 2) potato in Mali and Senegal, and 3) cabbage in Mali and Senegal. A two-day planning workshop was held in Bamako, Mali, May 26 and 27 to develop a work plan and research protocols for the project. Protocols for the project included plans for establishing locations for the IPM projects, conducting farmer surveys, identifying farmer participants and development of strategies for institutional capacity building and long-term training. Efforts were then focused on implementation of the research plan. We have identified research sites, conducted farmer surveys, identified farmer participants and initiated IPM research activities at sites within the participating three West African countries.

Identification of research sites for implementation of tomato IPM programs

Ghana

Bob Gilbertson/UC-Davis, Michael Osei/CSIR-CRI

Three regions in Ghana were chosen for this project. These included the Ashanti, Brong Ahafo, and the Upper East regions. Two locations were established or selected in Ashanti and Brong Ahafo regions with three locations also selected in Upper East region. In the Ashanti region, Agogo and Akomadan were selected. Likewise, Tanoso and Tuobodom were selected for the Brong Ahafo region. Vea (Bongo district near Bolgatanga), Tono near Narvrongo and T.N.D, Pawlugu were also sites chosen for the project at Upper East regions. At each location selected, the Ministry of Food and Agriculture’s (MOFA) Director was contacted for Agriculture Extension Agents (AEAs) who already have contact with tomato growers in that locality. They were briefed with the project objectives, activities and expectations.

Mali

Bob Gilbertson, Moussa Noussourou

Four regions were chosen for this project. These included Segou, Sikasso, Mopti and Koulikoro with 20 villages and 200 farmers.

Surveys for tomato production practices, yields and disease and pest problems

Ghana

Bob Gilbertson, Michael Osei

Questionnaires were designed to elicit information from Farmers at the locations selected. Questionnaires have so far been administered in the Ashanti (Agogo and Akomadan) and Brong Ahafo (Tanoso and Tuobodom) regions only. At each location, 20 farmers were called or invited for the survey. The questions were most often translated to farmers in their local languages.

Mali

Bob Gilbertson, Moussa Noussourou

Surveys were conducted on tomato in Segou with 50 farmers in five villages (Garo Nalogo, Konobougou, Cinzana Village, and Dona). The results of these surveys indicated that on tomato diseases like leaf curl, viral infection and death of tomato plants (wilting) are most frequent. They are followed by insect damage caused by caterpillars that bore into the fruits of tomato.

Other constraints that were found included a scarcity of varieties adapted to the rainy season which prevents the cultivation of the tomato during the rainy season. Faced with these problems, farmers have no way to control the major pest problems because the chemicals they use are not effective.

In the region of Sikasso, surveys on tomato pests were conducted in the villages of Noumorilakôdé, Kaboïla, and Natchien Diomantènin with 50 farmers. Major pest problems that were identified in the order of priority: 1) bacterial wilt, 2) virus and 3) insects - caterpillars that bore fruit (*Helicoverpa*) and grasshopper (*Zonocerus variegates*). For control methods, the farmers indicate they use chemicals and wood ash sometimes without much success.

In the Mopti region, surveys were conducted in 8 villages with 50 farmers. The surveys indicated that the main pests on tomato in order of importance are fruit boring caterpillars, tomato virus, wilting and termites. Farmers use neem leaf extracts and wood ash for controlling tomato pests. In the region of Koulikoro, results of surveys conducted in the villages of Diago, Kati, Komits and Koro indicated that the main pests in tomato production are wilting and viral infection.

Sampling and Identification of Sweet Potato Whitefly biotypes

Mali

Carlyle Brewster, Moussa Noussourou

Spatiotemporal sampling of whitefly populations was conducted during the reporting period at two cropping areas (Baguienda and Kati) in Mali. This data, when combined with sampling data collected during the previous phase of the IPM CRSP project, gives us almost three years of data on whitefly population dynamics at the two cropping areas. Preliminary analyses of the complete data set show a consistent annual pattern of whitefly dynamics at both areas. Whitefly populations at the Baguienda site were always higher than at the Kati site. In addition, whitefly densities tended to be relatively low at both areas during mid-April to November, a period that corresponds to the time during which the host-free period is implemented at Baguienda.

Senegal

Carlyle Brewster, Kemo Badji

Spatiotemporal sampling of whitefly populations was conducted on 12 occasions during the reporting period at three cropping areas (Gorom, Mboro, and Kolda) in Senegal. Preliminary analyses of the complete data set show several things. Among these are that whiteflies are present (>3 immatures/ sq. cm of leaf) throughout the year on crops at all three sites, and the seasonal patterns of their dynamics vary unpredictably within or among the cropping areas.

Implementation of Tomato IPM Package: No host recommendations

Ghana

Bob Gilbertson, Michael Osei

Open pollinated and hybrid tomato seeds were received from the USA, Mali and AVRDC for varietal trials in Ghana. This was to select for tolerance or resistant lines to numerous tomato diseases such as TMV, TYLCV and nematodes among the rest for use in the main IPM package. Varietal trials were established during the rainy season at Afari near Kumasi and at Northern Ghana. This would be repeated in the dry season to select the best variety(ies) for the IPM Package.

Mali

Bob Gilbertson, Moussa Noussourou

The tomato IPM package development included coverage of the nursery stocks with the sailing screen and cleaning plots one month before transplanting. One month after transplanting, yellow traps were installed and weekly treatments with neem oil began. Fertilization was done with the compost "Profeba," and the soil was treated with lime.

In the Sikasso region, tests were carried out in the Kaboïla, Natchien, Kampiasso and Niena villages. The varieties tested included: Formosa, Estrella, C20-5, and Icrixina, SF83-61 (varieties adapted to the rainy season). In each village, the trial was conducted with 3 farmers. Nurseries were installed in Kaboïla, Natchien and Kampiasso and the seedlings were transplanted. Bacterial wilt was not very prevalent. Viral infection was observed in the varieties Formosa, C20-5 and was less on Icrixina. No cases of viral disease were detected in Kaboïla. Farmers preferred the variety Icrixina because of its earliness and its productivity.

In the Koulikoro region, tests on the IPM package for control of pests of tomato were initiated in four villages (Sonityeni, Diago, and Komitan Toniba). Nurseries were planted in early July 2010 and tomato plants transplanted in late July-early August 2010. The varieties used were: SF 83-61, Estrella, Formosa, Icrixina, C20-5 and Roma VF. Bacterial wilt was present in all villages but was much more pronounced in Toniba and Diago. Viral disease was more pronounced in Toniba. The local variety of tomato has been totally damaged by viral disease, more than most of the varieties tested. Varieties SF83-61 and C20-5 were preferred because of their early maturity and productivity.

At Sotuba, the varieties tested were: Roma VF, Estrella, Shasta, Nemadoro, Mamou, F1 Thorgal, Formosa, C20-5, Icrixina, SF83-61, H88-04 and Beef Heart. It was found that the Shasta Thorgal F1 and Roma VF suffered from bacterial wilt in areas where there was stagnant water. The variety Formosa was affected less by the viral disease than Estrella. From the point of view early maturity, varieties Estrella and SF 83-61 were the best, and for yield varieties Formosa, Icrixina, Shasta, Thorgal F1, C20-25 and SF 83-61 were most productive.

Survey of weeds

Ghana

Jim Westwood, Carlyle Brewster, Michael Osei

Initial weed surveys were done at Ashanti and Brong Ahafo regions. The following weed species were observed: *Ageratum conyzoides, Fleurya aestuans*, *Cyperus* spp.*, Bidens pilosa, Sida acuta, Eluesine indica, Celosia* spp.*, Spigelia anthelmia, Imperata cylindrical, Centrocema pubescens, Solanum torvum, Panicum maximum*, *Commelina* spp.*, Talinum triangulaire,, Rottboellia cochinchinensis .*, *Euphorbia heterophylla, Tridax procumbens, Setaria* spp.*,* and *Euphorbia hirta.*

Selection of sites for implementation of potato IPM package

Mali

Sally Miller, Bob Gilbertson, Seriba Katile

The survey was conducted in three regions (Sikasso, Mopti and Koulikoro) with 15 villages and 150 farmers.

Surveys of potato production practices, yields and Pests

Mali

Sally Miller, Bob Gilbertson, George Mbata, Seriba Katile

In the Sikasso region, surveys on potato production were conducted in the villages of Noumorilakôdé, Kaboïla, and Natchien Diomantènin with 50 farmers. The results of the surveys indicated the major pests in order of priority were: rotting of potato tubers during storage, the blackening of the meat, and potato blight. The farmers indicated that they have no solutions to control these problems.

In the Koulikoro region (Diago, Komita and Koro), phytosanitary constraints on potato production identified from the surveys were bacterial wilt, tuber worm, mildew and rotting of tubers during storage. Farmers indicated that they sometimes apply chemical to control the pest problems, but have little effect.

In the Mopti region, surveys were conducted in 14 villages in 50 farmers including 18 women. In this region, phytosanitary problems associated with potato production are: priority larvae that attack the tubers, locusts that attack foliage, mildew and bacterial wilt. Farmers use neem extracts and wood ash to control some of the pests.

Surveys for potato production practices and pests

Mali

Doug Pfeiffer, Kadidiatou Gamby, Issoufou Kollo

In the Sikasso region, surveys on cabbage production conducted in Noumorilakôdé, Kaboïla, and Natchien Diomantènin villages included 50 farmers. The survey information obtained indicated that the main pests were bugs, diamondback moth and cabbage webworm of cabbage plants. For control of caterpillars, farmers apply pyrethroid insecticides.

In the Koulikoro region (Diago, Komitas and Koro), pest problems were caterpillars, aphids and diseases that cause root rot. The farmers surveyed indicate that they apply chemicals 5 to 6 times per season.

IPM CRSP South Asia Regional Program

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Summary

In Bangladesh, IPM packages developed for tomato, eggplant, okra, bitter melon, cucumber, cabbage and country bean were field tested and validated. Several vegetable varieties were screened for resistance to insect, fungal, bacterial, viral and nematode pests. Enhanced efforts were made to popularize the use of *Trichoderma,* and insect parasitoids and pheromone traps for control of fungal and insect pests, respectively. A baseline survey was carried out in three vegetable growing districts, Jessore, Narsingdi and Bogra, with a total of 300 farmers. In India at the Tamil Nadu Agricultural University, IPM packages of tomato, okra, eggplant and onion were field tested. The onion IPM package was demonstrated in different districts of the Tamil Nadu state. Information on IPM was disseminated by organizing field days, exhibitions, demonstrations, and training sessions. For mass media communications, government radio and TV channels, and newspapers were utilized to reach the public. The Energy and Resources Institute conducted tomato, eggplant, okra, and cucurbit IPM field demonstrations in Uttar Pradesh, Andhra Pradesh and Karnataka states. Out of a total of 51 field trials, 29 were conducted in Uttar Pradesh and 22 in Andhra Pradesh and Karnataka. Mass media covered most of the field days conducted to demonstrate the IPM packages especially in Uttar Pradesh. In Nepal, experiments were conducted with several biopesticides and biofertilizers for the development of IPM packages for tomato, cucurbits, coffee and tea.

Bangladesh

Evaluation of eggplant germplasm for resistance to fruit and shoot borer, red spider mites and jassids

S. Ahmad, M. A. Rahman, M. S. Nahar, A. K. M. Khorsheduzzaman, J. Chowdhury, L. Yasmin, M. Afroz, A.N.M.R. Karim

Selected eggplant lines were evaluated against fruit and shoot borer (FSB) under conditions of natural infestations without any pest control measures. Twelve promising eggplant lines that were selected last year were planted in three replications in unit plots of 10 x 1 meter using a 12 x 12 Latin Square design. Data were recorded on fruit yields and on infestations of jassids, red spider mites and FSB at appropriate stages of plant growth. Among the twelve test lines, SM-020, BARI Begun-7, and SM-183 suffered no damage of FSB, but fruit yield of SM-183 was extremely poor. Moderate jassid infestations were observed on all the entries, except on SM-011 and SM-191 lines that suffered no leaf burn, but the fruit yield of SM-011 was very poor. All the test lines were free from red spider mite infestation except SM-011 that suffered 44.4% infestation. Based on overall results, the lines SM-182, SM-191 and SM-020 were selected for further tests as source materials for developing improved eggplant varieties.

Evaluation of eggplant and tomato lines against Bacterial Wilt (BW)

Twenty eggplant lines were evaluated during the winter season in BW sickbeds using a completely randomized design with three replications. Each replication contained 10 seedlings of the test lines planted in one-meter rows with 30 cm spacing between plants and 50 cm spacing between rows. Records of wilted plants due to BW infection were recorded every week. Among 20 test entries, EGN-0027 showed resistant reaction (17% wilting) and SM-0011, SM-0012, SM-0058 and SM-0187 moderate resistant reactions (23% to 40% wilting). These materials were selected as sources of resistance for developing BW-resistant eggplants.

Sixteen tomato lines were tested in three replications in BW sickbeds during the winter season. Ten one-month old tomato seedlings were planted in a one-meter row with 30 cm spacing between plants and 50 cm distance between rows. Each row served as a replication. Data on wilted plants due to BW infection was recorded every week. Among the test lines, none exhibited resistance except the line F1-4 which was moderately resistant, showing 30% wilted plants.

Evaluation of eggplant lines against RKN

Nineteen eggplant lines were evaluated against RKN in sickbeds during the winter season. One-month old eggplant seedlings were planted in RKN sickbeds in two replications with 20 cm spacing between plants and 30 cm between rows. After 45 days of planting, the plants were uprooted and washed in running water to examine and grade the galls in the root system on a 0 to 10 scale, with 0 representing no gall (highly resistant) and 10 signifying severe galling (highly susceptible). Among 19 test entries, two (SM-0011 & SM-0179) showed resistant reaction (galling index of 1.0) and seven entries (EGN-0017, SM-0018, SM-0020, SM-00183, SM-00185, SM-00187 & SM-0021) were moderately resistant having galling index of 1.25 to 1.5. These materials were selected for using them as sources of RKN resistance in developing improved eggplant varieties.

Development of cucumber varieties resistant to virus diseases

M. A. Hoque, G. M. A. Halim, A. Muqit, M. S. Hossain, M. Nazim Uddin, A.N.M.R. Karim

Attacks by a complex of viruses, such as *Water melon mosaic virus* (WMV), *Cucumber green mottle mosaic virus* (CGMV), and *Papaya ring spot virus* (PRSV), are the major causes of huge yield losses to cucumber (*Cucumis sativas*). Six cucumber lines that were selected last year having various degrees of virus resistance were retested along with two commercial varieties under natural field conditions at Gazipur during 2010 summer season. Twenty-day old seedlings were transplanted in unit plots of 7.5m x 1m at 1.5m spacing between plants using RCB design with three replications. Standard cultural practices were applied without taking any measure for pest control. Data were recorded on pest and disease incidence, fruit characteristics, fruit weight, fruits per plant, and yield. All the test lines were superior to the commercial varieties (Baromashi and Shila) with respect to virus infestation and insects, fruit characteristics, and fruit yield. Among the lines, CS-0079 and CS-0080 suffered lower virus infection and produced higher number of fruits per plant and higher yield, and they were selected for testing them in “advanced yield trials” in order to propose them as varieties.

The selected two lines of CS-0079 and CS-0080 along with two commercial varieties of 'Baromashi' and 'Shila' were planted at HRC-BARI farm, Gazipur in an RCB design with 3 replications. Standard cultural operations were carried out without taking any pest control measures. Data were taken on infestations of

Table 1. Performance of CS-0079 and CS-0080 cucumber lines against virus disease and yields

Variety/line	Virus incidence (%)	Infestation of leaf feeders (%)	White fly infestation (%)	Fruits per plant (No.)	Fruit yield (t/ha)
CS-0079	26	7.1	6.2	12.7	22.3
CS-0080	20	5.3	4.3	14.1	25.4
Baromashi	33	8.9	5.3	10.7	12.6
Shila	40	7.2	8.5	5.8	11.0

pest insects and virus disease, fruits per plant, and fruit yield. Results of the experiment confirmed that the test lines (CS-0079 and CS-0080) were better than the commercial varieties having lower virus infection (20% to 26% as compared to 33% to 40% of the commercial varieties), and produced twice the yield that commercial varieties did (Table 1). Among these two lines, however, CS-0080 was selected for release because of its better agronomic traits and resistance to virus and other pests.

Evaluation of okra germplasm for resistance to Bhendi yellow vein mosaic virus

M. A. Hoque, S. Ahmad, M. Saifullah, S. R. Mollik, and M. A. Rahman

Bhendi yellow vein mosaic virus is the most damaging disease of okra in Bangladesh. An on-station replicated trial was conducted at BARI farm, Gazipur, during 2010 summer season with five okra lines selected from last year's trial. Pest control measures were avoided in order to induce natural infestation of the YVMV white fly vector (*Bemicia tabaci*). Weekly records of virus infection were taken until final harvest. Agronomic data on fruit size, fruit weight, fruits per plant and yields were recorded. Selfing of the virus-resistant plants was done to prevent out-crossing as well as to maintain the genotypic feature of the plant.

All the test lines were superior to BARI Dherosh-1, a recommended okra variety used as a control with respect to yield and virus infection. As compared to 10% virus infection on BARI Dherosh-1, no virus infection was observed on the five test entries (OK-0137, OK-0146, OK-0147, OK-0212, OK-018) when they were 45 days old. After 65 days of planting, BARI Dherosh-1 suffered 30% virus infection as compared to 5% to 22 % on the test entries. But, at 95 days after planting, virus infection was as high as 95% on BARI Dherosh-1 as compared to 58% to 80% on the test entries; the lowest (58%) was observed on OK-018, followed by 62% on OK-0212. Fruit yields of the test lines were also 59% to 85% (15.8 to 18.4 t/ha) higher than that of BARI Dherosh-1 (9.9 t/ha); OK-018 and OK-0212 lines significantly out-yielded all other test lines. Based on the results of lower virus infection and fruit yields, OK-018 and OK-0212 were selected for purification and confirmation of the results.

Development of country bean varieties resistant to pod borer and virus diseases

M. A. Hoque, G. M. A. Halim, A. Muquit, M. S. Hossain, and A. N. M. R. Karim

Production of country bean, *Dolichos lablab*, is seriously constrained due to the attacks of pod borer (*Maruca vitrata*) and *Yellow vein mosaic virus* symptoms. Several moderately resistant country bean lines have been identified through evaluations of available germplasm over the last few years. During 2009-2010 winter season, five country bean lines that were selected last year as promising ones were tested under natural infestation condition in the field of BARI farm, Gazipur, along with a recommended variety 'BARI Sheem-1' as a check. The test lines were planted one meter apart in unit plots of 6m x 1m in three replications using a RCB design. Standard cultural practices were adopted without taking any pest control measure. Data were recorded on pest and virus incidence, agronomic characteristics and yield.

Incidence of pest insects and virus disease was moderate. Among the five test lines, CB-0029 suffered moderate infestations of pod borer and aphid and virus infection. On the other hand, CB- 0223 and CB-0230 had lower virus infection, but were moderately susceptible to pod borer and aphid. In terms of yield and other agronomic characteristics, however, CB-0009, CB-0203, CB-0230 performed better than others. All these lines need to be retested next year to confirm their performance for yields and reactions to pests and virus disease.

Development of IPM packages for country bean, cabbage and tomato

S. N. Alam, N. K. Dutta, Akhtaruzzaman Sarker, and A.N.M.R. Karim

Pest damage is a serious constraint for satisfactory production of country bean, cabbage and tomato. The most damaging pests are pod borers (*M. vitrata* and *Helicoverpa armigera*) and aphids in country bean; diamond back moth (*Plutella xylostella*) and armyworm (*Spodoptera litura*) in cabbage; and fruit borer (*H. armigera*) and white fly transmitted *Tomato leaf curl virus* ((TLCV) in tomato. Trials were continued at BARI farm, Gazipur, to develop suitable IPM packages for the above crops.

Country bean: The country bean plants were raised in plots of 20m x 20m in three replications using an RCB design. There were three treatments consisting of two IPM practices and farmer practice as follows: T_{1}= IPM package consisting of (a) manual destruction pest-infested flowers and pods at alternate days, (b) weekly release of egg parasitoid, *Trichogramma evanescens*, at the rate of 1g parasitised eggs/ha/week and larval parasitoid, *Bracon hebetor*, at the rate of 800-1000 adults/ha/week and (c) spraying soap water (5g/liter of water) during initial aphid infestation; T_{2}= weekly release of bio-control agents as described in treatment-1; and T_{3}= farmers' practice of application of pyrethroid insecticide (Cymbus 10EC) at the rate of 1ml/liter of water every three days. The IPM and non-IPM (farmers' practice of pesticide use) were separated by about 200m. Data were taken on healthy and infested flowers and pods by borers and aphids, pest management cost and yield.

The IPM package (treatment-1) performed significantly better in controlling the pests as well as producing higher yields as compared to that of releasing bio-control agents only (treatment-2) and farmers' practice of pesticide applications (treatment-3). As compared to farmers' practice, the use of IPM package reduced flower infestation by 85% and pod borer infestations by 94% and aphid infestation by 87%, thereby increasing the yield 2.3 times higher and reducing the pest management cost by 43%. Release of bio-control agents only (treatment-2) was effective in controlling the pests and producing higher yields than the farmers' practice, but it was not comparable to the IPM package (Table 2). Similar results were obtained in the past three years, confirming that country bean can be successfully grown by adopting an IPM package practices without pesticides.

Table 2. Performance of IPM and non-IPM practices in controlling pests on country beans at BARI Farm, Gazipur; winter season 2009-2010

Treatment	Flower infestation by borer (%)	Pod infestation by borer (%)	Flower infestation by aphid (%)	Cost of pest management (Tk/ha)	Yield (t/ha)
IPM package	3.2±0.9a	1.4±0.4a	2.5±0.2a	12,500	18.6±1.9b
Release of bio-control agent only	6.4±1.3b	7.8±0.9b	8.9±1.7b	6,500	14.3±1.5b
Farmers' practice	21.3±2.1c	25.4±2.6c	19.4±2.7c	22,000	7.9±0.7a

(b) Trial for cabbage: In order to ensure optimum pest infestations, three experiments were carried out by planting cabbage at the following three different times during the winter season of 2009-2010: (a) First planting on November 8, 2009 (early winter) and harvesting on January 20, 2010; (b) second planting on December 12, 2009 (mid-winter) and harvesting on March 15, 2010; and (c) Third planting on January 7, 2010 (late winter) and harvesting on April 19, 2010. The cabbage seedlings were planted in plots of 10m x 10m, keeping a distance of 200m between IPM and non-IPM (farmers' practice) plots. The following three treatments were laid out in RCB design with three replications: T_1= weekly release of egg parasitoid, *T. chilonis*, at the rate of 1g parasitized eggs/ha/week and larval parasitoid, *B. hebetor*, at the rate of 880-1000 adults/ha/week and spraying of Bt suspension at the rate 4g/liter of water; T_2= weekly release of egg parasitoid, *T. chilonis*, at the rate of 1g parasitized eggs/ha/week and larval parasitoid, *B. hebetor*, at the rate of 880-1000 adults/ha/week and spraying of Spinosad (Tracer 45SC) suspension at the rate of 4g/10 liter of water; and Farmers' practice of spraying pyrethroid insecticide (Cymbush 10EC) at the rate of 1ml/liter of water every three days. Records were taken on pest infestations, number of caterpillars of diamond back moth (DBM) and armyworm (*S. litura*) infesting cabbage heads and yields.

Wide differences in the incidence of DBM and armyworm were observed on the cabbage plants planted at three different times. Irrespective of treatments, cabbage plants grown during the early winter season (planted on November 8, 2009) were completely free from infestation of DBM and armyworm, resulting in no variation in yields among the treatments. Moderate pest infestations were observed in cabbage plants grown during mid-winter period (planted on December 12, 2009). Highest infestation of 17.1% was recorded in the treatment of farmers' practice (applications of pyrethroid insecticide), followed by 2.4% in treatment-2 (release of parasitoids + application of Spinosad insecticide). No cabbage head was infested in treatment-1 (release of parasitoids + application of Bt). Plots receiving IPM treatments, therefore, produced 15% to 20% higher yields than that of farmers' practice. The cabbage crop grown during the late winter period (planted on January 7, 2010) suffered severe pest infestations. All the cabbage plants in the treatment of farmers' practice (pesticide applications) were totally damaged by the

Table 3. Performance of IPM practices in controlling pests of cabbage grown during early winter (November 2009 to January 2010) BARI farm, Gazipur

Treatments	Cabbage infested (%)	DBM larvae per cabbage head (No.)	Armyworm per cabbage head (No.)	Marketable yield (t/ha)
	Early winter	Early winter	Early winter	Early winter
T_1=Release of parasitoids + application of Bt suspension	0.0a	0.0	0.0a	44.8a
T_2= Release of parasitoids + application of Spinosad suspension	2.4±0.9b	0.0	0.1±0.5b	43.2a
T_3= Farmers' practice of pesticide application	17.1±0.6c	1.3±0.3	1.2±0.7c	37.4b

pests, resulting in no harvest of marketable cabbage heads. On the other hand, plots receiving IPM treatments suffered only 4.1% to 5.5% pest infestation, resulting in satisfactory yields of 24.3 to 22.6t/ha (Table 3).

Tomato: Two treatments, one consisting of an IPM package and the other of farmers' practice, were laid out in three replications in plots of 15m x 15m using a RCB design. IPM treated plots were separated from the non-IPM plots (farmers' practice) by about 200m. The IPM package treatments consisted of (a) planting of TLCV-resistant tomato line TLB-182; (b) manual destruction of pest-infested fruits; (c) weekly release of egg parasitoid, *T. evanescens*, at the rate of 1g parasitized eggs/ha/ week and weekly release larval parasitoid, *B. hebetor*, at the rate of 800-1000 adults/ha/week; and (d) use of *Helicoverpa* pheromone bait trap at 10m apart. The treatment of farmers' practice consisted of planting of TLCV-susceptible tomato ((variety BARI Tomato-2) and spraying of synthetic pyrethroid insecticide (Cymbush 10EC) at the 1ml per liter of water every three day days. Data were recorded on white fly numbers, virus incidence, fruit borer infestations, yields and pest management costs.

Compared to farmers' practice that consisted of pesticide applications only, the use of IPM package was highly effective in reducing the

Table 4. Performance of IPM package in controlling pests in tomato production; BARI farm, Gazipur, Winter Season 2009-2010

Treatment	Borer infestation (%)	White fly per leaf (No.)	Virus infected plants (%)	Pest management cost (Tk/ha)	Yield (t/ha)
IPM package	2.0±0.6b	0.5±0.3b	8.8±1.1b	10,000	48.6±0.7b
Farmers' practice-use of pesticides	11.8±1.2a	3.4±0.7a	74.3±4.7a	21,000	33.9±0.9a

infestations of fruit borer by 83%, white fly by 84% and virus infection by 88%. As a result, plots receiving IPM treatments produced 43% higher yield and the pest management cost was half as that of farmers' practice (Table 4). The results including those of the past years confirm that pesticide-free tomato crops can be profitably produced by deploying IPM practices that will improve tomato production as well as farmers' economic gains.

Performance of an IPM package for bitter gourd controlling fruit fly and borer pests

M. Yousuf Mian, S. N. Alam, M. A. Sarker, M. Ishakul Islam, and A.N.M.R. Karim

Cucurbit fruit fly (*Bactrocera cucurbitae*) is the most damaging pest of bitter gourd. In recent years, however, caterpillars of *S.litura* and *S. exigua* and one of *Palpita* (*Diaphania*) *indica* (pumpkin caterpillar) have become major pests causing considerable yield losses. A trial was conducted in farmer's field in Bagharpara upazila of Jessore district to compare and confirm the performance of an IPM package with that of farmer practice that consisted solely of pesticide use every 2-3 days. The treatments of the IPM package consisted of (a) manual destruction of pest-infested fruits every week; (b) use of cuelure pheromone bait trap; and (c) weekly release of egg parasitoid *T. evanescens* at the rate of 1g of parasitized eggs/week/ha and weekly release of larval parasitoid *B. hebetor* at the rate of 1000-1200 adults/week/ha. The treatments were laid out in RCB design with four replications. Records were taken on infestations of fruit fly and borers, pest management costs and fruit yields.

The results of the use of IPM package confirmed those of previous years producing excellent performance in reducing the infestations of fruit fly by 89% and that of borers by 85%. As a result, plots receiving IPM package treatments produced 1.5 times higher yield than that of farmer's practice which was 2.8 times more costly for controlling the pests (Table 5). The results again showed that healthy bitter gourd crops can be profitably grown by adopting IPM practices without relying on pesticide use.

Efficacy tests of Tricho-compost and Tricho-leachate for controlling soil-borne diseases and production of some vegetable crops

M. A. Rahman, M. S. Nahar, L. Yasmin, Mafruha Afroz, and A.N.M.R. Karim

A series of trials were conducted to evaluate the performance of Tricho-compost and Tricho-leachate in controlling soil-borne diseases in lady's finger, stem amaranth and cabbage crops, and to determine the optimum dose of application of Tricho-compost in eggplant, tomato and cabbage crops. Production of Tricho-compost was prepared mixing *Trichoderma harzianum* spore suspension (3 x 10^7 cfu/ml) with definite proportions of decomposed cow dung, decomposed poultry refuse, water hyacinth, vegetable waste, sawdust, ash, maize bran, and molasses at different layers inside a brick-built open top house. The finished product of Tricho-compost

Table 5. Performance of IPM package in controlling fruit fly and borers and its effects on production of cucurbit crop

Treatment	Fruit fly infestation (%)	Borer infestation (%)	Pest management cost (Tk/ha)	Yield (t/ha)
IPM package	2.8±0.4a	4.8±0.8a	12,000	33.7±0.7a
Farmer's practice- use of pesticide	25.4±2.4b	31.7±1.9b	34,000	22.4±0.9b

was available after 6-7 weeks of decomposition. The excess amount of liquid produced during decomposition of Tricho-compost, termed as Tricho-leachate, is also rich in various nutrients and *Trichoderma* spore population. Both Tricho-compost and leachate are effective to control soil-borne disease pathogens and add nutrients to the soil. The following trials were conducted with the Tricho products.

(a). Performance of Tricho-compost in controlling soil-borne diseases and production of okra and stem amaranth: Separate experiments on okra (variety BARI Dherosh-1) and stem amaranth (variety BARI Danta-1) were carried out at HRC-BARI farm with two treatments: (a) use of Tricho-compost at the rate of 3t/ha plus half the amount of recommended dose of chemical fertilizers, and ((b) a control using recommended amount of decomposed cow dung. Using unit plots of 12 sq. meters (4m x 3m), the treatments were laid out in four replications using a paired plot design. The average initial population of root-knot nematode (RKN- *Meloidogyne* spp.) in the experimental plots was two larvae per one gm of soil. Data on RKN infestation in the roots were graded on a scale of 0 to 10, where 0 denotes no visible root galling and 10 represents severe galling. Application of Tricho-compost significantly reduced RKN infestation by 52.2% in okra and 18.7% in stem amaranth. Seedling mortalities also decreased significantly in both the crops. Similarly, Tricho-compost application increased the yields of both crops with 44% yield increase in okra and 52.2% in stem amaranth.

(b). Performance of Tricho-compost and Tricho-leachate in controlling soil-borne diseases in cabbage seedling production: Separate experiments were conducted in tin trays, measuring 75cm x 50cm x 30cm, and in seedbed nursery to determine the effects of Tricho-compost and Tricho-leachate in controlling soil-borne diseases for cabbage seedling production. In tin trays, the effects of Tricho-compost applied at the rate of 50gm/Kg of soil and Tricho-leachate applied at the rate of 50ml/Kg of soil were compared with a control treatment of cow dung applied at the rate of 200gm/Kg of soil. Each treatment was replicated four times. Before adding the treatments, the soils of the tin trays were inoculated with *Sclerotium rolfsii* fungus grown in rice husk at the rate of 20gm/Kg of soil, and the treatments of Tricho-products were applied to the soil 15 days before sowing the cabbage seeds. Data were taken on disease incidence, seedling mortality and seedling weight (fresh).

In the seedbed nursery, Tricho-compost was tested at two rates of application, 5t/ha and 7t/ha, to compare their effects for cabbage seedling production with a control treatment of cow dung applied at 5t/ha. The five treatments were laid out in randomized complete block design with three replications, each measuring 3 square meters (3m x 1 m). The soils of the seedbed nurseries were inoculated artificially with *Sclerotium rolfsii* fungus before adding the treatments. Cabbage seeds were sown 15 days after applying the treatments. Data were taken on seedling germination, plant mortality and seedling growth as observed from seedling weight (fresh weight).

The results of both the experiments carried out in tin trays and in seedbed nurseries showed that applications of Tricho-compost and Tricho-leachate are highly effective in controlling soil-borne pathogens, such as *S. rolfsii,* as reflected from much lower plant mortalities. In tin trays, Tricho-compost and Tricho-leachate reduced plant mortalities by 86% and 91%, respectively. These treatments did not however affect plant growth probably due to lower rates of application. On the other hand, Tricho-compost application in the seedbed nursery was highly effective in producing higher germination of seedlings (71% to 74% higher germination), reduced plant mortalities (86% to 91% lower) and better seedling growth as measured by seedling weight (57% to 62% heavier seedling weight). These results suggest that Tricho-compost and Tricho-leachate can be used profitably to produce cabbage seedlings without the use of chemical fertilizers and pesticides.

(c) Standardization of application rates of Tricho-compost for controlling soil-borne disease pathogens and production of eggplant, tomato and cabbage: Replicated trials were carried out separately on eggplant, tomato and cabbage crops to determine the optimum rates of application of Tricho-compost in field plantings. The experiments were conducted at HRC-BARI farm during the winter season with the following treatments: (a) Tricho-compost at the rate of 100gm/plant plus half the recommended dose of chemical fertilizer; (b) Tricho-compost at the rate of 150gm/plant plus half the recommended dose of chemical fertilizer; (c) Tricho-compost at the rate of 200gm/plant plus half the recommended dose of chemical fertilizer; and (d) a control treatment with only full dose of recommended fertilizers. The initial population of RKN was two larvae per 1gm of soil. The treatments were laid out in RCB design with three replications. Data were recorded on RKN infestation, plant mortalities and yields.

Results of the tomato trial showed that applications at all the rates of Tricho-compost reduced RKN infestation significantly by 46% to 63%, and increased the yields by 16.4% to 25.3%. Similar results were obtained for eggplant and cabbage crops, reducing RKN infestations by 29% to 50% in eggplant and by 50% to 65% in cabbage. The yield increase ranged from 22.5% to 35.6% in eggplant and 45% to 56% in cabbage. In all the experiments of the three crops, however, Tricho-compost applied at 200gm/plant produced the best results.

Study of nematode trophic groups in IPM and non-IPM systems

M. A. Rahman, M. S. Nahar, and A.N.M.R. Karim

Nematodes are broadly classified in to (a) Plant parasitic nematodes that feed on plants are harmful for agricultural crops; (b) Microbivorous and bacteria-feeding nematode, which feed on fungi, bacteria and various decayed products, are beneficial for plants; and (c) Carnivorous or predatory nematodes which are also considered beneficial as they feed on other nematodes and small animals. Earlier studies showed that fields or plots cultivated with IPM approach of organic soil amendments had increased numbers of beneficial nematodes and decreased the number of plant feeding nematodes.

In order to confirm the results of earlier trials, soils amended with various doses of Tricho-compost for growing cabbage, tomato and eggplant crops were examined for the presence of nematodes. Tricho-compost is an organic fertilizer fortified with a fungal bio-control strain of *T. harzianum*. The control plots received recommended doses of chemical fertilizers. Ten soil samples were collected from each treatment of each crop, and extraction, identification and counting of nematodes were performed by using standard procedures.

In tomato crop, Tricho-compost applications at different doses reduced the populations of harmful nematodes by 34% to 67% and increased the populations of beneficial nematodes 2 to 2.7 times more than that of the control plot (treated with chemical fertilizers). Similar results were obtained from eggplant and cabbage crops reducing the harmful nematodes by 31% to 71% and increasing the beneficial nematodes by 35% to 126%. Averaging for the three crops, Tricho-compost application reduced the harmful nematodes by 39% (range 32% - 52%) when applied at 100g per plant (about 2.5t/ha); by 63% (range60% - 66%) when applied at 150g per plant (about

Table 6. Applications of Tricho-compost in Tomato, eggplant and cabbage crops on the population of nematodes

Treatment	Plant-feeding nematode (No.) per 10g of soil			Bacteria-feeding nematode (No.) per 10g of soil		
	Tomato	Eggplant	Cabbage	Tomato	Eggplant	Cabbage
Tricho-compost at 100g/plant	19.7b	26.3b	15.0b	229.0b	179.3b	231.3c
Tricho-compost at 150g/plant	11.3c	15.7c	10.7b	262.7ab	268.3a	291.3b
Tricho-compost at 200g/plant	10.0c	10.3d	9.0b	295.0a	273.3a	327.0a
Control- use of chemical fertilizers	29.7a	39.0a	31.0a	109.3c	132.3c	144.7c

3.75t/ha); and by 71% (range 67% - 74%) when applied at 200g per plant (about 5t/ha). On the other hand, populations of beneficial nematodes increased by 68% (range 35% - 109%) when Tricho-compost was applied at 100g per plant; by 114% (range 101% - 140%) at application rate of 150g per plant; and by 134% (range 106% - 170%) at application rate of 200g per plant (Table 6). The increase in the numbers of fungal feeder, omnivore and predatory nematodes in the Tricho-compost treated plots was, however, marginal indicating that these nematodes probably required richer substrates for their nutrition and growth. The results conform to those of the earlier studies confirming that IPM practices with organic soil amendments will enrich the soils with higher abundance of beneficial nematodes, which will eventually protect the crop plants from the attack of harmful nematodes and animals, and help produce better crops with higher yields.

Mass production of egg and larval parasitoids and predators

S. N. Alam, M. A. Sarker, M. Nabi, and A.N.M.R. Karim

Earlier studies showed that the populations of different parasitoids which are available in vegetable fields could increase three-fold, if pesticide applications were withheld or avoided for a year. Biological controls being a fundamental tool of IPM system studies were carried out to develop techniques for mass rearing of egg and larval parasitoids (*Trichogramma* spp. and *B. hebetor*) and lady bird beetle for their use in controlling various vegetable pests.

(a) Mass rearing of egg parasitoid, *T. chilonis*, on *Sitotroga cerealella* eggs: Five Kg of wheat grains, soaked for 2-3 minutes in boiling water, were spread in equal quantities (2.5kg) over two tin trays (60cm x 50cm x 10cm) and 1g of *S. cerealella* eggs was scattered on the grains and kept undisturbed for 5-6 days. In order to conserve moisture for hatching and development of larvae, an adequate amount of water was mixed with the grains by gentle stirring. After 22-25 days, the tin trays containing the infested wheat grains with *S. cerealella* larvae were transferred to a mass-rearing chamber for adult emergence. Thousands of the emerged adults were collected from the mass-rearing chamber and released in a big cylindrical glass jar, the mouth being covered with a fine 32-mesh net. After mating, the eggs that were laid by the adults on the walls of the cylindrical jar were collected after sieving and cleaning.

Five grams of fresh eggs of *S. cerealella*, taken in a long glass cylinder which was moistened by keeping it for few minutes in a freezer, were rolled so as to make the eggs cling to the inside wall of the cylinder. Then a vial containing 1g of eggs parasitized by *T. chilonis* was put in the glass cylinder and kept under a fluorescent light at 25±2^{0}C. After 9-11 days, all the eggs of *S. cerealella* were parasitized. By following this procedure, thousands of *S. cerealella* eggs parasitized by *T. chilonis* were produced at regular intervals. The parasitized eggs were preserved at 3-4^{0}C and 75-80% RH for 1-1.5 months for using them in different experiments.

(b) Mass rearing of larval parasitoid, *Bracon hebetor*: Larvae of wax moth (*Galleria melonella*) were used as the host of *B. hebetor*. A parent stock of wax moth was first developed in honeycomb placed inside a glass jar. First to second instar larvae of wax moth were reared on an artificial diet prepared by mixing measured amounts of wheat flour, maize flour, milk, animal fat, sugar and yeast. The artificial diet was sterilized in an autoclave putting it at 125^{0}C and 1.5PSI for 70 minutes. Two hundred full grown larvae of the wax moth (takes 18-20 days to develop fully) were then transferred in to a plastic jar containing a corrugated paper sheet, and the larvae slowly settled in the furrows of the corrugated sheet for pupation. Forty adults (30 female and 10 male) of *B.hebetor* were then released within the plastic jar for 8-10 days for egg laying, pupation and adult emergence through parasitizing the wax moth larvae. The mouth of the jar was closed with a piece of black cloth after providing a honey cube inside the jar as food for the adults of *B. hebetor*. The adults of *B. hebetor* parasitized all the larvae of the wax moth in 8-9 days (Avg. 8.8 days). The number of adults of *B. hebetor* emerging from 200 larvae of wax moth averaged 960 (range 888-1025) and the adults lived for about 24 days. This procedure of mass-rearing was followed to produce hundreds of adults of *B. hebetor* at different batches, and thereafter, they were used for controlling the pests in different experiments.

(c) Development of a protocol for mass rearing of lady bird beetle, *Monochilus sexmaculatus*: The work of mass rearing of lady bird beetle (LBB) was carried out simultaneously both at the entomology greenhouse of BARI and the Ispahani Biotech laboratory (IBT) in Konabari of Gazipur from December 2009 to June 2010. A separate set of mass rearing was maintained under natural conditions. Mass rearing of LBB was done by releasing a pair of newly hatched larvae of LBB on an adequate number of 3-day old eggs of *S. cerealella* taken in a petri dish and the LBB larvae were allowed to feed on the eggs to complete its life cycle. This procedure was followed in several batches from egg to adult stages to record various growth periods of LBB.

The growth periods and life cycle parameters were similar for the LBB when reared at BARI and IBT laboratories, but differed when they were reared under natural condition. The maximum number of eggs laid by a female LBB at BARI and IBT ranged from 250-300 compared to 1000 under natural condition. Similarly, the larval period ranged from 10-15 days under laboratory conditions as against 15-30 days under natural conditions. The LBB also lived for a much longer period (60-90 days) under natural conditions as compared to 45-55 days under laboratory conditions. Although the overall growth of LBB was observed to be satisfactory under laboratory conditions, as much as 26.7% loss in body weights of adult LLB was observed when reared for successive generations. This indicated that LBB should be reared with diversified mixed food items and the populations need to be replenished periodically to avoid inbred depression.

Demonstration trial of IPM package for production of cabbage in farmer's field

M. A. Rahman, M. S. Nahar, M. A. Sarker, Mafruha Afroz, and A.N.M.R. Karim

In Bangladesh, cabbage production is seriously constrained due to the damage of the leaf-eating caterpillars of *S. litura* and diamond back moth. In addition, attacks of soil-borne fungal pathogens of *Pythium*, *Sclerotium* and *Phytopthera* species and root-knot nematode also cause considerable yield losses. In an effort to protect the cabbage crops from pest damage, the farmers rely solely on frequent applications of various kinds of pesticides without achieving any satisfactory control of the pests. IPM package consisting of several IPM practices have been found to effectively control these pests and produce better and healthy crops. A demonstration trial was therefore established in farmer's field in Gokulmerpara village in Bogra to determine the performance of the IPM package.

Seedlings of 'summer warrior' cabbage variety were raised using the following three soil amendment treatments: T_1= Incorporation of Tricho-compost at the rate of 1.5t/ha; T_2= Incorporation of Tricho-compost at the rate of 1.0t/ha; and T_3= Farmers' practice of incorporation cow dung at the rate of 5t/ha + use TSP fertilizer at the rate of 100Kg/ha. After 30 days of seedling growth, data were recorded on different aspects of seedling growth, such as (a) Number of seedlings per square meter; (b) Seedling mortality; (c) Shoot height; and (d) shoot weight. One-month old seedlings were then transplanted in 3 replications using a RCB design having the following four treatments: T_1= Incorporation of Tricho-compost at the rate of 1.5t/ha + ¾th of the recommended dose of $NPKSZ_nBM_o$ + use of pheromone baiting for *S. litura* + release of egg and larval parasitoids + destruction of leaf-eating caterpillars by hand-picking; T_2= Incorporation of Tricho-compost at the rate of 2.5t/ha + ¾th of the recommended dose of $NPKSZ_nBM_o$ + use of pheromone baiting for *S. litura* + release of egg and larval parasitoids + destruction of leaf-eating caterpillars by hand-picking; T_3= Incorporation of Tricho-compost at the rate of 3.5t/ha + ¾th of the recommended dose of $NPKSZ_nBM_o$ + use of pheromone baiting for *S. litura* + release of egg and larval parasitoids + destruction of leaf-eating caterpillars by hand-picking; and T_4= Incorporation of recommended full dose of $NPKSZ_nBM_o$ (control).

Results of the effects of soil amendments on seedling growth showed that incorporation of Tricho-compost at both rates of 1.0t/ha and 1.5t/ha were highly effective in reducing seedling mortalities caused by various soil-borne disease pathogens and produced healthier and stronger cabbage seedlings. Presently, the demonstration trial is on-going and is expected to be terminated after final harvest in the first week of November.

Development of an IPM package for production of cucumber

G.M.A. Halim, M. Nazim Uddin, M.S. Nahar, A. Muquit, Shahadat Hossain, A.N.M.R. Karim, Ed Rajotte and Sally Miller

Attacks by a complex of viruses, such as *Water melon mosaic virus* (WMV), *Cucumber green mottle mosaic virus* (CGMV), and *Papaya ring spot virus* (PRSV) are the main constraint to satisfactory production of cucumber. In addition, plants are also attacked by angular leaf spot disease caused by a bacteria *Pseudomonas syringae* pv. *lachrymans*, *Epilachna* beetle, leaf-eating caterpillars and leaf miners.

A few cucumber lines have been identified through symptomatic and visual examinations as moderately resistant to the virus diseases and pest insects after evaluating about 100 local and exotic cucumber germplasms during the past few years. Among the selected cucumber lines, CS-0079 and CS-0080 were more promising than others in respect of agronomic characters and reactions to virus disease and pests. In order to develop an IPM package for producing healthy and profitable cucumber crops, these two lines (CS-0079 and CS-0080) along with a commercial variety known as 'Baromashi' were included for testing three IPM packages and compared with a control treatment. The IPM package consisted of the following three soil amendment practices along with applications of recommended rates of cow dung (CD) and chemical fertilizers: (a) Tricho-compost at the rate of 3t/ha; (b) Poultry refuse at the rate of 3t/ha; and (c) Mustard oil-cake at the rate of 300 Kg/ha. The following 12 treatments were laid out in three replications using a factorial randomized complete block design: T_1= CS-0079 + Tricho-compost + ½ CD + ½ chemical fertilizer; T_2= CS-0079 + poultry refuse + ½ CD + ½ chemical fertilizer;T_3= CS-0079 + mustard oil-cake + ½ CD + ½ chemical fertilizer; T_4= CS-0079 + CD + ½ chemical fertilizer; T_5= CS-0080 + Tricho-compost + ½ CD + ½ chemical fertilizer; T_6= CS-0080 + poultry refuse + ½ CD + ½ chemical fertilizer; T_7= CS-0080 + mustard oil-cake + ½ CD + ½ chemical fertilizer; T_8= CS-0079 + CD + ½ chemical fertilizer; T_9= Baromashi + Tricho-compost + ½ CD + ½ chemical fertilizer; T_{10}=

Table 7. Performance of various IPM package treatments for production of cucumber; BARI farm, Gazipur, Summer Season, 2010

Treatments	Days to first harvest	Virus infection after 75 days (%)	Fruits/plant (No.)	Yield (t/ha)
T_1 (CS-0079 + Tricho-compost + ½ CD + ½ chemical fertilizer)	62	73	12.5	20.3
T_2 (CS-0079 + poultry refuse + ½ CD + ½ chemical fertilizer)	62	100	13.0	12.9
T_3 (CS-0079 + mustard oil-cake + ½ CD + ½ chemical fertilizer)	61	93	18.6	27.1
T_4 (CS-0079 + CD + ½ chemical fertilizer)	62	92	13.9	21.1
T_5(CS-0080 + Tricho-compost + ½ CD + ½ chemical fertilizer)	52	100	18.7	30.3
T_6(CS-0080 + poultry refuse + ½ CD + ½ chemical fertilizer)	52	92	16.6	30.1
T_7 (CS-0080 + mustard oil-cake + ½ CD + ½ chemical fertilizer)	57	80	14.0	19.2
T_8 (CS-0079 + CD + ½ chemical fertilizer)	52	93	17.1	26.9
T_9 (Baromashi + Tricho-compost + ½ CD + ½ chemical fertilizer)	52	92	16.6	25.6
T_{10} (Baromashi + poultry refuse + ½ CD + ½ chemical fertilizer)	50	93	3.3	21.7
T_{11} (Baromashi + mustard oil-cake + ½ CD + ½ chemical fertilizer)	50	100	20.0	29.1
T_{12} (Baromashi + CD + ½ Chemical fertilizer)	59	100	16.1	24.4

Baromashi + poultry refuse + ½ CD + ½ chemical fertilizer; T_{11}= Baromashi + mustard oil-cake + ½ CD + ½ chemical fertilizer; and T_{12}= Baromashi + CD + ½ Chemical fertilizer. Five 20-day old cucumber seedlings, grown in polybags, were planted in unit plots of 7.5m x 1m at 1.5m spacing. There was 1.5m spacing between plots. Records were taken on virus infection and pest infestation, time of first flowering, fruit characteristics, fruits per plant and yield.

Although all the plants were virus free up to 45 days after planting, 73%-100% plants exhibited mild to moderate virus infection. Infestation of leaf-eating insects was negligible. White fly infestation was moderate with insignificant differences among the treatments. Variation in yields in different treatments was minimal because of mild severity of virus infection. Based on yields and other characteristics, the treatments of T_5 (CS-0080 + Tricho-compost + ½ CD + ½ chemical fertilizer); and T_6 (CS-0080 + poultry refuse + ½ CD + ½ chemical fertilizer) appeared to be more promising (Table7). The results indicate that there is need to include additional treatments in order to protect the plants from virus infection.

Development of IPM package for production of okra

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The attack of Bhendi yellow vein mosaic virus vectored by white fly is the main constraint to satisfactory production of okra. Growth and production of okra are also considerably affected due to the attacks of anthracnose disease and root-knot nematode. As the use of pesticides as practiced commonly by the farmers is ineffective, a trial was conducted to develop an IPM package for the management of the pests. The trial was conducted at BARI farm, Gazipur, and the IPM practices included to develop the package consisted of tactics that are applicable to control soil-borne disease pathogens, RKN and Bhendi yellow vein mosaic virus. The okra variety, 'BARI Dherosh-1, was used for the trial. The following five treatments were laid out in three replications using a RCB design in unit plots of 5m x 3.2m: T_1= Soil incorporation of Tricho-compost at the rate 3t/ha + spray of salicylic acid; T_2= Soil incorporation of Tricho-compost at the rate 3t/ha + spray of milk at 0.5%; T_3= Soil incorporation of Tricho-compost at the rate 3t/ha + spray of 10% neem seed kernel extract (NSKE); T_4= Soil incorporation of Tricho-compost at the rate 3t/ha + spray of soap water at 0.5%; and T_5= Untreated control. Data were recorded at 15 days interval on YVMV infection, RKN infestation and yields.

Starting from 30 days of plant growth, YVMV infection increased gradually with plant growth and maximum infection ranging from 77.4% to 96.4% was observed at 75 days of plant growth. IPM treatments reduced RKN infestation by about 50% to 60% as compared to the control. No significant differences in yields, however, were observed between the treatments and the control, indicating clearly the impact of the damaging effects of YVMV on the plants. It is obvious from the results that development of suitable IPM practice(s) for Bhendi yellow vein mosaic virus management is the most crucial need for developing an effective IPM package for okra production.

Tricho-compost and Tricho-leachate production and their field efficacy test

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On-station trials were conducted to determine the rates of application of Tricho-compost and Tricho-leachate for production of healthy cabbage seedlings in nursery beds. In order to enable the farmers to produce Tricho-compost by themselves on their farmyard, a separate trial was conducted to use Tricho-leachate as an alternative to *Trichoderma* spore suspension for production of Tricho-compost.

(a) Determination of application rates of Tricho-compost and Tricho-leachate for production of cabbage seedlings in nursery seedbed: Two on-station trials were conducted, one at BARI farm in Gazipur and the other at BARI-OFRD farm in Bogra. The trial conducted at BARI, Gazipur consisted of the following four treatments, laid out in a completely randomized block design with three replications: T_1= Tricho-compost @150g + Tricho-leachate @100 ml per sq. meter; T_2= Tricho-compost @100g and Tricho-leachate @ 150 ml per sq. meter; T_3= Only Tricho-leachate @ 500ml per sq. meter; and T_4= Control (Cow dung 3 kg + TSP 50 g per sq. meter). The trial conducted at BARI-OFRD farm in Bogra consisted of the following three treatments laid out in a completely randomized design in four replications:T_1= Tricho-compost @150g + Tricho-leachate 100 ml per sq. meter; T_2= Tricho-compost @100g + Tricho-leachate @ 150 ml per sq. meter; and T_3= Control (cow dung 3 kg + TSP 50 g per sq. meter). Each seedbed measured 3.5 sq. meters.

Tricho-compost and Tricho-leachate were used 12 days before seed sowing. After application of Tricho-compost and Tricho-leachate, the seedbed was covered with polyethylene sheet. In the control treatment, cow dung and TSP were used one day before seed sowing. Two grams of cabbage seed (about 1620-1650 seed) were sown in each seedbed. Germination percentage was 96. Fifty seedlings of one month old were sampled for fresh and dry weight measurement. Data were recorded on disease incidence and seedling growth.

In both the trials conducted at Gazipur and Bogra, the cabbage seedlings grown in seedbed nurseries treated with Tricho-compost and Tricho-leachate were better and healthier in respect of seedling emergence, shoot height and weight, and seedling survival. Seedling emergence in the nurseries treated with Tricho-compost and Tricho-leachate was 5%-18% higher, and the seedlings were 29%-37% taller, and 24%-52% heavier than those of the control treatment; survival of the seedlings in Tricho-compost and leachate treatments were also as high as 92.5% to 98% against 87.3% in the control treatment. Tricho-compost and Tricho-leachate treatments effectively controlled the infections caused by *Rhizoctonia* and *Fusarium* species, but failed to control the attack of *Pythium* spp. as evident from seedling mortalities. Further investigation is needed to confirm the results.

The results of the trial conducted at Bogra were also similar to that obtained at Gazipur. Seedling emergence in the nurseries treated with Tricho-compost and Tricho-leachate was 16% higher, and the seedlings were 21%-29% taller, and 58%-106% heavier than those of the control treatment; survival of the seedlings in Tricho-compost and leachate treatments were also as high ranging from 78% to 81% against only 49% in the control treatment (Table 16). In this trial also, Tricho-compost and Tricho-leachate treatments failed to control the infection of *Pythium* spp., but very effectively controlled the infections caused by *Rhizoctonia*, *Sclerotium* and *Fusarium* species as evident from seedling mortalities.

(b) Use of Tricho-leachate for production of Tricho-compost at Farmer's Level

The scientists BARI-HRC have developed an organic compost fertilizer known as "Tricho-compost" which is enriched with a strain of *T. harzianum*. Tricho-leachate, a liquid byproduct of Tricho-compost, contains *Trichoderma* spores, and it is equally effective for controlling soil-borne pathogens. Presently, spore suspension of *T. harzianum* is being used for Tricho-compost production. Production of T*richoderma* spore suspension needs technical knowledge and a laboratory for its production. In order to spread the technology of Tricho-compost production at the farm level, Tricho-leachate was used as an alternative to spore suspension of *T. harzianum* for producing Tricho-compost. Before using Tricho-leachate for producing Tricho-compost, however, the following tests were conducted to examine (i) size and number of spores of *T. harzianum* present in Tricho-leachate; (ii) pure culture of *T. harzianum* spores of Tricho-leachate and inhibition test for the efficacy of the spores; and (iii) effectiveness of Tricho-leachate to decompose the organic materials for production of Tricho-compost.

(i) Spore number and their size present in Tricho-leachate: Two sets of spore suspension of *T.harzianum* present in Tricho-leachate was diluted 25 fold. Spores of each set were examined under an inverted compound microscope at 100X resolution and were counted by using Hemacytometer and calculated by using the following formula of Hansen (2000): Number of spores in original sample = cells present in 5 small squares of hemacytometer x 50,000 x dilution factors.

Counts of spores taken from two sets after dilution in one ml solution showed that there were 8.5 x 10^7 spores in the first set and 7.9 x 10^7 spores in the second set. On the other hand, only a density of 3 x 10^7 spores per ml of solution is required for complete decomposition of organic materials. Therefore, the density of *T. harzianum* spores present in Tricho-leachate was found to be adequate for using it as a decomposer to produce Tricho-compost.

(ii) Pure culture of *T. harzianum* spores derived from Tricho-leachate and inhibition (effectiveness) test of the spores in the laboratory: In order to obtain a pure culture, two drops of Tricho-leachate was mixed in sterilized Richards solution and the mixture was shaken at a minimum rpm of 40 per minute for 10 days. It was replicated three times. As a control treatment, a small amount of 2 mg of Tricho-compost was mixed similarly with sterilized Richards solution and allowed for shaking for 10 days. After 10 days, the mycelium grown in Richards solution was carefully separated, and a small amount was put on a PDA plate and replicated four times. To maintain its original strength, the process was repeated taking the samples from the pure culture. Similarly, the pathogens of *Sclerotium* and *Fusarium* species were isolated from vegetable crops and were maintained in PDA media.

Effectiveness of *T. harzianum* spores derived and cultured from Tricho-leachate by examining the inhibition zone through utilizing "Dual Culture Technique". *T. harzianum* spores isolated from Tricho-compost and Tricho-leachate were tested for their mycoparasitic ability *via* a colonized plate method. Two assessments were made following the dual culture techniques. The first was to obtain the percentage inhibition of radial growth (PIRG) of *S. roflsii*, and the second one was the number of days taken for the *T. harzianum* isolates to totally overgrow onto the *Sclerotium* colony. Sterilized PDA was poured into petri dishes at 20 ml per plate. Each plate was then seeded with 5mm diameter agar disc cut from the edge of an actively growing pure culture of *S. roflsii*, placed at the circumference of an 8.5cm diameter PDA culture plate. Similarly, a 5mm disc was taken from the edge of a 4- day old pure culture of each *T. harzianum* isolates and placed at the periphery (0cm) on the opposite side of the same petri dish. For the control plate, only *S. rolfsii* was placed in a similar manner without *T. harzianum* on a fresh petri dish. Plates were repeated at least three times under room temperature of 28±2ºC. Results revealed as mean colony growth of the causal pathogen in the presence of the antagonistic pathogen and its growth on the control plate. The outcome of two readings was incorporated into the formula (Skidmore and Dickinson 1976) for calculating the inhibition percentage of radial growth (PIRG) as below:

$$PIRG = \frac{R_1 - R_2}{R_1} X100$$

Where PIRG = percentage inhibition of radial growth, R_1 = radial growth of *S. rolfsii* in absence of the antagonist (control); R_2 = radial growth of *S. rolfsii* in presence of the antagonist. PIRG and colony overgrowth assessments showed that both the isolates of *T. harzianum* inhibited 60% growth of *S. rolfsii* pathogen within 5 days; complete inhibition of the pathogen occurred after 10 days. The results thus confirmed that *T. harzianum* spores present in Tricho-leachate were highly viable and effective for controlling soil-borne pathogen like *S. rolfsii* and, therefore, Tricho-leachate can be used as an alternative to *T. harzianum* spore suspension for production of Tricho-compost.

(iii) Effectiveness of Tricho-leachate to decompose organic materials for production of Tricho-compost: Organic materials such as cow dung, sawdust, water hyacinth, poultry refuse, maize bran, molasses, and ash were processed and mixed in a defined proportion. Spore suspension of Tricho-leachate containing *T. harzianum* having a density of 8.5 x 10^7 was sprayed in layers and mixed with the organic materials to allow decomposition. The following three treatments were tested to determine and prepare Tricho-compost: T_1= Water spray at the rate of one liter per Tricho-compost house (control); T_2= Tricho-leachate spray at the rate of one liter per Tricho-compost house; and T_3= Tricho-leachate spray at the rate of two liters per Tricho-compost house. There were three replications involving three farmers for each replication per treatment, totaling 9 farmers. Each Tricho-compost house was constructed by placing three concrete circular rings (each measuring 70cm dia x 30cm high) one above the other vertically. Each Tricho-compost house was loaded with about 420Kg organic materials mixed with Tricho-leachate. The liquid byproduct (Tricho-leachate) coming out of the Tricho-compost house was collected from a small pit (30cm x 30cm x 30cm) dug out along the side of each Tricho-compost house, and the leachate started to accumulate in the pits from the second week of decomposition. The rate of decomposition of organic materials, temperature of the decomposing materials, odor and color of the decomposed materials were recorded.

Results showed that *T. harzianum* spores present in Tricho-leachate were highly effective to decompose the organic materials used for producing Tricho-compost. Both the rates of Tricho-leachate, 1liter or 2liters per Tricho-compost house, were equally effective to decompose the organic materials in 40 days as against 72 days of the control treatment to produce a quality amount of odorless Tricho-compost. The results strongly suggest that, with minimum hands-on training, the farmers will be able to produce Tricho-compost at their farmyard at a minimum cost for its use to protect their vegetable crops from the attacks of various disease pathogens and nematodes. Moreover, the use of Tricho-compost will help increase soil fertility.

Study on the prevalence of natural enemies of *Epilachna* beetle and their parasitism efficacy in vegetable crops

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The recent emergence of *Epilachna* beetle (mainly *Epilachna octo-punctata* and *Epilachna 28-punctata*) as a damaging pest on some vegetable crops. This study was conducted to exploit the possibility to control the pest by utilizing natural control system approach, such as the use of parasitoids. Grubs of *Epilachna* beetles, collected weekly from insecticide-free fields of eggplant, sweet gourd and bottle gourd crops, were reared in the laboratory and examined for parasitism. The emerged parasitoids were preserved in 80% alcohol for identification.

The parasitoids that emerged from the mummies of *Epilachna* beetle were locally identified as *Pediobius foveolatus* (Hymenoptera: Elophidae). The parasitism rates observed from the field collected

Table 8. Distribution of sampled respondents

District	IPM farmers			Non-IPM farmers			Grand Total
	Male	Female	Total	Male	Female	Total	
Jessore	38	4	42	58	-	58	100
Bogra	20	7	27	70	3	73	100
Narsingdi	20	10	30	65	5	70	100
Total	78	21	99	193	8	201	300
Gender (%)	26	7	-	64	3	-	-

Epilachna grubs starting from first week of July to second week of September 2010 averaged 14.7% ranging from 2.2% to 52.6%, the highest (52.6%) being in the fourth week of August and lowest (2.2%) in the first week of September. The number of parasitoids emerging from each mummy of the *Epilachna* beetle averaged 19.4 ranging from 5.7 to 32.0. The study clearly showed that natural control of *Epilachna* beetle by parasitoid exists in vegetable fields, and its population can be augmented and conserved.

Global Theme Programs in Bangladesh

Impact Assessment: Baseline Survey on Adoption and Impact of IPM Practices

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IPM technologies developed for vegetable crops by BARI scientists through IPM CRSP project have been adopted by the farmers in different areas of Bangladesh because of their effectiveness against pests and diseases, higher crop yields and high cost-effectiveness. As a result, farmers have switched over from conventional use of pesticides to IPM practices in several areas, enabling them to minimize cultivation costs and fetch higher profits. The recent approval of the government for commercialization of IPM inputs (pheromones and bio-pesticides) has opened up the opportunity for the farmers to collect the IPM inputs from the local markets at suitable times of their need. In order to record the status of the above developments, baseline surveys were carried out in three intensive vegetable growing districts of Jessore, Narsingdi and Bogra.

From each district, two upazilas (sub-district) and from each upazila two agricultural blocks (comprising a minimum of 1,000 acres) were selected for the study. 300 farmers, 100 farmers from each district, comprised of male and female as well as IPM and non-IPM farmers were randomly selected (Table 8) and interviewed by using a pre-tested questionnaire containing a total of 27 questions on (a) demographic & socio-economic characteristics; (b) farming systems; (c) insect pests & diseases; (d) provision of support services; (e) farmers' intentions towards IPM practices; and (f) women's participation.

The demographic and socio-economic characteristics of the responding farmers in three districts were comparable in most cases. The majority (89%) of both the IPM and Non-IPM farmers were 21 to 60 years of age, 48% between 21-40 years and 47% between 41-60 years. IPM farmers had slightly more education and literacy the non-IPM farmers; 79% of the IPM farmers received primary and secondary level education as compared to 70% of the non-IPM farmers. No significant differences were observed with respect to average family size (5.8 to 6.1 per family), average farm size ((0.87 to 1.2 ha), and average working members (2 to 3 per family). Similarly, little variation was observed between IPM and non-IPM farmers in annual income, 75% of which came from farm activities. As much as 58-61% of the income was used for purchasing food for the family. 85% (range 73-91%) of the IPM farmers were associated with IPM school/clubs, cooperative society, and NGOs as compared to only 46% of non-IPM farmers. Farmers of Jessore area were higher in this respect (91%).

The benefits achieved by IPM adopters and non-IPM adopters differed considerably with respect to the cost of vegetable production, crop yields, and profitability. The IPM and non-IPM farmers grew as many as 13 vegetable crops. A higher proportion of IPM farmers, however, grew some vegetable crops more than others probably due to the availability of the IPM inputs, such as sex pheromone baits for growing bitter gourd, teasel gourd, and bottle gourd. Except for the production of country bean, okra, cauliflower and ridge gourd, the costs of production of the rest of the nine vegetable crops were 6% to 158% lower when IPM practices were adopted by the farmers. Production costs of country bean and okra are higher as effective IPM technologies for growing these crops are yet to be developed. On the other hand, the reason of higher production costs for cauliflower and ridge gourd is not known as suitable IPM practices for them are available. IPM practices produced increased yields for five crops, but lower yields for 8 crops. Similarly, by adopting IPM practices, the IPM farmers received 12% to 60% higher economic returns for 7 crops, but lost 14% to 59% in 6 crops. Both IPM and non-IPM farmers sold about 98% of their vegetable production; the rest was used for family consumption.

Of the 12 kinds of insects reported by the farmers to attack their vegetable crops in the three districts of Jessore, Bogra and Narsingdi, the eggplant fruit and shoot borer (FSB) was the most damaging and widespread, followed by fruit fly and red pumpkin beetle in cucurbit crops, pod borer in country bean and yard-long bean, fruit borer in tomato, and cutworm in cauliflower. Among the diseases, the most damaging ones were bacterial wilt, little leaf and phomopsis in eggplant; damping-off and virus disease in tomato; anthracnose and virus disease in country bean and yard-long bean; virus disease in okra; and powdery mildew and virus disease in cucumber and teasel gourd. The non-IPM farmers rely solely on pesticide use for controlling pests and diseases in their crops and applied as many as 11 kinds of insecticides and four types of fungicides. Insecticides of pyrethroid group (mainly cypermethrin) were the most common ones, followed by organophosphates, such as cartap, carbosulfan, diazinon, malathion and quinalphos.

Among the fungicides, the commonly used were mancozeb (ridomil gold) and carbendazim (bavistin). On average, the non-IPM farmers applied pesticides as many as 28 times on bean crops, 25 times on eggplant, 20 times on tomato and 18 times on cucurbit crops. The IPM farmers, on the other hand, adopted various available IPM technologies, such as use of pheromone bait traps, use of soil amendment practices, and destruction of caterpillars by hand-picking and destruction of infested fruits and twigs. All the IPM farmers used pheromone bait traps in their eggplant and cucurbit crops (e.g., cucumber, bitter gourd and bottle gourd). As many as 67% of the IPM farmers adopted soil amendment practices in sweet gourd crop in Jessore, 62% in pointed gourd in Bogra and 75% in bottle gourd in Narsingdi. In absence of suitable IPM technologies, the IPM farmers growing cauliflower, country bean and yard-long beans practiced soil amendment and sanitation by destroying the pest caterpillars mechanically by hand-picking and by clipping off the infested fruits and twigs.

The IPM farmers received IPM training more than once (2-3 times) from the department of agricultural extension or/and BARI. As many as 75% of the respondents showed willingness to adopt IPM practices mainly (a) to reduce pesticide cost (72% respondents), and (b) to avoid health hazards (82% respondents) and environmental pollution (76% respondents). The non-IPM farmers, on the other hand, did not support IPM because of its slow action (72%), lack of knowledge (77%), ineffectiveness against all kinds of pests (71%), and non-availability of pheromone traps (55%).

In Bangladesh, women play an important role in vegetable production, particularly in the homestead gardens. Although the male members (husband) carried out major part of farming, the women took part in vegetable planting (11%), use of IPM practice (39%) and harvesting (76%). In livestock rearing, however, both wife and husband were equally involved.

The overall results of the survey indicate that the adoption rate of IPM practices among the farming community across a vegetable growing area is still in the early stage. Interestingly, none of the IPM adopters mentioned the use of bio-control agents, which are available at the field level. The use of bio-control tool could have a large impact. Expansion of IPM practices appeared to be constrained mainly because of (a) farmers' lack or inadequate knowledge of IPM, (b) lack of farmers' training and field demonstrations, (c) non-availability of IPM inputs, and (d) absence of appropriate IPM package for other major crops.

Global Theme Program on International Plant Diagnostic Network (IPDN)

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In IPM system, the ability to diagnose and detect pests and diseases is indispensable for implementation of proper management practices. In most cases, particularly in Bangladesh, crop losses and misuse of pesticides at the farm level are related with incorrect or wrong diagnosis of pests and diseases. Moreover, there is dearth of facilities in the fields of infrastructure, equipment, and trained personnel. Bangladesh with its tropical agro-climate is highly prone to the proliferation of numerous pests and diseases and was therefore included in IPDN starting from year 1 (2009-2010) of the IPM CRSP phase IV program to address the field problems as well as to fulfill, as much as possible, the needs of capacity building. A team of fungal pathologists, bacteriologists, nematologists and entomologists was involved to carry out the diagnostic activities.

For diseases, surveys were conducted in two districts of Narsingdi and Bogra on six kinds of vegetable crops (cucumber, bitter gourd, sponge gourd, bottle gourd, snake gourd, and pointed gourd). After collecting the diseased samples, they were brought back to the laboratory for identification by growing them in growth medium. Except for a few, incidence of several diseases was fairly high ranging from 28% to 60% on bottle gourd, sponge gourd, cucumber, and snake gourd crops. Disease incidence was lower in bitter gourd and pointed gourd (Table 9). Sponge gourd was mainly infected by virus disease.

A fairly intensive survey was conducted in four regions of Bangladesh: Gazipur, Pabna and Narsingdi (central region), Jessore (south western region), Sylhet (North eastern region) and Rangpur (Northern region) to collect information on the incidence of papaya mealy bug (*Paracoccus marginatus*) which is a highly virulent invasive pest insect. The mealy bug was recorded for the first time in 2008. It feeds on the sap of the vegetative parts as well as fruits causing chlorosis, stunting of plants, leaf deformation, and early leaf and fruit defoliation. Heavy deposition of honeydew induces thick growth of sooty mold fungus.

Table 9. Incidence of diseases in several cucurbit crops in Narsingdi and Bogra districts, Summer Season 2010

Location	Crops	Disease and organism	Disease incidence (%)
Narsingdi	Cucumber	Angular leaf spot (*Pseudomonas lachymans*)	45
	Bitter gourd	Cercospora leaf spot (*Cercospora* sp.)	12
	Snake gourd	Cercospora leaf spot (*Cercospora* sp.)	60
	Sponge gourd	Mosaic virus	46
	Pointed gourd	Fusarium wilt (*Fusarium* sp.)	5
	Bottle gourd	Leaf blight (*Mycospherella* sp.)	37
Bogra	Snake gourd	Cercospora leaf spot (*Cercospora* sp.)	52
	Sponge gourd	Mosaic virus	28
		Cercospora leaf spot (*Cercospora* sp.)	13
	Bottle gourd	Leaf blight (*Mycospherella* sp.)	28
		Leaf spot (*Collectotrichum* sp.)	34

Plants often die in case of high infestations. Papaya mealy bug is polypagous, and therefore, the survey was carried out also on guava, jujube, custard apple, eggplant and okra crops.

Incidence of the papaya mealy bug was observed only in Gazipur and Narsingdi districts on papaya, guava, jujube, custard apple, eggplant and okra crops, with papaya being the most susceptible and damaged crop. In Pabna, a very low population was observed only on custard apple.

Global Theme Program on International Plant Virus Disease Network (IPVDN)

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Surveys were conducted from June to August 2010 in five districts of Gazipur, Narsingdi, Chittagong, Jessore and Bogra to record incidence of virus diseases on 11 vegetable crops of cucumber, sponge gourd, ridge gourd, teasel gourd, pointed gourd, bottle gourd, bitter gourd, okra, yard-long bean, country bean and summer tomato. Most of the crops were in mid vegetative to late fruiting stages at the time of collecting the samples. Severity of viral infection was assessed by visual observation. Samples of diseased plant parts (mainly leaves) taken in an ice box were brought back to the laboratory and preserved at 0^0 C in a refrigerator for ELISA test.

Among the crops, cucumber, ridge gourd, sponge gourd, bottle gourd, okra, and yard-long bean were the most affected ones by viral infection; cucumber topped in disease incidence and severity. Bitter gourd was found to be virus-free, except in Jessore area. Teasel gourd and pointed gourd crops were apparently virus-free.

Global Gender Program: Role of women in vegetable cultivation and IPM technology adoption

Shahnaz Huq-Hussain, Tahera Sultana, Umme Habiba, A.N.M.R. Karim and Maria E. Christie

Gender plays an important role in agriculture and pest management. Farm activities are usually gendered based on their nature of task, which is also related to access to various resources that include land, labor, education and credit. Additionally, farm tasks are also gender based on knowledge, aptitude and practice which influence the adoption of a particular agricultural practice or IPM. Bangladesh is a multi-religious country having varied cultures. Muslim women as well as those of the higher caste Hindu religion do not work in open fields, but they take active part in homestead vegetable gardens and rearing of animals (cattle and poultry). In recent years, many women have become actively involved in vegetable production in several districts of Bangladesh, and they play important roles in decision making and IPM practices.

In order to assess the role of women in vegetable cultivation and adoption and use of IPM practices, two pilot surveys were conducted by two graduate research students (Ms. Tahera Sultana and Ms. Umme Habiba) of the Dhaka University in Jessore and Narsingdi districts.

Women's role in using IPM inputs with emphasis on poultry refuse: A case study in Jessore district

A pilot survey was conducted by Ms. Tahera Sultana, graduate research student of the Dhaka University, for a week in two villages of Gaidghat and Khajura in Jessore district by using a questionnaire that included questions to gather information mainly on (a) demography and socio-economy, (b) vegetable cultivation, (c) production and marketing of vegetables, (d) poultry farming, and (e) pest management practices. Information was collected from 12 women respondents only, 6 from each of the two villages.

The women associated with vegetable production in both villages were relatively young (25-34 age group); 70% of them received primary education, 10% secondary education, and the rest 20% received no formal education. All the women owned the land of their homestead gardens and their experience in vegetable production averaged 10 years. Although 70% of the women earned their income mainly from vegetable cultivation, about 40% of them also earned from poultry farming.

The women grew as many as nine kinds of vegetables, such as cabbage, cauliflower, radish, tomato, country bean, eggplant, okra, cucumber and Indian spinach. About 30% of vegetables were sold and the rest was used for family consumption. Of the sampled women, 25% of them were engaged for four years with poultry farming which served as the main source of income as well as provided nutrition to the family members, particularly the children. Only 10% of the women poultry farmers were knowledgeable about using poultry refuse as bio-fertilizer.

The women could name only few insect-pests that often damaged their crops. These are leaf-eating caterpillars, aphids, cucurbit fruit fly and eggplant fruit and shoot borer. They were not however knowledgeable about the correct names of the diseases. Only 20% of the women heard about IPM and 80% of them used IPM tactics. On the other hand, 80% of the women claimed pesticide use as the main method of pest control, but only 40% of them used pesticides in homestead gardens. In 82% cases, the decisions for pest management actions were taken by the women. The women seemed to be aware of the role of natural enemies that suppress or control various pest insects, but they lacked knowledge about their use and availability. As high as 90% of the women who grew cucurbit crops (gourd crops) adopted pheromone bait traps for fruit fly control. Only 8% of the women heard about poultry refuse as an IPM input and 35% of them used it.

The overall results strongly indicate that the women, although playing an important role in homestead vegetable production that partially meets up their family demand and fetches additional income, have remained largely unexposed to the recent developments in IPM practices. IPM practices will invariably expand among the women farmers if appropriate opportunities are carefully planned and implemented at the village level.

Food security and homestead gardening: women's role in Bangladesh

This pilot survey was carried out by Ms. Umme Habiba, graduate research student of the Dhaka University, in three upazilas (sub-districts) of Shibpur, Belabo and Raipur of Narsingdi district. Women of only 12 homesteads, four from each upazila, were sampled and interviewed through a pre-tested questionnaire that included the following major items: (a) Demographic characteristics, (b) Income and resource, (c) Vegetable cultivation, (d) IPM practices, ((e) Indigenous knowledge on homestead gardening, and (f) Food security.

The age of the respondents ranged from 15 to 65 years; 37.5% of them were in 36-45 age group and the rest were young and old aged. About 75.5% of the women respondents were literate having primary education and 12.5% received degree level education from universities. The area of the homestead vegetable gardens ranged from as small as 1.2 decimal to 15 decimals of land. About 62.5% women were associated with vegetable production and the rest 37.5% grew fruit trees. Sweet gourd, bitter gourd, bottle gourd, eggplant, tomato, country bean and leafy vegetables (e.g., red-leaf amaranth and Indian spinach) were the major vegetable crops cultivated by the women. Vegetable production was the main source of income for 57.5% women; other sources of income included fruit production and poultry rearing. All the women used the vegetables produced in their gardens for family consumption, particularly for the children. The leafy vegetables served as one of the main sources of nutrition and food security of the family.

The women possessing larger homestead gardens were able to produce vegetables commercially. All the women associated with vegetable cultivation received orientation in IPM through a private agency and adopted IPM methods for controlling the pests. They used Tricho-compost and bio-control agents in tomato and country bean crops. The women growing cucurbit crops, such as sweet gourd and bottle, adopted pheromone bait trapping for fruit fly control. For leafy vegetables, they used poultry refuse and mustard oil-cake.

The overall results showed that the women associated with vegetable production in Narsingdi area are exposed to using improved vegetable production methods including the IPM practices, and they are playing important roles in addressing food security problems of their family vis-à-vis the society.

Dissemination of IPM Technologies by NGOs

MCC (Mennonite Central Committee), an international NGO, and GKSS, a local NGO, are actively involved in dissemination of different IPM practices in their target areas. In association with 13 local NGOs, MCC carried out as many as 119 demonstrations involving as many farmers in five districts on seven IPM technologies in seven crops (cabbage, cauliflower, eggplant, tomato, cucumber, bitter and potato) during 2009-2010. Results of the demonstrations showed that the participating farmers harvested 10% to 45% higher crop yields and earned 29% to 58% additional income by adopting the IPM technologies on different crops. Moreover, the farmers were able to reduce the cost of cultivation by 25% 45%. MCC also arranged 45 field days for these demonstrations to reach the IPM technologies to as many as 1,575 participating farmers. In collaboration with the local NGOs, MCC organized ToT (training of trainers) for 41 NGO field staff that involved 11 women participants. MCC also imparted training to as many as 10,500 farmers on different IPM practices.

GKSS (Rural Farmer Assistance Committee), a local NGO produced as much 62 tons of Tricho-compost, an organic fertilizer developed by IPM CRSP-BARI scientists for controlling various soil-borne diseases and improving soil fertility. The organic fertilizer was distributed to establish 40 demonstrations on 11 crops involving several hundred farmers. The participating farmers obtained 25%-30% higher crop yields by using Tricho-compost. In order to popularize the adoption of Tricho-compost, GKSS organized 44 training programs for a total of 1,673 farmers, and held four field days that were participated by 250 farmers.

Role of Private Agricultural Enterprises in Expanding IPM Practices

Presently, some six private agricultural enterprises are engaged in producing different bio-control agents (e.g. parasitoids and predators) and supplying of sex pheromones that are regarded as the most important effective inputs of IPM technologies in Bangladesh. Among the private enterprises, Safe Agriculture Bangladesh Limited (SABL) and Ispahani Bio-tech Limited (IBL) are the leading firms that are contributing significantly to expand IPM technologies at the farm level through providing necessary IPM inputs.

During 2009-2010, SABL supplied as many as 75,000 lures of 'cuelure' pheromone for controlling fruit fly in cucurbit crops of at least 750 ha that involved an estimated 6,000 farmers. SABL also supplied egg and larval parasitoids (e.g., *Trichogramma* spp. and *B. hebetor*) to about 6,000 farmers that covered about 750ha of crop land for controlling various kinds of pest insects. IBL has also been actively contributing to disseminate IPM technologies through producing and supplying various IPM inputs. IBL distributed a record number of 130, 708 'cuelure' pheromone lures that covered about 1,860ha of cucurbit crops belonging to about 15,000 farmers. Supply of bio-control agents (e.g., *Trichogramma* spp. and *B. hebetor*) was made to an estimated 4,600 farmers to cover about 575 ha of crop land for controlling various pest insects.

Based on a special governmental permission, the private agricultural firms have so far been supplying the IPM inputs to the farmers who have been participating in the demonstrations of IPM technologies in different areas. This was done to familiarize and popularize the technologies to the farmers within and around the demonstration areas. In absence of official approval for marketing of the inputs, the farmers therefore were not able to purchase the inputs according to their needs. As a result, adoption of IPM technologies was confined to a limited section of the farming community. Only recently on May 13, 2010, the government approved commercialization of all bio-rationals (e.g., pheromones, bio-pesticides, botanical pesticides) through a gazette notification enabling the private firms to manufacture, formulate, import and market various IPM products. This governmental provision has now opened opportunities for the farmers to adopt IPM technologies by using necessary IPM inputs.

INDIA – TNAU and TERI

Summary

TNAU - Integrated Pest Management modules on vegetable crops with special emphasis on biocontrol were field tested. The module on Onion IPM was demonstrated to onion growers under IPM - CRSP program in large areas in Perambalur and Dindigul districts. IPM plots recorded lesser incidence of thrips, basal rot, purple blotch, leafminer and cutworm compared to farmer's practice coupled with higher bulb yield and cost: benefit ratio. Field Days were organized to popularize vegetable IPM in different districts of Tamil Nadu. Exhibitions, demonstrations, special lectures, scientists-farmers interactions were organized

and distribution of bio-pesticides and IPM pamphlets to vegetable growers were done during that occasions. In addition, popularization of vegetable IPM technology was made through seminars organized by Department of Agriculture/Horticulture, private agencies, All-India Radio (talks, messages, farmer interaction), publications through local journals, newspapers, etc.

TERI carried out IPM demonstrations in Uttar Pradesh, Andhra Pradesh and Karnataka. A total 51 trials were conducted this year, 29 trials in Uttar Pradesh in the villages Tatarpur, Upeda, Bhoorgarhi, Bagadpur, Patana and Hapur and 22 trials were carried out in Andhra Pradesh and Karnataka in the villages Battegoudanour, Gudipalli, Hanumanthnagar, Dodrahalli, Banahally, Gesthampalli, Balamande and Boyiluru covering total area of 41.5 acres.

Tomato

TNAU:

Two IPM farmer participatory research trials are underway with IPM components dealing with preplant seed and soil treatments (*Trichoderma viride, Pseudomonas fluorescens*), neem cake applied in planting period, use of virus-free seedlings, rouging virus-infected plants within 45 days of transplanting, marigolds as border crops, pheromone-based monitoring of *Helicoverpa* and *Spodoptera*, release of egg parasitoids (*T. chilonis*), yellow sticky traps, neem formulations applied in production period, and need-based application of nematicides/insecticides/fungicides.

These research trials are still in progress. Preliminary data reflect significant improvements in IPM approaches. The following means reflect IPM plots versus non-IPM plots, respectively: % infection by PBNV: 6.9% vs. 7.8-15.0%; infection by tomato leaf curl virus: 1.4% vs. 2.7%; thrips per flower: 2.4-3.8 vs. 5.2-5.6; % fruit injury: 7.3-8.3 vs. 15.6-22.7; nematodes/250 ml soil: 8.0-9.2 vs. 396-410.

TERI:

The IPM package for tomato included use of resistant/tolerant varieties, seed/soil/ seedling treatments with *T.viride,* or *Pseudomona fluorescens*, neem cake applied in planting period, pheromone-based monitoring of *H.armigera*, yellow sticky traps for monitoring and mass-trapping of whiteflies, jassids, and aphids, biopesticides (neem, *Beauveria bassiana*, *Helicoverpa* NPV, applied in production period, and need-based application of spinosad, imidacloprid, thiamethoxam, acetamiprid, propargite, and Sulfex. Plots were maintained in northern India (Uttar Pradesh) as well as southern India (Karnataka, Andhra Pradesh).

We conducted seven trials in three villages. Most of the tomato crop was lost this year due to excessive heat, with the exception of a heat tolerant variety (US 1080), which gave satisfactory results. The major yield-limiting factor in this area was a tospovirus, which attacked tomato and drastically reduced the crop yield. In a cooperating, non-IPM farm, average infection by tospovirus approached 90% of the crop while in IPM plots, virus was present but IPM inputs limited virus impact so the crop was not affected severely. Pest incidence status was low in IPM demonstrations in comparison to the non-IPM farm practices. Jassids were 1.2 to 3.6 per leaf while in the non-IPM farm, populations averaged 5.2 per leaf. Leafminers averaged 2.6 per leaf in IPM plots and 6.3 per leaf in non-IPM farm practice was observed. Leaf curl, fruit rot and tospovirus were higher in non-IPM farm practice but were manageable in IPM demonstrations. Only one IPM demo site suffered with damaged equal to the non-IPM farm practice, attributable to lack of irrigation water.

Brinjal

TNAU

Research on IPM packages took place in two IPM farmer participatory research trials, employing the following IPM components: seed/soil/seedling dip treatment with *Pseudomonas* or neem cake, maize as border crop against movement of whiteflies and *Liriomyza* leafminers, yellow sticky traps against whiteflies and *Liriomyza*, clipping to remove shoot borer-infested terminals, *Leucinodes orbonalis* adult monitoring with pheromone traps, *Trichogramma* release after each brood emergence of *Leucinodes*, application of neem products (azadirachtin based formulations/NSKE), and need based application of insecticides.

These trials are still in progress. Preliminary results reflect consistent improvements using IPM approaches. The following means reflect IPM plots compared with non-IPM plots: percent shoots damaged by eggplant fruit and shoot borer, *L. orbonalis*: 2.3-2.8 vs. 5.1-6.4%' percent fruits damaged by *Leucinodes*: 3.8-4.6% vs. 10.6-12.5%; leafhoppers per leaf: 2.7 vs. 6.8-7.8; whiteflies per leaf: 5.6-12.6 vs. 12.8-22.8; nematodes/250 ml soil: 120-140 vs. 360-420. *Leucinodes* pheromone lures produced locally at TNAU were effective as those produced by IICI.

TERI

Research and demonstration on brinjal IPM packages in both northern and southern India included work on high yielding and tolerant/resistant varieties, seed/soil/seedling treatment with *T.viride* and *P. fluorescens* or neem cake, monitoring and mass trapping of *Leucinodes* with pheromone traps, yellow sticky traps for monitoring and mass trapping of sucking pests, biopesticides (neem, *Beauveria* and *Bt* formulations for pest management in production period, clipping of infested shoots, and need based spray of eco-friendly insecticides/fungicides. Brinjal demonstrations were carried out in two different villages on seven farmers' fields. The major yield limiting factors observed were *Leucinodes*, jassids, and aphids. The options viz., yellow sticky trap, neem spray and *B.bassiana* managed the sucking pest complex. The lepidopteran insect (*Leucinodes*) was managed by using shoot clipping, pheromone traps, *Bt* and spinosad.

Okra

TNAU

Farmer participatory research on okra IPM package in Tamil Nadu included the following IPM components: seed/soil treatment with *T.viride* or *Pseudomonas* or neem cake, maize as a border crop against movement of whiteflies and *Liriomyza* leafminers yellow sticky traps against whiteflies and *Liriomyza*, *Helicoverpa* and *Earias* adult monitoring with pheromone traps, *Trichogramma* release after each brood emergence of *Helicoverpa* and *Earias,* application of neem products, and need-based application of insecticides/fungicide/acaricide.

These trials are still in progress. Preliminary results reflect consistent improvements using IPM approaches. The following means reflect IPM plots compared with non-IPM plots: 5 infected with yellow vein mosaic virus 2.2 vs. 7.5%; powdery mildew % disease index: 11.2 vs. 20.2; 5 leafminer infestation: 1.8 vs. 5.2%; % fruit damage: 2.3 vs. 12.9%; leafhoppers per leaf: 7.5 vs 18.9; whiteflies per leaf: 2.6 vs. 9.7; nematodes/250 ml soil: 68 vs. 389.

TERI

Development of an okra IPM package in southern India included: resistant/tolerant varieties, seed and soil treatment with *T. viride* and *P. fluorescens*, neem cake and *Paecilomyces* (the latter for nematode management), pheromone traps for monitoring and mass trapping of *Earias vitella*, yellow sticky traps for monitoring and mass trapping of whiteflies, aphids and jassids, biopesticides such as formulations neem, Bt, *B. bassiana* and *Helicoverpa armigera* NPV, and need-based use of green label safe pesticides, e.g. spinosad, imidacloprid, thiomethoxam, acetamiprid, and propargite.

Nematode infestation was the major yield-limiting factor in the village Bhoorgarhi where 40 and 45 % yield losses were recorded. Most of the non-IPM farmers used carbofuran granules for nematode control but they could not control the damage.

Major insect-pests causing considerable damage to okra crop were whitefly (*Bemisia tabaci*), jassids (*Amrasca devastans*), aphids (*Aphis gossypii*), as sucking pests. The chewing insect complex included the insect's viz., *E. vitella*, and *H. armigera*. Major diseases causing loss to okra was BYVMV disease.

Okra IPM demonstrations were conducted on eight different locations of Kolar and Chittoor district of Karnataka and Andhra Pradesh, respectively. Bhendi yellow vein mosaic virus was the major yield-limiting factor in this particular belt. Most of the farmers in this area are growing tomatoes round the year as mono cropping, which increased the particular insect pest of the tomatoes. Due to this problem, we are conducting okra IPM demonstrations and suggesting the farmers to rotate the crops every year. Jassids, whiteflies, *Earias* and *Helicoverpa* were the major insects which reducing okra yield. In non-IPM control farms, BYVMV infestation was up to 50% of the total plant population while in our IPM trials it ranged from 4 to 30% due to the effective use of IPM module. Most of the varieties, which are showing resistance/tolerant against BYVMV in north, were susceptible in south.

Cauliflower

TNAU

Our IPM farmer participatory research trial included the following IPM components: seed/soil/seedling/ nursery treatment with *Pseudomonas*, neem cake, mustard inter crop to attract *Plutella*, yellow sticky traps against aphids, *Plutella* adult monitoring with pheromone traps, application of neem products (azadirachtin based formulations/ NSKE), and need-based application of insecticides and fungicides.

In the IPM plots, there were 5.6% injured by diamondback moth, compared with 13.3% injured in non-IPM plots. Nematodes were reduced by 70% in IPM plots.

Onion

TNAU

Farmer participatory research trials on onion IPM included the following IPM components:

Bulb treatment and soil application using Plant Growth Promoting Rhizobacteria (PGPR) consortia + *T. viride,* + Azophos (trichlorfon) (4 kg/ha) + neem cake (250 kg/ha), PGPR + *Beauveria bassiana* azadairachtin, need-based application of profenophos or dimethoate 2ml/lit/Hostathion (triaziophos) for thrips/leafminer/cutworm management, need-based application of mancozeb (2 g/lit)/ tebuconazole (1.5 ml/lit)/ zineb, yellow sticky traps, pheromone traps for *S. litura*.

The results indicated that the mean onion thrips incidence in IPM plot was 10.81/plant as compared to 14.85/plant in non-IPM plots. Leafminer incidence averaged 13.20 per cent in IPM plots compared to 23.61 per cent in Farmers' practice. Cutworm incidence was 5.48 per cent in IPM plot compared to 9.13 per cent in farmers' practice.

With respect to diseases, basal rot and purple blotch were the two diseases which appeared in the experimental plots. Incidence of basal rot was found to be lower in IPM plot (1.8 %) as compared to 5.6 % in Farmers' practice. Occurrence of purple blotch was noticed in both the plots and the severity was lesser (20.0 %) in IPM plot when compared to farmers' practice which recorded a disease severity of 45.6 %.

The bulb yield in IPM plot was higher i.e., 15.62 t/ha compared to 12.13 t/ha in Farmers' Practice.

Chilies and cucurbits

TNAU

A survey of the current status of IPM in chillies and cucurbits was conducted.

The observations collected from farmers' fields are listed below:

Chilies

- Serpentine leafminer, damping off were seen in nursery.
- Heavy incidence of thrips and mites were recorded on hot pepper
- Heavy incidence of root knot nematode with gall index ranging from 3-5 in chillies and bell pepper.
- Viral disease complex was severe in hybrid chillies. CMV occurrence was observed. Stray incidence of Capsicum chlorosis and flower gall midge was recorded.
- Fruit borer and anthracnose were recorded in some intensive vegetable growing regions.
- Both *Bemisia tabaci* and spiraling whitefly were noticed in hybrid chillies in summer season.
- Pesticide application was more in hybrid chillies as compared to inbreds.
- IPM package adoption is very low in chillies, except the use of castor as border crop; however the benefit of this is unknown by farmers.
- No biocontrol agents were used by farmers in chillies.
- Monitoring pests with traps is practiced by less than 1% of farmers.

Cucurbits

- Heavy incidence of root knot nematode with gall index of 5 in cucumber.
- Root Knot nematode was noticed in many gourds.
- Mosaic Viral disease was higher in bitter gourd, ash gourd and pumpkin.
- Serpentine leaf miner, red pumpkin beetles and fruit flies were predominantly present in all gourds.
- Sporadic incidents of semiloppers were noticed in bottle gourd and snake gourd.
- No biocontrol agent was used by farmers in cucurbits. IPM component adoption is nil in cucurbits.

TERI

Development of the IPM package for cucurbits in northern India included the following elements: high yielding and disease resistant/tolerant varieties, seed treatment

Reduction in pesticide sprays with IPM practices in South India

Crop	Average no of sprays		% Reduction
	IPM	Non-IPM	
Okra	7	14	50
Egglant	7	15	66
Tomato	7	20	54
Cucurbits	5	8	20
Okra	9	14	36
Tomato	9	18	50

with *Trichoderma* and *Pseudomonas*, soil treatment with neem cake, crop staking using wire and bamboo stakes, pheromone traps for monitoring and mass trapping of fruit fly, *Bactrocera cucurbitae*, yellow sticky traps for monitoring and mass trapping of whiteflies, aphids and jassids and leafminer adults, biopesticides such as neem, *Bt*, and *Beauveria* formulations, and need-based use of safe chemicals.

Demonstrations were carried out in three villages on five different farmers' fields. IPM interventions were seed treated with *T. viride* and *P. fluorescens*. Yellow sticky traps were installed to monitor and mass trapping of whiteflies, jassids and winged form of leafminer just after germination. The pheromone traps for *B. cucurbitae* monitoring and mass trapping were installed one month after sowing.

Fruit fly (*B. cucurbitae*), red pumpkin beetle (*Aulocophora fovicolis*), leafminers, whiteflies, and mosaic were observed infesting cucurbits crop in field. The major yield limiting factors observed were fruit fly, red pumpkin beetle and leafminers but at middle age of the crop mosaic virus also had adverse impact and reduced yield of the crop. The fruit fly in control (non-IPM farm practice), caused 16.3 percent fruit damage, whereas it ranged from 4.6 to 7.3 percent fruit damage in IPM practices. Red pumpkin beetle and leafminer were highest in control 4.8 per plant and 9.4 per leaf, respectively and ranged from 1-3 per plant and 3-6.3 per leaf in IPM trials, respectively. Yellow mosaic virus symptom was also severe in control plots (up to 50%) whereas it was in ranged from 15-35 percent in IPM plots. In some of the non-IPM farmer's field 100 % of mosaic virus infestation was also seen.

Farmer meetings and Field Days: 22 farmer's meetings on IPM for vegetable crops were organized by TERI in Upeda, Bagadpur and Tatarpur, Hapur and Battegoudanour with 101 male and 38 female participants. Farmer field days organized with 202 males and 89 females. Demonstration of IPM practices on vegetable crops in farmer fields in six villages in UP, three villages in AP, and four villages in Karnataka. Targeted farmers population in these villages is nearly 80,000 including woman farmers.

Impact Assessment

The IPM demonstrations were carried out in three villages in Andhra Pradesh and three

Increase in yield per hectare because of IPM

Crop	Average yield obtained per hectare	Yield percent increase with respect to average farmers practice
North India		
Okra	10922 kg	40
Brinjal	18817 kg	34
Tomato	19697 kg	60
Cucurbits	11115 kg	98
South India-		
Okra	9373 kg	61
Tomato	12172 kg	27
Brinjal	25000 kg	-

villages in Karnataka in southern India. A total of 19 demonstrations were carried out to promote IPM activities among the farmers during 2009-10 (eight okra and 11 tomato crops). The same IPM packages being implemented in northern India were also effective in southern India with slight modifications in spray schedule.

IPM practice proved better than current farmers practice with respect to yield, quality, environmental impact and price of the commodity and led to a 20-66% reduction in pesticide usage. The IPM crop fetched 1.5-2 times more price in the market than the non-IPM produce. Enhanced income is being utilized by farmers on children's education and construction of a house. Farmers reported better taste of food with IPM crops.

Nepal

IPM Package Development for Tomato

Tomato trials were conducted at Lalitpur and Kaski Districts in plastic tunnels. Seedlings were prepared on raised seedbed amended with compost, *Metarhizium* and *Trichoderma*. Three weeks old seedlings were planted on raised beds laid with drip pipes. The fields were amended with Bio-Fertilizers and Bio-Pesticides along with Compost. Plants were irrigated once a day and staked a month after transplanting. Foliar sprays of bio-pesticides were applied after the first appearance of pest and disease symptoms. Fruits were harvested once in every two days and weighed.

Evaluation of Bio-Fertilizers and Bio-Pesticides

Experiment was laid out in Completely Randomized Block Design with four blocks (four farmers) and five treatments each treatment containing 20 plants.

Treatment 1: Bio-fertilizers and Compost (FYM):11 kg, Nitro fix: 21.76g, P-sol-B: 20.4g, K-sol-B: 54.4g, Agri-VAM: 22.0 g

Treatment 2: Bio-pesticide and Compost (FYM): 11kg, *Trichoderma viride:* 27.5g, *Trichoderma harzianum:*27.5g, *Pseudomonas fluorescens:*27.5g, *Metarhizium anisoplae:*55.0g, *Paecilomyces* spp.:55.0g, *Bacillus subtilis:*11.0g

Effect of bio-fertilizers and bio-pesticides on tomato in Lalitpur District

Treatments	**Mean Yield in (Kg)**
Bio-fertilizers	63
Bio-pesticides	57
Bio-fertilizers + bio-pesticides	73
Farmer's practice	63
Control	28

(Average yield in kg from 20 plants, 1 replication and 7 harvests)

Effect of bio-fertilizers and bio-pesticides on tomato in Kaski District,

Treatments	Mean Yield in (Kg), p = 5%
Bio-fertilizers	42 b
Bio-pesticides	39 c
Bio-fertilizers + bio-pesticides	48 a
Farmer’s practice	38 c
Control	31 d

(Average yield of 20 plants, 4 replications and 7 harvests)

Treatment 3: Bio-fertilizers + Bio-pesticides and Compost (FYM):11 kg, Nitro fix: 21.76g, P-sol-B: 20.4g, K-sol-B: 54.4g, Agri-VAM: 22.0 g, *T. viride:* 27.5g, *T.harzianum:*27.5g, *P. fluorescens:*27.5g, *M. anisoplae:* 55.0g, *Paecilomyces* spp.:55.0g, *B. subtilis:*11.0g

Treatment 4: Farmers’ practice: Urea: 172g, DAP: 390g, Potash: 300g, Compost (FYM): 11kg. Full dose of Potash and phosphorous along with half dose of urea were applied at transplanting. Remaining half dose of urea was applied in three split doses (30, 45 and 60 days after transplantation).

Treatment 5: Control

Yield of tomato increased due to the combined effect of bio-fertilizer + bio-pesticides on tomato crops as compared to other treatments.

Among the treatments, use of bio-fertilizers and bio-pesticides produced significantly more yield.

Comparison of Grafted and Non-Grafted tomato plant

Grafted plants were evaluated against non-grafted plants in a farmer’s field at Lalitpur district. Plants were grown in plastic tunnel adopting farmer’s practice. Each treatment had 20 plants

The variety, ‘Srijana’ grafted on *Solanusm sisymbriifolium* yielded 54 kg where as the

non-Grafted plants of the same variety ‘Srijana’ 49.5 kg/ plant.

Evaluation of Mulching

Black Plastic mulch of 500 gauge was used to test its efficacy in crop production. Each treatment had 20 plants and 3 replications.

Yield of tomato crops increased significantly due to mulching as compared to hand weeding and control.

Effect of mulching on tomato in Kaski District

Treatments	**Mean Yield in (Kg), p = 5%**
Mulching	72 a
Hand weeding	59 b
Control	34 c

(Yield is an average of 20 plants in 10 harvests)

IPM Package Development for Cucumber

Cucumber trials were conducted in three different project districts namely Lalitpur, Kaski and Rupandehi. Seedlings were raised in poly-bags containing a mixture of soil, sand, compost and *Trichoderma*. Four week old seedlings were used for transplantation. Before transplanting, the field was amended with bio-fertilizers, bio- pesticides and compost. Plants were irrigated once a day. Plants were staked a month after transplantation. Soap water traps with mashed sweet gourd were set at the flowering stage to control fruit flies. Foliar spray of bio-pesticides was done after the first appearance of pest/disease symptoms. Fruit were picked from 50 to 90 days after planting.

Effect of Bio-fertilizers and Bio-pesticides on cucumber

Treatment 1: Bio-fertilizers and Compost (FYM):18.6 kg, Nitro fix: 21.76g, P-sol-B: 56g, K-sol-B: 84g, Agri-VAM: 37.2g

Treatment 2: Bio-pesticide and Compost (FYM): 18.6 kg, *T. viride*: 46.5g, *T. harzianum:* 46.5g, *P.fluorescens:*46.5g, *M. anisoplae:* 93.0g, *Paecilomyces* spp.:93.0g, *B. subtilis:* 18.6g

Treatment 3: Bio-fertilizers + Bio-pesticides and Compost (FYM):18.6 kg, Nitro fix: 21.76g, P-sol-B: 56g, K-sol-B: 84g, Agri-VAM: 37.2g, *T. viride:* 46.5g, *T. harzianum*: 46.5g, *P.fluorescence*:46.5g, *M. anisoplae:* 93.0g, *Paecilomyces* spp.:93.0g, *B. subtilis:* 18.6g 4.

Treatment 4: Farmers' practice: Urea: 156g, DAP: 112g, Potash: 168g, Compost (FYM): 18.6kg. Full dose of Potash and phosphorous along with half dose of urea were applied during transplantation.

Treatment 5: Control

There was a significant difference in yield of the treatment with bio-fertilizers and bio-pesticides over other treatments.

Yield of cucumber significantly increased due to the combined effect of bio-fertilizer + bio-pesticides as compared to bio-pesticides only, farmer's practice and control but remained at same level of significance with bio-fertilizers only.

Effect of bio-fertilizers and bio-pesticides on Cucurbit in Lalitpur District

Treatments	Mean Yield in (Kg), P = 5%
Bio-fertilizers	83.4 ab
Bio-pesticides	76.8 b
Bio-fertilizers + bio-pesticides	93.3 a
Farmer's practice	77.9 b
Control	58.7 c

(Average yield from 8 plants, 4 replications and 15 harvests)

Effect of bio-fertilizers and bio-pesticides on Cucumber in Kaski District

Treatments	Mean Yield in (Kg), p = 5%
Bio-fertilizers	15.25 ab
Bio-pesticides	14.25 bc
Bio-fertilizers + bio-pesticides	17.25 a
Farmer's practice	11.75 c
Control	11.75 c

(Average yield of 20 plants, 4 replications and 3 harvests)

Evaluation of effect of Mulching for cucumber plants

Black Plastic mulch of 500 gauge was used to test its efficacy in crop production. Experiment was Completely Randomized Block Design with four blocks and two treatments each treatment containing 20 plants.

Plots with black plastic mulch produced an average yield of 112.25 kg whereas the non-mulch plot yielded 78.47 kg in 10 harvests.

IPM Package Development for Coffee

Trials on coffee IPM package development are being conducted at Palpa district. Palpa represents the typical mid-hills of the country where coffee is regarded as one of the important commercial crops. Our trials were mainly focused on the improvement of production through use of bio-fertilizers and management of coffee white stem borer (CWSB) using a pheromone lure and the enotomo-pathogenic nematode, *Steinernema indic*a. CWSB has become the most important pest and it destroyed several hectares of coffee plantations in the recent few years. The trails were mainly concentrated on 3-4 year old coffee plants.

IPM Package Development for Tea

One experiment on tea IPM package development was conducted at Illam district. Illam is one of leading producer for tea in Nepal. Tea mosquito, red spider mites and thrips were the major pest problems.

Evaluation of performance of Bio-Fertilizers and Bio-Pesticides

An experiment was conducted with four replications and five treatments. Each

Effect of bio-fertilizers and bio-pesticides on Tea in Illam District

Treatments	Mean Yield in gm, p = 5%
Control	4440.0 ns
Farmer's practice	4836.3
Bio-fertilizers	5191.3
Bio-pesticides	4743.3
Bio-fertilizers + bio-pesticides	5140.5

ns – not significant

(Average yield in (g.) from 20 plants, 4 replications and 19 pickings) treatment had 20 plants.

Treatment 1: Bio-fertilizers and Compost (FYM):10kg, Nitro fix: 15.36g, P-sol-B: 19.2g, K-sol-B: 38.4g, Agri-VAM: 17.4g

Treatment 2: Bio-pesticide and Compost (FYM): 10 kg, *T. viride: 12.8g*, *T. harzianum*: 12.8g, *P.fluorescens:* 21.8g, *M.anisoplae: 43.6g*, *Paecilomyces* spp.:43.6g, *B. subtilis:* 8.7g

Treatment 3: Bio-fertilizers + Bio-pesticides and Compost (FYM): 10 kg, *T.viride: 12.8g*, *T. harzianum:*12.8g, *P.fluorescence:* 21.8g, *M. anisoplae: 43.6g*, *Paecilomyces* spp.:43.6g, *B. subtilis:* 8.7g , compost (FYM):10kg, Nitro fix: 15.36g, P-sol-B: 19.2g, K-sol-B: 38.4g, Agri-VAM: 17.4g

Treatment 4: Farmers' practice: Urea: 76.8Kg, DAP: 40g, Potash: 76.8g, Compost (FYM):10kg were applied before the emergence of new leaves.

Treatment 5: Control

Yield of tea was not significantly different among the treatments.

Gender

Patriarchal Value and Practice (PVP) has governed Nepalese society and created the gender discriminative status between man and woman. To break down the gender discrimination, Nepal government has taken initiation of gender equality laws, polices and rules. The gender survey in IPM CRSP was designed to analyze the participation, access to assets, beliefs/perception and laws and policies on gender perspective in three districts of Nepal, two districts are located at Hill and one is Terai.

Majority respondents (15% male & 46% female) are belonging to Bahun, Chetri, Janajati, Dalit and Madhesi communities, and altogether 74% female and 26% male respondents were participated in the study. Majority women had primary level education and majority men have higher secondary school level. This information indicates that women had opportunity of education, but at lower level. Majority households (97% women and 90% men) are involving in vegetable production. 75% women and 90% men decide their product price as per market. They sold vegetables two times in a week except one household. 73% women out of 59 female respondents and 62% men out of 21 male respondents were members of Market Planning Committee and Community Forest User Group.

The patriarchal beliefs and practices still dominate unequal status of women and men in all communities and classes in Nepal. Although, government has taken initiation gender equality policy, rules and budget to minimize the gender issues giving emphasis to increase women's participation in all types of programs. Similarly, program implementing organizations are also alerted on gender equality and they have focused to increase the number of women.

Ecologically-Based Participatory IPM for Southeast Asia

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Summary

In this phase of the IPM CRSP Cambodia was added to the countries involved with the IPM CRSP in the region. The objectives of the project in Cambodia are focused on transfer of proven IPM tactics developed and implemented during previous phases of the IPM CRSP. To this end, after meetings with an array of government and NGO organizations currently active in agricultural development projects with the purpose of identifying appropriate collaborators the National IPM Program, housed in the General Directorate of Agriculture, was selected and initial activities were begun.

With the beginning of phase IV, some of the regional project's previous collaborators were deleted from the program while the collaborators best suited to the technology transfer emphasis of the new phase were strengthened. In the Philippines, PhilRice and the University of the Philippines at Los Banos are the leading institutions. Each is focusing on vegetable IPM in their respective regions. Eggplant, onion, tomato, bitter gourd, and chilies are the major vegetables for these efforts.

In Indonesia, collaborators continue to be the *Institut Pertanian Bogor* (IPB) in West Java, Sam Ratulangi University in North Sulawesi, and FIELD/Indonesia which conducts farmer training in technology transfer activities in North and West Sumatera. The USAID Mission in Jakarta is emphasizing high value crops in their Mission strategy, which meshes well with the IPM CRSP program already established in Indonesia. Vegetables, including tomato, peppers, onion, and crucifers, are important high value crops that the IPM CRSP has been working with for many years. Fruits, including papaya, are important because of their high value income generation, but also because recent attacks by the papaya mealybug provide a significant need for IPM intervention. IPM CRSP collaborators in Indonesia are conducting field tests and outreach activities that directly relate to the USAID strategy.

Indonesia

Institut Pertanian Bogor, Bogor, West Java

Papaya

Economic impact of the papaya mealybug invasion

Ivakdalam L, A Nurmansyah, D Sartiami, A. Rauf, M. Hammig

Papaya (*Carica papaya* L.) is one of the important horticultural crops in Indonesia. Based on the consumption rate per capita, the economic potential of papaya ranks second

Table 1: Benefits and costs analysis of papaya cultivation before the invasion of Papaya mealybug in subdistrict of Sukaraja, Bogor

Farm enterprises Component	Village				Mean
	Cikeas	Sukaraja	Sukatani	Nagrak	
Production costs (million rp/ha)	45.6	41.5	42.7	41.0	42.7
Yield (ton/ha)	158.6	158.9	177.8	186.3	170.4
Revenue (million rp/ha)	142.7	143.1	160.0	167.7	153.4
Profit (million rp/ha)	97.2	101.5	117.4	126.6	110.7
R/C	3.13	3.44	3.75	4.09	3.59

after banana. In mid 2008, thousands of papaya trees in Bogor died because of a new pest, *Paracoccus marginatus* (Hemiptera: Pseudococcidae). The most severely infested papaya plantings were in the subdistrict of Sukaraja. As a result of the outbreak of papaya mealybug, most papaya farmers replaced their plants with cassava plants. A survey was conducted from August to October 2009, with the objective to assess the economic impacts of the papaya mealybug infestation.

The survey was conducted by interviewing 40 papaya farmers spread across four villages (10 respondents per village). The economic impact of the papaya mealybug infestation was assessed using simple benefits and costs ratio analysis for a one year period at the time before and after the arrival of papaya mealybug, as well as after farmers switched to cassava cultivation. The results of the analyses are presented in Tables 1, 2, and 3.

Prior to the invasion of papaya mealybug, the average papaya production was about 170 tons/ha (Table 1). Papaya cultivation required a substantial capital. The average production cost was 42.7 million rupiahs per hectare, of which the largest expenditures were for fertilizer and labor. In spite of that, the papaya business was very promising (R / C = 3.59) because the average profit that farmers gained from this business was about 110 million rupiahs per hectare. Apparently, this gain had attracted many residents, especially those who had capital, into the papaya cultivation.

After the infestation of papaya mealybug, yield declined from the previous year, to an average of 71.7 ton / ha (Table 2) or a decrease in

Table 2: Benefits and costs analysis of papaya cultivation after the invasion of Papaya mealybug in subdistrict of Sukaraja, Bogor

Farm enterprises Component	Village				Mean
	Cikeas	Sukaraja	Sukatani	Nagrak	
Production costs (million rp/ha)	58.0	86.9	83.2	86.8	78.7
Yield (ton/ha)	83.7	74.5	69.7	59.1	71.7
Revenue (million rp/ha)	75.3	67.0	62.7	53.2	64.6
Profit (million rp/ha)	17.3	-19.9	-20.5	-33.6	-14.2
R/C	1.29	0.77	0.75	0.61	0.82

production of around 58%. At the same time, the production costs increased from the previous amount of 42 million rupiahs per hectare to 78 million rupiahs per hectare, an increase of approximately 46%. This cost increase was caused by the increased use of insecticides. Before the mealybug infestation, papaya farmers usually applied insecticides once a month, but after the attack, the farmers increased the frequency of insecticide application to every week or even with some of the farmers, every three days. The average cost increased from 2.0 million rupiahs to 5.7 million rupiahs, an increase of 3.7 million rupiahs. As a result of the increase in production costs and decrease in production, the profit that farmers gained decreased and they even suffered a financial loss as shown with the value of R / C in Table 2, which was 0.82.

After the outbreak of the papaya mealybug in 2008, almost all farmers in the subdistrict of Sukaraja replaced papaya with cassava as their main commodity. The commodity replacement was done because the papaya farmers were not able to control this new pest, although they had already sprayed many kinds of insecticides. The reason why the farmers chose cassava as a substitute for papaya was because cassava cultivation did not require as much intensive care as with papaya cultivation. In addition, around the cultivation area there were many tapioca mills that would buy their produce.

Compared to papaya cultivation, the production costs of cassava cultivation were much smaller with an average of 3.3 million rupiahs per hectare (Table 3). This lower cost was due to the method of cassava cultivation which is much simpler than papaya cultivation. The largest portion of the cost was for seed and labor. The price of seeds was 100 rupiahs per stem and the labor needed was about 4.43 men per day. The average yield of cassava was 23.5 ton / ha.

The results showed that the cultivation of cassava still provides benefits to farmers in the four villages surveyed, with an average profit of 13.2 million rupiahs per hectare (Table 3). However, this advantage was much smaller than when the farmers still cultivated papaya without mealybug infestation. At that time, the average profit of papaya farmers was 110.7 million rupiahs per hectare. This means that the profit obtained by farmers was reducing about 88%. In addition to this negative impact on economic profit, the mealybug infestation also affected the income of farm laborers. Papaya cultivation required a lot of laborers for maintenance and harvesting; this was different from the cultivation of cassava. Thus, the shift from papaya to cassava planting was thought to have led to reduced local workforce that could be employed.

Table 3: Benefits and costs analysis of cassava cultivation in subdistrict of Sukaraja, Bogor

Farm enterprises Component	Village				Mean
	Cikeas	Sukaraja	Sukatani	Nagrak	
Production costs (million rp/ha)	2.9	2.8	4.4	2.9	3.3
Yield (ton/ha)	25.6	22.4	27.0	18.9	23.5
Revenue (million rp/ha)	18.0	15.7	18.9	13.2	16.4
Profit (million rp/ha)	15.1	12.8	14.5	10.3	13.2
R/C	6.2	5.5	4.3	4.6	5.1

Culturing of papaya mealybug in the laboratory

Maharani Y, D Sartiami, R Anwar, A Rauf, BM Shepard

Invasion of the papaya mealybug in early 2008 has caused serious damage to papaya production in Bogor. Biological studies of the papaya mealybug were carried out for development of integrated pest management of the pest. To study the development and reproduction of the papaya mealybug in the laboratory. Papaya mealybug was confined in a micro-cell chamber that was comprised of two acrylic plates (2 x 4 cm), with a 1 cm diameter hole in the middle and a piece of papaya leaf placed between the plates. Immature development, adult longevity, and number of eggs laid were checked daily. The female passed through three nymphal instars whereas the male had four nymphal instars. The first instar known as crawlers, are very active and move from one part of the plant to another. Subsequent instars tend to settle and less mobile. The difference in appearance between male and female papaya mealybugs can be determined during the latter part of the second instars when males change their color from yellow to pink. The difference becomes more evident in latter instars and in the adult. Third (prepupa) and fourth (pupa) nymphal instars of males are pink in color and have elongate bodies covered by a cocoon made from fibers of wax. The third nymphal instar of females have oval bodies and are yellow in color.

The adult female has no wings. The total immature developmental time was 26-27 days. Adult females lived for 15 days while males lived for 3 days. When females were reared on a piece of papaya leaf in a micro-cell chamber, numbers of eggs laid was 48.2±5.50 (n=27). In another experiment using caged living papaya seedlings as a source of food, the fecundity averaged 324.6±41.8 (n=10). This indicated that the rearing condition and quality of food affect the fecundity of papaya mealybug. The sex ratio of adults emerging on caged papaya seedlings was female-biased, with the mean proportion of adult females being 88.6±1.4%. To determine whether the papaya mealybug can develop parthenogenetically, twenty virgin females were held individually without males in a micro-cell chamber until they died. None of them laid eggs, indicating that there is no evidence for parthenogenetic reproduction in papaya mealybug.

Predation preference of *Curinus coeruleus* on the papaya mealybug

Pramayudi, N., A. Rauf, B.M. Shepard, E. Benson

The lady beetle, *Curinus coeruleus* (Mulsant) was introduced into Indonesia from Hawaii in 1986 to control leucaena psyllid, *Heteropsylla cubana* Crawford. During the outbreak of the papaya mealybug in Bogor, the beetle was often found associated with the papaya plants infested by the papaya mealybug. Studies were conducted in laboratory with the objectives to determine development and predation preference of the beetle on the papaya mealybug. Our studies revealed that eggs of *C. coeruleus* hatched in 7.00 days. Development of larval first instar took 6.06 days, second instar 5.5 days, third instar 6.11 days, and fourth instar 8.43 days. The pupal stage was 6.66 days. The longevity of male adult was 49.08 days, while that for female was 76.99 days. Number of eggs laid by a single female averaged 145.68. The sex ratio of male to female was 1:3. Life table analysis indicated gross reproductive rate (GRR) was 101.934, net reproductive rate (Ro) 93.776, intrinsic rate of increase (r) 0.073, mean generation time (T) 62.461 days, doubling time (Dt) 9.534 days, and finite rate of increase (λ) was 1.075. In a no-choice test, significantly ($p < 0.001$) higher numbers of nymphal instar I of the mealybug were preyed upon as compared to other instars. Similarly, in a free choice test, the predator significantly preferred nymphal instar I of the mealybug. None of the adult females of papaya mealybug were preyed on by the

Figure 1 : Entomopthoralean-infected (black) and healthy (yellow) mealybugs

predator in a free-choice test. The preference of the predators toward nymphal instar I of the prey was thought to be related to body size. Nymphal instar I is smaller than others and its body is not covered with wax.

Entomophthoralean fungus and parasitoid of the papaya mealybug

Anwar, R., A. Rauf, Pudjianto, G.R. Carner, B.M. Shepard, R. Muniappan

An entomophthoralean fungus tentatively identified as *Neozygites* sp. has been observed in many samples of the papaya mealybug. Infected mealybugs become black in color as compared to yellow in healthy ones (Fig.1). Field surveys on papaya mealybug were conducted in 2009 in papaya plantations in Bogor, Sukabumi, Tangerang, Cianjur, Purwakarta, West Java, and Lebak, Banten. The objective was to determine natural control potential of entomophthoralean fungus on papaya mealybug in the field. Our study showed that the highest level of fungus infection on papaya mealybug occurred at a papaya plantation in Bogor. The vegetative stage was the predominant stage found at almost all locations. Others fungus stages found were primary conidia, conidiophores and saprophytic fungus, especially in Bogor. Papaya mealybug infected by secondary conidia occurred in Bogor and Tanggerang. There was no papaya mealybugs found infected by resting spores. Another study in subdistricts of Sukaraja and Rancabungur, Bogor during March to May 2010 revealed that level of fungus infection varied between stands and times. The level of fungus infection increased whenever the papaya mealybug population was high. It seemed that entomophthoralean fungus, tentatively identified as *Neozygites* sp., offers a great potential for naturally occurring biological control.

Another promising natural enemy was an encyrtid that was recently collected in Bogor. The parasitoid was identified as *Acerophagus papayae* Noyes and Schauff by Dr. Gregory Evans, a taxonomist from USDA. *Acerophagus papayae* is the dominant parasitoid controlling papaya mealybug in Puerto Rico and the Dominican Republic. It is believed that the parasitoid was accidentally introduced into Indonesia along with the host *Paracoccus marginatus*.

Onion

Efficacy of several natural UV protectants for SeNPV

Samsudin, Y.M. Kusumah, T. Santoso, A. Rauf, B.M. Shepard, G. Carner

This experiment aimed to study the effectiveness of several subtances as UV protectants. Several powdered subtances used as protectants were husk charcoal powder, coconut shell charcoal, soot, talcum powder and yam bean powder, whereas the liquid subtances used were molasses, green tea filtrate, turmeric filtrate and yam bean filtrate. Each of the UV protectants, 0.1 mg or 0.1 ml, was added to 10 ml virus suspensions (1.13 x 10^8 PIBs/ml) to make a 1% final concentration. The UV protectants and virus suspension were mixed thoroughly and three drops of each mixture was applied using a Pasteur pipette onto artificial diet in medicine cups. The cups were placed under direct sunlight for 30 minutes at 12.30 -19.00 in the afternoon. Each treatment was repeated 4 times with 30 cups per repeat. After sunlight treatment, a third instar larva of *Spodoptera exigua* was placed into each cup. All of the cups were placed at room temperature.

Based on the OAR (original activity remaining) values, it is showed that 30 minutes exposure to direct sunlight reduced the infectivity of SeNPV as much as 50% of its original potential. Addition of natural compounds, except the talcum powder, effectively reduced the loss of SeNPV infectivity due to direct sunlight exposure, as shown by the RE (relative efficiency) values which are significantly different from the negative control (Table 4). The same result was also observed in the liquid UV protectants treatment. The RE values show that molasses, yam bean filtrate, turmeric filtrate, and green tea filtrate were effective as UV protectants for SeNPV from UV radiation.

Tomato and Chili Pepper

Survey for virus diseases of chili and tomato

Detection and diagnosis of viruses was initially implemented by collecting field samples from West Java for mainly three vegetable crops, i.e. tomatoes, chili pepper, and long bean. Serological technique using ELISA (enzyme-linked immunosorbent assay) was routinely used for early detection method. Further diagnosis using PCR and nucleic acid sequence analysis of the PCR product was undergone when necessary. ELISA of tomatoes and chili pepper was usually conducted using 4 different antisera, i.e. tobacco mosaic virus (TMV), cucumber mosaic virus (CMV), general poty virus, and one additional antisera for chili pepper i.e. chili veinal mottle virus (ChiVMV).

Table 4: OAR dan RE values of powdered UV protectants

Treatments	OAR (%)	RE
Control (-)	54.08	1.00 d
Talcum powder	62.83	1.16 cd
Yam bean powder	69.80	1.29 bc
Husk charcoal powder	78.62	1.45 b
Soot	79.40	1.47 b
Coconut shell charcoal	80.79	1.49 b
Control (+)	100.00	1.85 a

PCR method for detection of geminivirus was also conducted as routine activities since geminivirus infection has become epidemic in tomato and chili pepper in Indonesia for the last few years. Tomato and chili pepper samples from fields at Cipanas, Bogor, West Java, no infection of TMV, CMV, ChiVMV was detected but geminivirus infection was positively detected from 50% of chili pepper samples. This result was not surprising since we have learned from previous surveys, conducted on a yearly basis since 2006, that geminivirus is the predominant virus in tomato and chilli pepper. Geminivirus infection was thought to be associated also with yellow disease in long bean which occurred widely just recently in Indonesia. Specific diagnosis study was conducted by transmission experiment using whitefly and grafting, and intensive PCR based technique using universal primers for CMV, TMV, Luteovirus, CaBMV, Potyvirus, Crinivirus, and Geminivirus. No amplification product was gained except when using universal primers for coat protein core of Potyvirus (MJ1 and MJ2). This PCR product was further used for sequencing and the sequence analysis showed that the virus has the closest relationship with BCMV-BIC isolate VN/YB1, known to cause infection of *Vigna unguiculata* in Vietnam.

Sam Ratulangi University, Manado, North Sulawesi

Tomato

Resistantance of tomatoes varieties to viral diseases

All lines of tomatoes received from AVRDC were infected by different kinds of viral diseases. There is no significant difference in infection of viral diseases among the lines tested.

All the lines showed symptoms of mosaic, necrosis, and chlorosis. The highest percentage of infection was on line WVCT-6 with about 15.5 % followed by WVCT-1, WVCT-5, WVCT-2 and WVCT-8 with 11, 10.5, 7.5 and 7.0 %, respectively. Less than 5% infection was noted in the local varieties Amelia, Anna, Permata and Chung.

Use of Yellow Sticky Traps in Tomato Field

D.T. Sembel, M. Meray, M. Ratulangi, E. Baideng

Yellow Sticky Traps were used for monitoring leafminer, *Liriomyza sativae* and its parasitoids in tomato fields. The traps also caught a few adults of the fruit fly, *Bactrocera papayae*, which has become a serious pest of tomato in North Sulawesi.

Application of Plastic Mulch, Rice Straw Mulch and Yellow Sticky Trap on Tomato Crops

D.T. Sembel, M. Meray, M. Ratulangi, E. Baideng

The population of the leafminer, *Liriomyza sativae* in plots without pesticide was lower than the plots with pesticide sprays. This is in concurrence with reports of other researchers as the populations of the parasitoids are severely affected by the sprays and the leafminer is resistant to most insecticides. The polulation of the leafminer in plots with plastic mulch was much lower than in control plots and plots with rice mulch.

Cabbage

Parasitism of Plutella xylostella by Diadegma eucerophaga in Cabbage

Samples of larvae of *P. xylostella* were collected from cabbage plantations in Rurukan (Tomohon) and Modoinding (South Minahasa) during the period April to August 2010. All samples were individually placed in plastic cups in the laboratory and the number of *P. xylostella* adults and the parasitoid, *D. eucerophaga* emerged were counted. The average parasitism of *P. xylostella* by *D. eucerophaga* on cabbage crops in Rurukan, Tomohon during the period between April to August 2010 was 91%, and at Modoinding was 71%.

Chili

Varietal preference of Aphis gossypii and Myzus persicae.

High populations of *Myzus persicae* were found on AVRDC chili pepper lines PP0543-139, PP0209-4 and PP97-7195-1 followed by local varieties Seta Super and Dewata F1. The lowest population was collected on PP9852-173 and PP0543-139

Higher populations of *Aphis gossypii* were found on PP0209-4, PP97-7195-1, Dewata F1 and Bara. The lowest populations were found on PP9852-173 and Seta Super.

Virus disease incidence in chili peppers

The highest percentage of infestation by viral disease was on PP0209-4 (63.8%) followed by Dewata F1 (62.8 %) and PP97-7195-1 (54.1 %). The lowest infestation was on PP0543-139 (37.5 %) and Bara (43 %).

Pseudomonas fluorescens from different soils in North Sulawesi

Some strains of *P. fluorescens* have been isolated from vegetable growing areas in Rurukan, Toure and Modoinding. These strains are being purified and identified for further characterization.

Papaya

Distribution of Paracoccus marginatus on papaya in North Sulawesi.

In August 2009, papaya trees in Manado were found infested by the papaya mealy bug, *P. marginatus*. Surveys conducted from April to September 2010 on papaya in North Minahasa, South Minahasa, Bolaang Mongondow, North Bolaang Mongondow, and West Bolaang Mongondow in North Sulawesi and found no papaya mealybug infestation.

FIELD/Indonesia, Medan, North Sumatera, Padang, West Sumatera

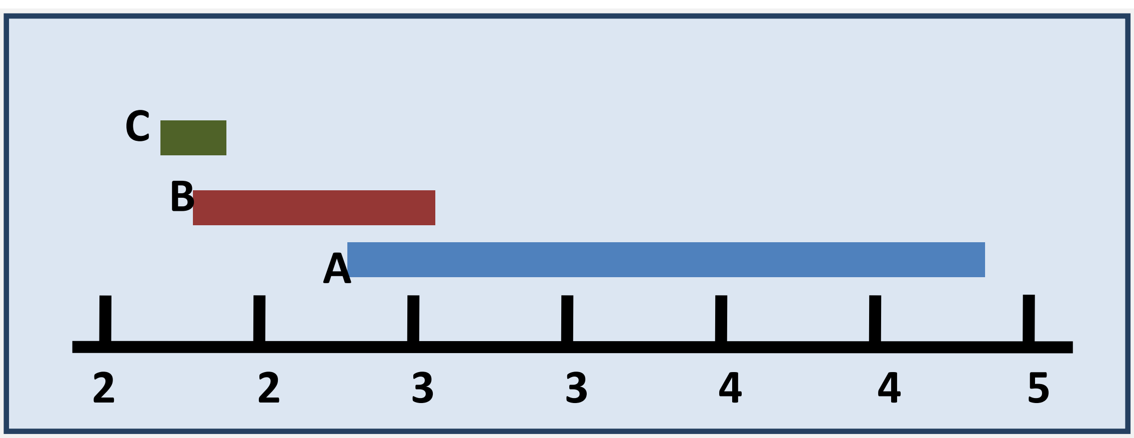
Cacao IPM Program

Formasi Pelita Kasih Farmers' Network of Sibolangit conducted a study in a cacao plantation with the following treatments.

A. compost + pruning
B. pruning only
C. control (no compost, no pruning)

The compost used for this study was prepared from mixture of: coconut water (20 liter), banana stem (10 kg), leaves (10 kg), durian rind (5 kg), goat manure (20 kg), wood sawing waste (20 kg) and kitchen waste (30 liter).

The result showed that treatment A (compost + pruning) gave significant increase in yield



Cacao yield in different treatments: Compost + Pruning (A); Pruning (B) and Control (C) compared to control, but not significantly different from treatment B (pruning only).

The use of compost and pruning technologies are being disseminated to other cacao farmers in Sibolangit area.

Philippines

Philippine Rice Research Institute - PhilRice

Eggplant, tomato, watermelon, melon, squash, bottle gourd

Development of vegetable disease diagnostic kit/tool for farmers

Vegetables are considered as cash crop in the rice-based cropping system. Diseases are limiting factors of the pre- and post-harvest production. There are about 57 diseases known attacking lowland vegetables. So far, we have identified 20 of them – 11 caused by fungi, 5 by bacteria, 6 by viruses, and 1 by nematode. Only common diseases of onion and tomato were fully reported and are published as field guide.

Availability of reliable and simple disease diagnostic kit is the key to help farmers in planning and deciding efficient disease management strategies. Quick and accurate plant disease diagnosis prior to taking action is the most efficient tool in disease management. Hence, this project aims to develop a simple and easy-to-use vegetable disease diagnostic kit/tool for farmers.

Simple diagnoses of common diseases of lowland vegetables were compiled based on vegetable crop, pathological types of the disease, disease symptoms, signs, disease onset and severity, and predisposing factors. All the diseases identified are presented in colored photos so that farmers can compare with the actual disease/diseases they encounter in their fields.

Development of biological control formulation for the management of soil-borne diseases

Bacterial biological control and root growth promoter and free-N fixing bacteria are indigenous resources in the rice-based vegetable cropping systems, yet they have not been explored and applied efficiently. Some isolates are collected and maintained at the Plant Pathology Laboratory of PhilRice.

Characterization of microbial bio-diversity associated with lowland vegetables is being done. This will identify rhizospheric and endophytic bacteria associated with rice-based vegetable farming systems. Hence, soil samples from different vegetable fields (chili, biter gourd, onion and winged bean) were taken and composited for isolation, identification and evaluation of their BCA potential.

Bacillus subtilis, B. pumilus, and *B. polymyxa*, *Streptomyces* spp. were commonly found in soil planted to the bitter gourd and winged bean. Biodiversity studies on the bacterial community in onion, bitter gourd and winged bean has been initiated. Assessment of growth plant hormonal bacteria isolates is also ongoing.

Initial in-vitro assay identified two isolates of *Bacillus subtilis* (C6 and E3) which are antagonistic against the fungal pathogen causing gummy stem blight of cucurbits and *Cladosporium* sp. of okra. Liquid and powdered forms of *Bacillus species* were initially produced for field trial against soil-borne pathogens of bitter gourd. Shelf-life of these bacterial preparations is about 6 months. Most of the liquid formulation had pH 5.6 which are compatible with the pH of the soil required for vegetable production.

Effective *Trichoderma* sp. and VAM have been identified and developed and now being promoted by the IPM CRSP/PL480 Projects. VAM besides its BCA property, also acts as biofertilizer. In a study conducted, using 780kg

VAM/ha costs P6,940. This is equivalent to the application of 130-108-84kg NPK/ha of inorganic fertilizer for onion costing P18,000 resulting in a savings of P11,060 or 61%.

Paeclomyces spp. for the management of whiteflies and thrips in vegetable crops

H. X. Truong, K. B. Pangilinan, H. R. Rapusas

The whitefly, *Bemisia* sp. is a serious pest of various vegetable crops. Farmers rely on the use of synthetic insecticides. However, this practice created pest resistance, hazard to the environment, and affect non-target organisms. Hence, the use of microbial agents is being explored in terms of identification of virulent and effective microorganisms, mass production of these organisms, and the safe and effective delivery system in the field.

Three species of beneficial fungi were identified (*Metarhizium anisopliae*, *Paecylomyces* spp., and *Beauveria bassiana*) to cause mortality of eggs and nymphs of the whitefly. However, *Paecilomyces* isolates were found most effective. Hence, collection of different isolates was continuously done resulting in 315 isolates collected. Of these, 160 were initially screened and 21 isolates showed potential for the management of this pest.

Currently suitable substrates for mass production are being identified for optimum fungal growth (spores/conidia) for the formulation. Further studies are being conducted to determine the right amount of spore concentration to be inoculated in the substrate, maximum days of incubation and proper drying of the substrate. Field testing on the effectiveness of *Paecilomyces* is being conducted.

Onion, bittergourd, chili pepper

Village level production and utilization of NPV in rice-vegetable cropping system

G. S. Arida, B. S. Punzal, B. M. Shepard

The high cost of insecticide inputs and its toxic effects to farmers and the environment is a big concern in vegetable production worldwide. Naturally-occurring beneficial organisms like NPV could be mass produced by farmers and use for several species of lepidopteran pests. Earlier studies showed that this organism could be mass produced and could be used by onion farmers with similar effect as synthetic insecticides for cutworm. Furthermore, several farmer cooperators successfully used NPV against the common cutworm, *Spodoptera litura* in onion.

A total of 118 (81 male and 37 female) vegetable farmers from four villages in Bayambang, Pangasinan attended demonstrations on the techniques in mass production and use of NPV from January to February 2010. Some farmers tried mass producing the organism themselves. The stock culture we used came from our culture maintained by the IPM CRSP group of the Crop Protection Division of PhilRice.

Onion, tomato, eggplant

Technology transfer, promotion and dissemination of pest management technologies

H. R. Rapusas, Ev Parac, Glenn Ilar, S. E. Santiago, J. M. Ramos

Implementation of IPM training programs on onion and other vegetables

Different types of trainings were conducted – Specialized training of trainers usually one week long (TOT), season-long training for farmers and agricultural technicians popularly known as farmers field school (FFS), a two-day intensive training composed mainly of lectures/

discussions, one-day technical briefings, specialized training (practicum- usually hands-on activities on specific activity or technology).

Farmers Field Schools (FFS).

There were 17 FFS conducted in different provinces and municipalities. Most of these were on IPM on onion, garlic, eggplant, tomato, bitter gourd and other vegetables. These were conducted mostly in Pangasinan, La Union, Ilocos Sur, Ilocos Norte, Nueva Vizcaya, and Nueva Ecija. We graduated 629 participants ranging from 20 to 60 participants from each site. Of these, 486 (77%) were males and 143 (23%) were females.

Farmers' trainings/briefings

These are usually a one-day or two-day activities. Nine farmers trainings/briefings were conducted in nine sites with a total of 302 participants. There were 219 (73%) male participants and 83 (27%) females. Four of these were conducted in Pangasinan, one each in Pampanga, Nueva Ecija, Nueva Vizcaya and two in Ilocos Sur.

Farmers' Field Days

Five farmers' field days were conducted during the year – Tomato field days in Catablan, Urdaneta City, Pangasinan and Sucsusquen, Piddig, Ilocos Norte, eggpalnt field days in Nalvo, Pasuquin, Ilocos Norte and Mulmulaan, Paoay, Ilocos Norte and an onion field day in Caranglaan, Alcala, Pangasinan. During the field days, farmers from other barangays were also invited.

Information Campaign (Oplan Sagip Sibuyas)

This information campaign was launched in Bayambang, Pangasinan (the highest onion producer of the province). This campaign supplemented the IPM activities after the launching. From the information gathered from baseline surveys and FGDs, The most serious problems of the onion growers are pests and diseases. The campaign aimed to increase/enhance rice-onion farmers' knowledge, attitude, and practice on the management of common insect pests and diseases which are causing major yield reduction in rice-onion farming system in the focus barangays.

During the launching, 401 farmers, extension workers, municipal and barangay officials, teachers, researchers, students/pupils and press people attended and participated. The launching was highlighted by a mini parade around the town.

After the launching, FFS and information caravans followed, campaign jingles produced, information materials produced and disseminated. Among the major activities of the campaign are media releases, information caravans, exhibits, farmers' field schools, distribution of extension materials like flyers, posters, bulletins, etc.

Campaign stories were also prepared and distributed to press people. Likewise, a blog site (http://OplanSagipSibuyas.wordpress.com/) is continuously maintained and regularly updated. IPM technologies were also made available on the Pinoy Farmers' Internet (http://www.OpenAcademy.ph/) under the vegetable category.

Village-level production, integration and implementation of VAM and *Tricboderma* sp.

H. R. Rapusas, S. E. Santiago. J. M. Ramos, M. B. Brown

As a result of the trainings or practicum on the mass production of VAM and *Trichoderma* sp., some groups of farmers (farmers' association/cooperatives) started mass producing the BCAs for a village-level or community-wide production and implementation of the technologies for different vegetable crops, onion, corn and even for tobacco in northern Philippines. These farmers realized the benefits of these BCAs in their vegetable production.

In the economic assessment conducted on the use of VAM and *Trichoderma* sp. their was an increase of 23% of the adopters over the non-adopters. There was also a reduction 46% and 19% on cost of fungicides and fertilizers, respectively in favor of the adopters. Analysis showed that farmers using both VAM and *Trichoderma* sp., the adopter/user had a net income averaging to P76,029.37/ha while the non-adopter/user had P26,179.05/ha resulting in an increase in net income of users by 169.56% over that of the non-users. This implies that the use of BCAs have contributed a lot in the reduction of production costs of users/adopters of the technologies.

Eighty percent (80%) of the sites where the practicum were conducted started mass producing the products at the village level.

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Tomato and Eggplant

Evaluation of new IPM technologies for IPM in tomato and eggplant:

For the IPM treatment, seedbed was prepared by adding 10 kg/ha of VAM (vesicular arbuscular mycorrhizae) to autoclaved garden soil. For the farmers' practice plots, no VAM was added to the seedbed. The experimental area was prepared with one plowing followed by two harrowings. Complete fertilizer (14-14-14 NPK) was applied basally prior to transplanting and urea (45-0-0 NPK) was side-dressed at 30 days after transplanting. Thirty-day old seedlings of tomato cultivar "Diamante" and of wild cherry tomato were transplanted on June 25, 2010 at a distance of one seedling for every 0.5 m^2, (approximately 20,000 seedlings per ha). Plants were irrigated as needed with a deep-well pump.

The treatments were 1) use of wild cherry tomato; 2) use of earwigs (*Euborellia annulata*; 20,000 earwigs/ha released at 7 and 14 WAT; 3) use of *Trichogramma chilonis* (six releases of 50 *Trichogramma* cards/release at 30, 34, 38, 42, 49, and 56 DAT); and 4) use of rice straw mulch (2.5 cm thick) applied at 7 DAT for weed control and to serve as refugia for the earwigs followed by two handweedings at 6 and 12 WAT.

The treatments for farmers' practice plots were 1) use of commercial cultivar 'Diamante': 2) weekly spraying of insecticide Selecron (profenofos, 1 L/ha) starting at 14 DAT; 3) weekly spraying of fungicide Dithane (mancozeb, 1 L/ha) starting at 14 DAT; 4) handweeding 7 times (2, 4, 6, 8, 10, 12 and 14 WAT).

Earwigs collected from borer-infested corn fields, were reared in the laboratory in acrylic pans (14.5 cm wide x 8.5 cm depth) containing 2-3 cm vermi-compost soil. A colony can be started with 5 acrylic pans, each containing 6 female and 3 male adult earwigs. The earwigs are fed with 1 tablespoon fry mash every 10 days. The females are allowed to lay 4 to 6 batches of eggs (40 eggs/batch) and eggs are allowed to hatch within 7 to 9 days. From the stock colony, 150 female and 50 male adult earwigs are placed inside a mass rearing box (37.5 cm x 73 cm x 28 cm) containing vermi-compost soil. The adults are fed with 400 g of fry mash initially, then with 200 g fry mash per box every 10 days. Additional cultures can be prepared by collecting the third instar nymph, placed in another acrylic pan with vermi-compost soil and fed until adulthood. At least 10 rearing boxes should be maintained for a 1-ha vegetable farm and should be set up 1.5 months ahead of planting date. The earwig adults are released twice, at 7 and 14 DAT, with two earwigs/m^2 or a total of 20,000 earwigs/ha. Continuous release of earwigs every cropping season is necessary to establish adequate earwig population in the vegetable

Table 1. Degree of weed, insect and disease infestation in tomato treated with IPM and Farmers' Practice in UPLB Central Experiment Station, June-October 2010

Treatment	Weed FW (g/m²)	Fruitworm % fruit damaged	Leafhopper % plant damaged	Leaf curl % plants damaged
Farmers' practice: cultivar 'Diamante'	183.5	37	25	100
IPM: wild cherry tomato	184.2	5	15	36
Reduction over Farmer's practice (%)	0	86	40	64

field. Mulching with rice straw at 7 DAT provides refugia for earwigs while preplanting cultural practices such as plowing and harrowing reduces earwig populations.

Treatments were replicated four times and laid out in a randomized complete block design. The degree of insect pest infestation (tomato fruitworm, leafhopper and whitefly) were recorded weekly and expressed as percent of fruits or plants damaged. The degree of disease infestation (tomato leaf curl virus) was recorded weekly and expressed as percent of plant or fruits damaged. Weed density (number/m^2) and fresh weight (g/m^2) by species were recorded at 4 WAT and at harvest.

Fruits were harvested starting from 45 to 115 days after transplanting Total yield (weights of marketable and non-marketable fruits) were recorded and yield expressed in t/ha. Cost of all crop protection and crop production inputs were recorded to estimate net profits obtained from the IPM treatments and were compared with those obtained from treatments with farmers' practices.

The wild cherry tomato showed two- to three-

Table 2. Fruit yield, crop value, pest control costs, total production costs and net profit in tomato treated with IPM and Farmers' Practice in UPLB Central Experiment Station, Laguna from June to October, 2010.

Treatment	Yield (t/ha)	Crop Value ($/ha)[1]	Weed Control Cost ($/ha)	Insect Control Cost ($/ha)	Disease Control Cost ($/ha)	Production cost ($/ha)	Net Profit[2] ($/ha)
Farmers' practice: cultivar 'Diamante'	6	4680	249	125	30	1, 140	3,540
IPM: wild cherry tomato	5	3900	115	47	8	871	3,029
Reduction over farmers practice (%)	16	16	54	62	73	24	14

[1] Farmgate price of tomato = Php 35/kg or $0.78/kg; $1 = Php45.00

[2] Total production cost – Pest control costs + other costs

Net profit: Crop value minus total production cost fold higher resistance to the tomato leaf curl virus, with 64% less incidence of the leaf curl virus compared with the commercial cultivar Diamante (Table 1). It also had higher resistance to insect pest infestation, with 86% lower infestation of fruitworm and 40% less infestation from leafhopper damage. Weeding treatments showed that three handweedings in the IPM plots provided adequate control, which was similar to control provided by seven handweedings in the farmers practice plots. This indicates that three handweedings is adequate for season-long weed control and that there is no need for seven handweedings throughout the season.

The cost of control from the IPM practices were also lower by 54% for weed control, 62% for insect control and 72% for disease control, resulting in total production costs which were 24% lower in the IPM plots than in the farmer's practice plots (Table 2). However, because the cherry tomato has small fruits compared to the commercial cultivar 'Diamante', it yielded 16 % lower marketable fruits than the commercial cultivar with a corresponding reduction of 14 % in net profits in the cherry tomato cultivar compared with 'Diamante'.

Thus, in spite of the 100% infestation from leaf curl virus, the cultivar Diamante still produced fruits, thus the lower crop protection costs incurred from using the wild cherry tomato cultivar was not able to compensate for its low yields, resulting in net profit which was 14% less than net profit obtained from using the commercial cultivar Diamante.

Eggplant

The study was conducted at the UPLB Central Experiment Station from June to October 2010.

Seedbed was prepared by adding 10 kg/ha of VAM (vesicular arbuscular mycorrhizae) to autoclaved garden soil for the IPM treatment. For the farmers' practice plots, no VAM was added to the seedbed.

A wild eggplant cultivar known to be resistant to bacterial wilt (*Ralstonia solanacearum*) was used as rootstock and grafted to a high yielding but bacterial wilt-susceptible commercial variety of eggplant, Dumaguete Long Purple (DLP). Seeds of the wild eggplant cultivar were sown 2 weeks ahead of Dumaguete Long Purple. (DLP germinates about 2 wks earlier than the wild eggplant cultivar). Twenty one day old seedlings of Dumaguete Long Purple (scion) and 40-day old seedlings of wild eggplant (root stock) were grafted. The wild eggplant cultivar was cut across the lower portion of the last node of the stem and the upper part of the shoot was discarded. The upper part of the shoot of DLP was cut wedge-shaped and inserted into the stem of the wild eggplant. Parafilm was wrapped around the cut stems to seal the grafted portion. The grafted seedlings were placed inside a moisture chamber for 1 to 2 weeks. To maintain moist condition inside the moisture chamber, water was hand-sprayed on the walls of the chamber about three to five times daily. The seedlings were placed under direct sunlight for 3 to 5 days for acclimation to field conditions.

Land preparation was done with one plowing and two harrowings. Complete fertilizer (14-14-14 NPK) was applied basally prior to planting and urea (45-0-0 NPK) was side-dressed at 30 days after transplanting. Sixty-day old seedlings of eggplant cultivar 'Dumaguete Long Purple' grafted with a wild eggplant cultivar and thirty day old non-grafted seedlings of commercial cultivar 'Dumaguete Long Purple' were transplanted on August 25, 2010 at a rate of one seedling per 0.5 m^2, (approximately 20,000 seedlings/ha). Plants were irrigated as needed with a deep-well pump and soil moisture maintained at field capacity. Fruits were harvested starting from 50 days after transplanting and still on-going.

The treatments for IPM plots were 1) use of commercial cultivar 'Dumaguete Long Purple' grafted with a wild eggplant cultivar as the rootstock; 2) use of earwigs (*Euborellia*

Table 3. Degree of weed, insect and disease infestation in eggplant treated with IPM and Farmers' Practice in UPLB Central Experiment Station, June-October 2010

Treatment	Weed fresh weight (g/m^2)	FSB (% fruit damaged)	Leafhopper (% plants damaged)	Bacterial wilt (% plants damaged)
Farmers' practice: non-grafted commercial cultivar 'DLP"	282	29	40	20
IPM: DLP grafted with wild eggplant	230	14	35	0
Reduction over Farmer's practice (%)	18	52	13	100

annulata; 20,000 earwigs/ha released at 7 and 14 WAT; 3) use of *Trichogramma chilonis* (six releases of 50 *Trichogramma* cards/release at 30, 34, 38, 42, 49, and 56 DAT; and 4) use of rice straw mulch (2.5 cm thick) applied at 7 DAT for weed control and to serve as refugia for the earwigs followed by two handweedings at 6 and 12 WAT.

The treatments for farmers' practice plots were 1) use of non-grafted commercial cultivar 'Dumaguete Long Puirple': 2) weekly spraying of insecticide Selecron (profenofos, 1 L/ha) starting at 14 DAT; 3) weekly spraying of fungicide Dithane (mancozeb, 1 L/ha) starting at 14 DAT; 4) handweeding 3 times (2, 4, and 6 WAT).

Preparation and use of earwigs was done in a manner similar to those used in the tomato study.

Treatments were replicated four times and laid out in a randomized complete block design. The degree of insect pest infestation (fruit and shoot borer, leafhopper) were recorded weekly and expressed as percent of fruits or plants damaged. The degree of disease infestation (bacterial wilt) was recorded weekly and expressed as percent of plant or fruits damaged. Weed density (number/m^2) and fresh weight (g/m^2) by species were recorded at 4 WAT and at harvest.

Fruits were harvested starting at 50 days after transplanting Total yield (weights of marketable and non-marketable fruits) were recorded and yield expressed in t/ha. Cost of all crop protection and crop production inputs were recorded to estimate net profits obtained from the IPM treatments and were compared with those obtained from treatments with farmers' practices.

Leafhopper infestation was 13% lower in the grafted seedlings than in the non-grafted seedlings (Table 3). Fruit and shoot borer infestation was also 52% lower in the grafted seedlings than in the non-grafted seedlings. The grafted seedlings also had zero bacterial wilt incidence, compared to 20% bacterial wilt incidence in the commercial cultivar Dumaguete Long Purple. In spite of only two handweedings in the IPM plots, weed infestation was 18% lower in these plots compared to the three handweedings in the farmer's practice plots, indicating that there is no need for three handweedings for adequate season-long weed control.

The cost of inputs for insect and weed control in the IPM plots were both 25% lower than in the farmer's practice plots (Table 4). However, use of grafted seedlings to reduce bacterial wilt infestation was about 30-fold more expensive than using non-grafted seedlings. Higher inputs incurred in producing grafted seedlings increased the total production costs by 1.2-fold,

Table 4. Fruit yield, crop value, pest control costs, total production costs and net profit in eggplant treated with IPM and Farmers' practice in UPLB Central Experiment Station, Laguna from June to October, 2010.

Treatment	Yield (t/ha)	Crop Value ($/ha)	Weed Control Cost ($/ha)	Insect Control Cost ($/ha)	Disease Control Cost ($/ha)	Production Cost[1] ($/ha)	Net Profit ($/ha)[2]
Farmers' practice: Non-grafted cultivar 'DLP"	1.9	1,045	106	63	15	1, 056	-11
IPM: DLP grafted with wild eggplant	2.5	1,375	79	47	452	1, 280	95
Reduction (or increase) over Farmer's practice (%)	24	24	25	25	(-96)	(-18)	(88)

[1]Total production cost = Pest control costs + other costs

[2]Net profit = Crop value minus total production costs; farmgate price of eggplant =25/kg or $0.55/kg; $1 = Php45.00

which was about 18% higher than total production costs when non-grafted seedlings were used.

Since harvesting of fruits has been done for only about two weeks, we obtained relatively low yields in all plots in both IPM and farmer's practice plots. Nevertheless, fruit yields and crop values from the IPM plots where grafted seedlings were used were both higher by 24% than those from the farmers' practice plots where non-grafted seedlings were used. This is presumably due to the lower weed, insect and disease infestation in the IPM plots, compared to higher pest infestation in the farmers' practice plots.

In the farmers' practice plots, inspite of the low expenses incurred in use of non-grafted seedlings, high input costs from three handweedings and from weekly spraying of insecticides was not enough to compensate for the low inputs incurred in disease control (non-grafted seedlings). Thus total production cost in the farmer's practice plots was higher than its crop value, resulting in negative net profits. In contrast, in spite of the high costs incurred in producing grafted seedlings in the IPM plots, higher fruit yields and crop values in these plots coupled with lower input costs incurred in weed and insect control resulting in lower total production costs and higher net profits than in the farmers' practice plots.

Thus, even if higher costs of grafting increased the total production costs in the IPM plots over those of the farmers' practice plots, higher crop yields due to lower pest infestation and lower costs incurred in insect and weed control resulted in higher yields, crop values and net profits in the IPM plots. In contrast, in the farmers' practice plots, lower cost of using non-grafted seedlings did not compensate for the higher weed control and insect control costs, resulting in total production costs which were higher than the crop values. Crop values were low due to low yields resulting from higher pest infestations in the farmer's practice plots. The overall result is negative net profits in the farmer's practice plots.

Dissemination of IPM CRSP technologies:

Monitoring of pest incidence and crop yields in Department of Agriculture *Gawad Kalinga Goodbye Gutom* vegetable plots treated with IPM CRSP technologies

The study was conducted at the UPLB Central Experiment Station at the *Gawad Kalinga* project Techno-Demo Area, from March to September 2010. The area was plowed once and harrowed twice. Twenty one day old seedlings of eggplant cultivar 'Dumaguete Long Purple' and tomato were transplanted into 10 m^2 raised plots (40,000 seedlings/ha) along with other vegetables (okra, bittergourd, tomato, bush sitao, pechay and kangkong) on March 2010. Organic fertilizer (vermicompost) was applied at 30, 60, 90 120 and 150 DAT at the rate of 20 kg/10m^2. Rice straw mulch (2.5 cm thick) was applied at 120 DAT on IPM treated plots to serve as refugia for earwigs and as weed management. To manage insects, earwigs (*Euborelia annulata*) were released at 120 and 127 DAT (20,000 earwigs/ha) followed by six releases of *Trichogramma* cards (50 Tricho cards per release) starting at 120, 124, 128, 132, 139, 146 DAT. Mechanical removal of plant parts damaged by insect pests and diseases was done starting at 120, 127, 134, 141 and 148 DAT. Insect and disease incidence was monitored at weekly intervals. Incidence of bacterial wilt and leaf curl was monitored in each plot at weekly intervals and expressed as percent of plant damaged. Weed density and fresh weights were recorded at 140 DAT. The incidence of fruit and shoot borer was expressed as percent of damaged fruits. The incidence of leafhopper was expressed as percentage damaged plants. Plants were irrigated as needed with a deep well pump and soil moisture maintained at field capacity. Eggplant and tomatoes were harvested starting from 45 to 180 days after transplanting.

Weed, insect and disease infestation in tomato and eggplant treated with IPM CRSP technologies consisting of use of natural enemies such as earwig and *Trichogramma* and cultural practices such as removal of damaged shoot and fruits due to bacterial wilt and leaf curl infection kept pest infestation at low levels; 27 to 35% in tomato and 25 to 42% in eggplant. These technologies also reduced input costs and cost the grower only $44/ha for weed and disease control and $47/ha for insect control. From using these technologies, the growers obtained fruit yields equivalent to 18 t/ha with a corresponding crop value of $14,040 for tomato and to 23 t/ha, with a corresponding crop value of $ 12,650 for eggplant.

For the past two years, IPM CRSP has provided technical assistance to the Department of Agriculture project known as *Gawad Kalinga* ("to give care") vegetable production project. The *Gawad Kalinga* project is a holistic community program that aims to eradicate poverty and hunger in the Philippines by providing housing and vegetable production activities to participating families, mostly from the urban poor.

Introduction of IPM CRSP technologies to the participants of the *Gawad Kalinga* project will help disseminate use of agro-ecological approaches such as use of natural enemies (earwig, *Trichogramma*), soil enhancement additives (VAM), and cultural practices (mulching, two timely handweedings for one cropping season, removal of infected plant parts) which are cost-reducing with minimum adverse effects on the environment. Low input costs from the IPM CRSP technologies will provide added benefits to growers in the form of higher net profits.

The *Gawad Kalinga* project is a nationwide project of the Department of Agriculture, and collaboration of IPM CRSP with the various GK sites, starting with the central and southern Luzon provinces, has the potential to provide a big impact on vegetable production in the country.

Cambodia

Establishment of a collaborative network in Cambodia to participate in the SE Asia regional program

Clemson scientists traveled to Cambodia with IPM CRSP Program Director and USAID AOTR to meet with potential collaborators in Cambodia and visit major production locations. The purpose of the trip was to identify Cambodian collaborators. It was decided that a collaboration with the National IPM Programme, in the General Directorate of Agriculture (GDA) of the Ministry of Agriculture, Forestry, and Fishery (MAFF) would be appropriate for the regional project. Several NGOs are active in Cambodia working in agriculture and rural development. IDE's program of Farm Business Advisors provides a useful network for extending IPM technologies to farmers.

Development and Delivery of Ecologically-Based IPM Packages in Central Asia

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Potato IPM Package

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Links with IPM CRSP Global Theme Projects

Pest Diagnostics**:** Sally Miller, Ohio State University

Viruses**:** Naidu Rayapati, Washington State University; Sue Tolin, Virginia Tech

Gender Issues**:** Linda Racioppi and Zahra Jamal, Michigan State University; Maria Elisa Christie, Virginia Tech

Socio-Economic Impact Assessment**:** Mywish Maredia and Richard Bernsten, Michigan State University; George Norton, Virginia Tech

Summary

This collaborative research and capacity building program has included research to improve pest management through enhancing capacities of existing biolaboratories and through a better understanding of landscape ecology, local biodiversity, and habitat management. Out of more than 50 locally collected plants screened, 8 plants have shown potential for their use in agricultural landscapes for enhancing biological control of pests. IPM outreach and educational activities have been initiated through Farmer Field Schools (FFS) and Student Field Schools (SFS) in collaboration with national agricultural research systems (NARS), non-governmental organizations (NGOs) and local universities.

Building on the strong foundation and the regional network established during past four years, the current project is implementing a new five-year collaborative program to develop and deliver ecologically-based IPM packages for key food security crops - wheat, tomato and potato. The IPM packages for these three crops

are targeted to address key pest management problems in Tajikistan, Kyrgyzstan and Uzbekistan.

The project places a strong emphasis on scholarship, publications and dissemination of research results through both electronic and print media. For additional information, please visit http://ipm.msu.edu/central-asia.htm

Wheat IPM Package for Northern part of Tajikistan

Screening of wheat varieties for resistance to cereal leaf beetle (CLB) (Oulema melanopa L. Coleoptera: Chrysomelidae)

In the last decade, cereal leaf beetle became one of the most dangerous pests in wheat crop in Central Asia. Researchers at ICARDA have identified different wheat lines that may be resistant to this pest. The objective of this study was to screen and select best lines that show resistance to cereal leaf beetle. Wheat seeds were received from Biodiversity and Integrated Gene Management Program (BIGMP) of Entomology section from ICARDA. On November 28-29, 2009, a total of 130 wheat entries were planted with susceptible check of the local wheat variety Sadoqat repeated after every nine entries at a research plot site of Research Institute of Farming "Zemledeliya" of the Academy of Agricultural Science of Tajikistan. The lines showing high resistance to CLB were krasnokolosaya, Frunsenskaya 60, and Lutescencs 1207\1.

Sunn pest monitoring: During May-June 2010, a survey was conducted to determine the distribution of Sunn pest in Tajikistan. The survey confirmed this pest has established only in northern region of Tajikistan (Table 1).

Table 1: Sunn pest distribution monitoring in wheat crop fields in the North region of Tajikistan, May 21-23, 2010

Districts/Location and date	GPS data	The sunn pest abundance in the 1 m^2 wheat field			Number of damage ears of wheat in 1 m^2
		Egg	Larvae	Adult	
Panjakent 21.05.2010	N 39.50820 E 067. 49311 Altitude: 924m	16	0	0	0
Istaravshan 22.05.2010	N 39.98263 E 069. 01879 Altitude: 823m	0	0	1	7
Istaravshan 22.05.2010	N 39.99459 E 069. 02714 Altitude: 794m	0	0	0	8
Zafarobod 22.05.2010	N 40.15412 E 069. 25397 Altitude: 402m	0	0	0	3
Spitamen 22.05.2010	N 40.12606 E 069. 25081 Altitude: 451m	0	1	0	4

Spitamen 22.05.2010	N 40.12798 E 069. 26469 Altitude: 465m	0	0	0	4
Spitamen, farmer Ilhom Boimatov 22.05.2010	N 40.13420 E 069. 31091 Altitude: 464m	0	5	3	5
Isfara, Jilgazi village 23.05.2010	N 40.15337 E 070. 71998 Altitude: 822m	0	3	3	4
Isfara 23.05.2010	N 40.16642 E 070. 74240 Altitude: 812m	0	2	5	4
Isfara, Bogiston village 23.05.2010	N 40.17256 E 070. 80219 Altitude: 809m	0	2	3	3
Konibodom, Madaniyat village 23.05.2010	N 40.22377 E 070. 27560 Altitude: 378m	0	0	0	0
Konibodom 23.05.2010	N 40.24834 E 070. 09825 Altitude: 358m	0	3	0	3
Konibodom, Karakjikum village 23.05.2010	N 40.24790 E 070. 08578 Altitude: 358m	0	2	0	2
Bobojon Gafurov 23.05.2010	N 40.21531 E 069. 92989 Altitude: 361m	0	5	0	2

Tomato Crop

In Uzbekistan, tomato is the fourth most important vegetable after pepper, onions and potato. Tomato is mostly grown for the local market and a minor proportion is exported to regional countries. The potential for growing tomato in Uzbekistan is great because it is labor intensive, and thus generates rural employment, improves nutrition of the people, has export potential, and increases the income of growers. However, compared to cotton and wheat, it gets less attention from the government.

The common tomato varieties grown in Uzbekistan are Shannon, Uysupovskiy, Avitsena and Bull heart.

Pests of tomato in Uzbekistan

Diseases: Common diseases observed are Early Blight (*Alternaria solani*), *Fusarium oxysporum* Late Blight (*Phytophthora infestans*) and Downey mildew (*Pseudoperenospora cubenis*). Early Blight caused by *A. solani* was the most widespread pathogen on tomato crop in Uzbekistan. Leaf Mold caused by *Cladosporium fulvum* appeared only in greenhouses.

Insect and Mite Pests: The common pests were whiteflies, leaf miners, tomato fruit worm (*Helicoverpa armigera*) and russet mites *Aculops lycopersici*. Whiteflies, tomato fruit worm and russet mites in the open fields, and leaf miners, whiteflies and aphids in green houses were serious pests.

Development of artificial diets for rearing of predator mite *Amblyseius mckenziei*

In Uzbekistan, sale of biological control agents account only for about 1% compared to pesticide sales. Predatory mites *Phytoseiulus persimilis*, *Metaseiulus occidentalis*, *Amblyseius californicus*, and other natural enemies have become expensive for use on most crops because of the high cost of production. In most cases, these natural enemies are raised on host mites, which must first be reared, often on a host plant. This process is very labor and space intensive. Replacement of the prey or host with an artificial diet, and development of associated mass production technology with decreased labor inputs, could cut down the cost.

In the laboratory of Uzbek Research Institute for Plant Protection, we have been conducting research on production of predatory mite *Amblyseius* sp. in different artificial diets. There were 3 kinds of artificial diets prepared that were marked as AD 1, AD2 and AD 3, where AD 1 had 300g bran, 20 g yolk, 10 g sucrose, 0,01 g of vitamin mixture and 0, 03g streptomycin sulphate in one liter container. Medium AD 2 is nearly the same, but instead of yolk, yeast autolysate 10g was added. AD 3 had 300 g mixture bran with flour, 100g of sugar, 50 g of margarine and 50 ml of milk.

Amblyseiuse mckenziei developed normally from egg to adult on the three artificial diets. However, the longevity of the adult females varied. AD3 showed the best results comparing to others where female longevity of *A.mckenziei* was 65 days, much longer then on AD1 (50 days), AD 2 (55 days) and on natural diet (37 days). Eggs showed no abnormalities; larvae fed on diets had normal development; and adults were comparable in size to individuals reared on a natural diet.

Potato Crop Management: Photos taken at Farmers Field Days – Kyrgyzstan 2010

This cost-effective method of rearing of *A. mchenziei* has the potential for dramatically reducing the use of conventional insecticides without increased crop loss.

Potato Crop

Pests of potato in Kyrgyzstan

Important fungal diseases are *Macrosporiu*m leaf spot, *Alternaria* leaf spot, Black scurf, and Late Blight on potato leaves. These fungus diseases cause serious damage under damp weather conditions, resulting in up to 60% rotten tubers. Late Blight occurred 10 - 35%, and the incidence of bacterial diseases, such as Bacterial ring rot and a Black leg, was 5%. About 20% of the farmers use fungicides and a few apply Trichodermin or Baikal M-1.

Common potato varieties grown are Picasso, Neva, Mondial, the Drag, Sante, the Symbol, Latona, Chelpek, etc. Potato varieties: Picasso, the Symbol, Nur, Latona, Neva, Dzhelli, and Beluga showed resistance to late blight.

Colorado potato beetle is the most serious insect pest.

Student field school on wheat crop

IPM in Tajikistan

The project objective on IPM outreach and education focused on both academic and nonacademic stakeholders through student field schools (SFS) and farmers field schools (FFS), in collaboration with NGOs, government institutes and local universities in Tajikistan. To enhance university education, an inventory of IPM educational programs in Tajik National University was conducted. SFS on wheat IPM for 12 students (5 female and 7 male) of grade III in the Biological faculty was implemented. The program course curriculum was consisted on 22 hour class/theoretical and 16 IPM practical/field parts.

Gender Issues in IPM

Dr. Racioppi and Dr. Jamal attended a full day training workshop with Dr. Maria Elisa Christie at Virginia Tech University in May. They also made a site visit to Tajikistan in July and August. They met with more than 20 individual experts and development groups, to engage in three focus groups in three villages in two different districts, and to undertake a Rapid Gender Assessment for each site. During the visit to Tajikistan they were able to identify Ms.

Students scouting the wheat pest

Shoira Pahlavonova from Tajikistan to serve as the coordinator of the gender related activities in the region, and to assist with networking and gender related training programs.

Impact assessment of IPM CRSP project activities in Central Asia

As an input into the planning of the impact assessment (IA) activities in Years 2 - 5, an impact pathway analysis worksheet was developed by the IA research team (Dr. Mywish Maredia and Dr. Richard Bernsten from MSU). This impact pathway analysis will be completed by the impact assessment team based on a one-on-one consultation with the project PIs. The outcome will be "impact pathways" for wheat, potato and tomato IPM research components in Central Asia. The goal is to help the researchers lay out the vision of success (impact goal) and a) make them aware of the consecutive steps needed to achieve that vision of success; and b) incorporate these steps as much as possible in their workplan for the remainder of the grant period.

Abating the Weed Parthenium (*Parthenium hysterophorus* L.) Damage in Eastern Africa Using Integrated Cultural and Biological Control Measures

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Summary

Parthenium (*Parthenium hysterophorus*), a native plant of tropical and sub-tropical South and North America, adversely affects food security, biodiversity, and human as well as livestock health, in eastern Africa. The goal of this project is to develop an integrated weed management system that reduces the adverse impact of parthenium on humans, crops, livestock and plant biodiversity in the East African region. The specific objectives are to: 1) collect accurate information on the distribution and spread of parthenium in Kenya and Tanzania with follow-up surveys in Ethiopia and Uganda, 2) evaluate and demonstrate best management practices for the control of parthenium, 3) evaluate parthenium biocontrol agents for their safety to non-target plant species, and 4) release and evaluate the impact of approved biocontrol agents for the control of parthenium. Under objective 1, a survey result from Uganda has shown the occurrence of parthenium in at least 13 districts. Invasion of new areas has indicated that it is spreading. It was observed in two main localities during a survey of northern Tanzania with densities ranging from low to high. A survey was also undertaken in central, western and coastal Kenya that has covered 3,700 km. In objective 2, an experiment on the competitiveness of indigenous pasture species against parthenium weed was established in eastern Ethiopia. Among the indigenous species tested, *Chrysopogon aucher* was found to be an effective competitor to parthenium. Under objective 3, a culture of *Zygogramma*, a beetle that feeds on parthenium, is being maintained under quarantine. A successful culturing of *Listronotus*, a stem-boring weevil bioagent has been achieved, and oviposition tests on crops including noog (*Guizotia abyssinica*) and sunflower (*Helianthus annuus*) have been conducted. No eggs were laid on these crops compared to an average of 112.8 eggs per plant on parthenium. In objective 4, an EA application has been submitted to USAID to release *Zygogramma* in Ethiopia. As part of this application, a newspaper notice was placed in one of the Ethiopian newspapers to solicit public comments on the release of *Zygogramma*.

Survey

A parthenium survey, during the year 2010, has been conducted in Uganda, Tanzania, and Kenya, and results are presented below.

Uganda: Parthenium was first detected in Uganda in 2008. A follow-up survey was carried out in Eastern and Western Uganda in July/August 2010 to determine the distribution of parthenium in Uganda. Parthenium was detected in several districts including Busia, Namutumba, Bugiri, Tororo, Mbale, Jinja, Buikwe, Mbarara, Ibanda, Masaka, Kampala, Kabale, and Kasese, indicating recent spread to new locations. It was found in a radius of approximately 50 – 100 m along the main Eastern entry route to Uganda through Busia-Kenya border. Monitoring and containment activities were conducted after the initial mechanical control efforts were undertaken at Namalemba and Bugembe sites in December 2008. The infestation was cleared by slashing, burning, and digging using hand-hoe. However, some parthenium seedlings still emerged at these sites indicating the need for an integrated management effort. Sites in Namutumba and Jinja Districts where parthenium had been removed in December 2008 were monitored in January 2010. Parthenium density had decreased but some seedlings had germinated. A farm in the Namutumba area previously heavily infested by parthenium had been planted with sweet potato, and no parthenium seedlings were observed in the field although seeds may still be present in the seed bank. Locals were requested to monitor and remove parthenium before seed production. Parthenium inflorescences have also now been observed being used by florists in floral arrangements and some local herbalists are also using parthenium as an herb to treat patients. It is feared that such activities will further spread the weed in Uganda. Countrywide seminars targeting florists, as well as the public, at sites where parthenium is present are planned to improve awareness of the problems associated with this invasive plant.

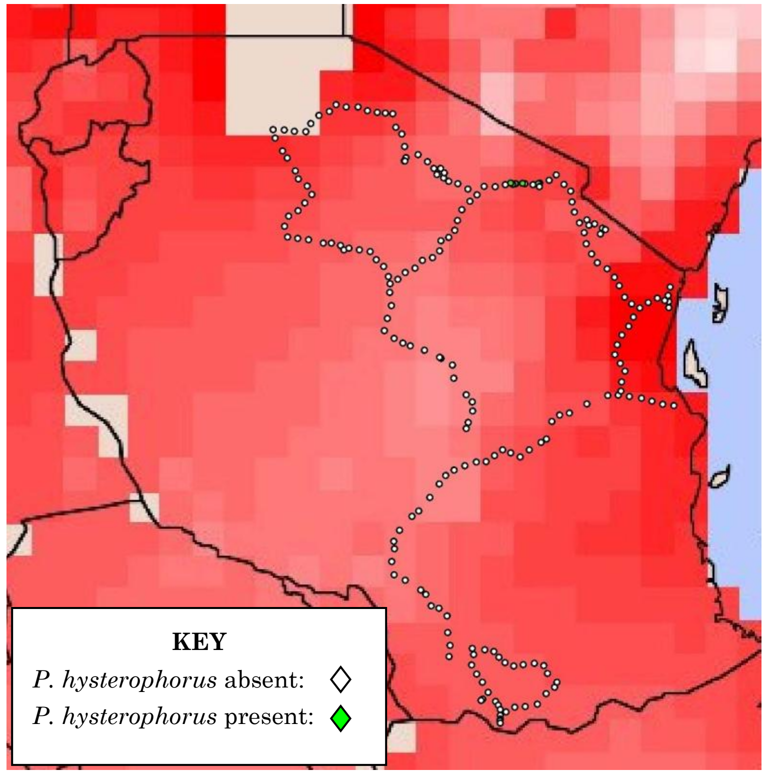

Figure 1. Map illustrating the results of the road side survey, white icons indicate absence of *P. hysterophorus* and green icons represent the presence of *P. hysterophorus*

Tanzania: In Tanzania, surveys were conducted in February and March 2010 by vehicles along selected available road networks, scanning both sides of the road for the weed. Particular emphasis was placed on surveying quarter degree squares (QDS) (25 km x 25 km) immediately surrounding previous sighting localities and areas which were estimated by the CLIMEX model to be suitable for the growth of parthenium. Parthenium was observed only in two main localities in northern Tanzania. One of them was in and around Kilimanjaro International airport, and the other near Arusha airport, in and around Arusha town (Figure 1). Densities varied from low to high. Further surveys in Tanzania are due to be conducted in February and March 2011. These will cover the north-western sections of Tanzania and the eastern coastline.

Kenya: Field surveys to establish the current status of parthenium in Kenya were undertaken during the last week of April to the first week of May in central and western Kenya. Localities targeted were identified based on the predictions made using CLIMEX software. About 2000 kilometers were covered in seven days of the survey. Data points from surveyed areas have been entered into an MS spreadsheet in preparation for mapping. Predictions from the CLIMEX analysis prioritized Coastal Kenya for surveys during August 2010. Five days were spent in this survey and a total of 1700 kilometers covered.

Based on the agreement reached during the project planning and training workshop in Ethiopia in December 2009, data points from the parthenium surveys from Kenya, Tanzania, and Uganda have now been received and will be submitted to relevant partners for mapping.

Evaluation and Demonstration of Best Management Practices for the Control of Parthenium

An experiment to determine the competitive effects of indigenous pasture species against parthenium weed was established in July, 2009 in Somali Pastoral and Agro Pastoral Research site, some 30 Km east of Jijiga town in Ethiopia. The experimental field was left to allow the indigenous plant species and parthenium to regenerate naturally from soil seed bank.

The study result revealed the existence of a total of 15 grass and forb species. The indigenous plant species *Botriochloa radicans, Chryspogon aucheri, Cenchrus ciliaris* and *Panicum cloratum* dominated the experimental plots both in coverage, dry matter production and growth. *Chryspogon aucheri* had up to 65% cover and *ca.* 1.25 m growth in height. The parthenium weed had up to 10% coverage and a mean height of 0.75 m. The dry matter biomass for the herbaceous species amounted to a mean value of 270 g/m^2. Such species as *Chrysopogon aucher* and other herbaceous species that have shown good performance will be considered for displacing parthenium under proper management conditions. This experiment will continue and scaling up of the new technology will be considered based on subsequent outcome of the research activity.

Evaluation of Parthenium Biocontrol Agents for their Safety to Non-Target Plant Species

This objective is being implemented. Cultures of the leaf-feeding beetle, *Zygogramma bicolorata,* and a weevil, *Listronotus setosipennis,* were housed at Ambo Plant Protection Research Center (PPRC) of the Ethiopian Institute of Agricultural Research (EIAR) and host-range evaluation of the latter was conducted at the quarantine facility.

Zygogramma bicolorata: This is the first bioagent introduced to Ethiopia from South Africa in October 2007. Host range tests, under quarantine, on economically important crop species and varieties, and indigenous species have been completed. A permit to release this beetle has been obtained from the Ethiopian government. After completion of the required tests, *Zygogramma* has been maintained for future use in the Ambo quarantine facility. The bioagent has been maintained by supplying vigorously growing and healthy parthenium plants. There were over 2500 adult *Zygogramma* as of September 30, 2010.

***Listronotus setosipennis*:** The second bioagent, stem-boring weevil, was introduced from South Africa in 2009. It has been kept in a separate quarantine facility that was refurbished to meet international standards. It has also been equipped with all the necessary materials that would enable one to conduct host range tests. The weevil lays its eggs on parthenium flowers and feeds inside the stem as opposed to *Zygogramma* which feeds on leaves. This feeding behavior has necessitated the availability of parthenium plants with young flowers and well developed stem for maintaining the culture and also to carry out host range tests. This has been achieved by growing parthenium plants of different age and providing the plants with the necessary nutrients through application of well decomposed manure.

Host range tests: Host range tests consist of collecting oviposition and larval development data. The major task, after maintaining the culture, has been to conduct oviposition tests on major crops and weeds growing in Ethiopia. Synchronizing the flowering of test plants and the proper bioagent stage of growth has been a major challenge. Sexually mature adults need to be released on flowering plants in order to carry out a proper test. Sexually mature bioagents of known age were produced by keeping track of the insect's development, starting from the larval/pupal stage all the way to emergence of adults.

Producing adults of the same age group: A pupation box was used to keep larva/pupa, removed from infested *Parthenium* plants, until adult emergence. Adults that emerged within a week were placed in boxes containing *Parthenium* plant and were considered to be of the same age group.

Growing of test plants: Similarly, plants were grown so they reach peak flowering stage at a time when insects of the right stage for tests are available. Beans, peas, sunflower, and niger seed (noog) were grown in plastic pots each with five plants and later thinned to three vigorous and healthy plants.

Testing: Adults of the same age group were used for tests 2-3 weeks later. First, they were removed from the cage early in the morning and kept in a petri dish. Five pairs of mating adults were kept separately in another petri dish and released on each of three plants representing a species of test plant. On the other hand, the same numbers of mating pairs were released on three parthenium plants that

Table 1. Number of eggs laid by *Listronotus* on different test plants and Parthenium under quarantine at Ambo PPRC

Test Plant	No. of Eggs			Total No. of eggs	Average No. of eggs/plant
	Plant 1	Plant 2	Plant 3		
Beans	0	0	0	0	0
Control (Parthenium)	146	153	56	355	118.3
Peas	0	0	0	0	0
Control (Parthenium)	46	106	109	261	87
Lathyrus	0	0	0	0	0
Control (Parthenium)	70	66	284	420	140
Noog (Esete)	0	0	0	0	0
control(Parthenium)	136	56	58	250	83.3
Sunflower (S R Black)	0	0	0	0	0
Control (Parthenium)	197	117	92	406	135.3

served as control. Eggs were counted seven days after release. No eggs were laid on any of the test crops, compared to an average of 112.8 eggs per plant on parthenium (Table 1).

Release and Evaluation of the Impact of Approved Biocontrol Agents for the Control of Parthenium

Host range tests, under quarantine, on economically important crop species and varieties, and indigenous species have established that *Zygogramma* is safe for release against parthenium. Based on the test results, the Ethiopian Ministry of Agriculture and Rural Development (MOARD) has issued a permit to release *Zygogramma* for the control of parthenium in Ethiopia. Subsequently, an **initial environmental examination (IEE)** document was prepared in early April, 2010 and submitted to USAID to get a permit to release *Zygogramma*.

Solicitation of public comment: As part of the application, USAID requested a public comment in Ethiopia on the release of *Zygogramma*. Pursuant to this request, an advertisement was placed on one of the widely distributed and read English Newspapers in Ethiopia, The Ethiopian Herald. The solicitation for comments on the application to release *Zygogramma* in Ethiopia was printed in the Newspaper (Vol. LXVI, No. 281, Wednesday, August 4, 2010). The public was asked to review the IEE document and send their comments to either Dr. Kassahun Zewdie of the Ethiopian Institute of Agricultural Research or Mr. Berhanu Gebre Medhin of the Federal Ministry of Agriculture and Rural Development (MOARD). No comment was received after two weeks of advertisement.

The International Plant Diagnostic Network: Gateway to IPM Implementation and Enhanced Trade

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Summary

The IPM CRSP International Plant Diagnostic Network Global Theme Program is working actively in 14 countries in four regions, and cooperating with six additional countries in two regions. The major goals in the first year of the second phase of the project were to strengthen the network of plant science professionals involved in plant diagnostics initiated in Phase I; develop closer ties with the IPM CRSP Regional Programs (RPs) to support them in diagnostic efforts in priority areas; and improve our distance diagnostic/information management web portal. We met in Antigua, Guatemala in March 2010 to review the strengths and weaknesses of the program in Phase I and make plans for Phase II. We expanded the network by establishing the South Asia network including labs in India, Nepal and Bangladesh. Additional labs were also added to the East and West Africa sites. During the year, we met with five of the six RPs to consolidate activities related to pest and disease diagnostics. Priorities for pest and disease diagnostics were established in the four major regions {South Asia, East and West Africa, and Latin American and the Caribbean (LAC)}. Surveys of major pests and diseases of priority crops were initiated in conjunction with the RPs in East Africa {tomato, passion fruit and onion in Kenya, and tomato viruses in Uganda (joint with AFRI project)}. The IPDN was instrumental in diagnosing new diseases and pests in several regions, including brinjal gall midge, bacterial canker, mango malformation disease and several viruses. Progress is being made on the development of Standard Operating Protocols (SOPs) and two are under evaluation. A 2-day diagnostics workshop was conducted in Indonesia at the request of the SE Asia RP. Two host country scientists from the East Africa RP were trained at Ohio State University in the 2-wk short course, "Pest and Disease Diagnostics for International Trade and Food Security."

Survey of professionals involved in plant disease and pest diagnostics

<u>Latin America and the Caribbean</u>: Few laboratories in the region have capacity for molecular diagnostics of bacteria and viruses. The recent outbreak of bacterial canker, caused by *Clavibacter michiganensis* subsp. *michiganensis*, in greenhouse tomatoes in Guatemala was complicated by the lack of experience in diagnosing this disease locally. There is a great need for training in bacterial disease diagnosis. The IPDN LAC is taking the lead in compiling results of capacity surveys

and preparing a publication, intended for *Plant Health Progress* or a similar journal.

East Africa: Taking cognizance of the fact that disease diagnosis and pest identification capacity is frequently inadequate in the East African region, a baseline and benchmarking workshop for crop health research was held in Kenya from 28th to 30th March 2010 with the theme "Pooling together to impact against pests". The workshop drew participants from all KARI centers with scientists carrying out crop health research work in the three main areas of arthropod pests, plant pathology, and weed science. The participants were identified over a period of 3 months through email and telephone consultations initiated by the Crop Health Coordinator by requesting scientists to submit personal profiles on a pre-designed template. The workshop drew 55 crop health scientists from across all research centers of KARI, the premier agricultural research and technology development institution in the country. The workshop agenda had the following broad areas of discussion: 1) Identifying crop health research capacity, constraints and priorities; 2) Integration of crop health research in agricultural product value chains; 3) Networking based on crop health research capacity (expertise and facilities); and 4) Scientific information dissemination (publications, advisory bulletins, etc.). Individuals and their specialties were identified to improve diagnostic services to farmers. Priority setting for crop health research was initiated after lengthy discussions on the criteria to use. Contact persons were identified in each research center for further crop health priority setting.

West Africa: Diagnostic capacity surveys were completed in West Africa in Phase I, and results will be compiled in Year 2, in cooperation with the LAC IPDN.

South Asia: Professionals involved in plant disease and pest diagnostics in India were surveyed for infrastructural and human capacity to perform critical functions. A preliminary survey on national laboratories (25) and professionals (56) involved in diagnostics of various crop maladies was done and a database was created.

Southeast Asia: Pest management professionals attending a joint IPM CRSP SE Asia/IPDN workshop, July 21-23, 2009, in Indonesia (see Training below) were surveyed for pest and disease diagnostic capacity at their institutions. Thirteen professionals from Indonesia, one from the Philippines, and one from Cambodia completed the surveys. Seven respondents were female and eight were male. Results of the survey are being analyzed and will be collated with those from other regions during Year 2.

Expansion of the network in IPDN regions

Latin America and the Caribbean: The IPDN is this region is working closely with the IPM CRSP LAC regional program to identify potential member labs and to recruit scientists to participate in IPDN activities. Contacts were made with professionals in Ecuador and efforts are being made to fully integrate them to the IPDN network. Zamorano University in Honduras is very interested in access to DDIS technology, and several other labs outside the IPDN network, particularly in Mexico, have inquired about access to DDIS technology; these inquiries are being evaluated.

The LAC IPDN hosted a conference of IPDN and Virus Global Theme (IPVD) leaders in Antigua, Guatemala, March 16-21, 2010. The meeting was designed to update host country and US program leaders on progress and plans for Phase II of the IPDN and promote cooperation with the IPVD. The first phase of the IPDN (2006-2009) was reviewed, focusing on strengths and weaknesses of the programs in each of the three Phase I Regions (West and East Africa, and Central America). Plans for Phase II for developed based on the approved proposal and the Year 1 Work Plan.

East Africa - The following are additional laboratories to those identified during phase I:

i. Department of Plant and Microbial Science of Kenyatta University – has been instrumental in providing expertise in nematology. So far, ten (10) technicians and research project assistants have been trained in diagnostic nematology.

ii. Plant Quarantine Station (PQS) of the Kenya Plant Health Inspectorate Service (KEPHIS), the National Plant Protection Organization (NPPO) in Kenya. Collaborative linkages are being established with KARI in testing of a diagnostic protocol for cassava brown streak virus. KEPHIS has RT-PCR equipment that can be used to discriminate between CBSV and CBSUV in samples collected from some parts of Kenya. Conventional PCR does not provide the required resolution.

The Diagnostic Clinic at Makerere University in Uganda was expanded in the Makerere University Agric. Research Institute Kabanyolo (MAURIK) with support of Makerere University and the Africa Food Security Initiative (AFSI) Associate Award, in collaboration with IPDN.

The following is an updated list of laboratories/ institutions that are participating in the plant diagnostics under the IPDN project in East Africa. A laboratory has not been identified in Rwanda as yet. However, interactions with Mr. Senkesha Ntizo of ISAR are in progress for this purpose.

Discussions are underway to integrate some activities spearheaded by the Global Plant Clinic (GPC) initiative with those of the IPDN project. In Kenya, the GPC has identified four clusters, each with particular agricultural produce market-based points, through which 'plant doctors' extend their diagnostic and pest management knowledge to farmers. In the event that some cases cannot be dispensed at the market meeting points, samples and other referral situations can be handled in diagnostic laboratories with capacity that has been enhanced through the IPDN activities.

West Africa: Laboratories in Ahmadu Bello University (Zaria, Nigeria), the University of

Lab Name	**Country**	**Lab leader Name**	**Email**
Plant Pathology Section, KARI-NARL	Kenya	Dr. Zachary Kinyua	kinyuazm@gmail.com
Namalere Phytosanitary & Diagnostic Laboratory, MAAIF	Uganda	Mr. James Karyabakora	korajames2006@yahoo.com
Plant Diagnostic Clinic, Makerere University Agric. Research Institute Kabanyolo (MAURIK)	Uganda	Dr. Mildred Ochwo-Ssemakula	mknossemakula@yahoo.com
Biotechnology laboratory, Faculty of Agriculture, Makerere University	Uganda	Dr. Richard Edema	redema@agric.mak.ac.ug
Plant Protection Section, ZARI	Zambia	Dr. Jack Chipili	jackchipili@yahoo.co.uk
Plant Protection Section, ARI (Tanzania)	Tanzania	Mr.Lebai Nsemwa	nsemwalth@yahoo.co.uk
Plant and Microbial Science Department, Kenyatta University	Kenya	Dr. George Kariuki	gmmkariuki@yahoo.com
Plant Quarantine Station, KEPHIS	Kenya	Mr. Abed Kagundu	akagundu@kephis.org

Ghana Lego (Accra, Ghana), and The Universite de Thies (Thies, Senegal) were added to the network. The diagnostics laboratory at the Institute D'Economie Rural (IER) in Sotuba, Mali, continues to develop with support of the IPM CRSP West Africa Regional Program. IPDN collaborates with the WA Regional Program in diagnostic activities in this laboratory.

Development of the IPDN network in South Asia

A list of laboratories in India for inclusion in the IPDN was prepared. Tamil Nadu Agricultural University (TNAU) serves as the Hub Lab. Spoke labs in India include the following: ADAC&RI, Trichy, HC&RI, Periyakulam, ARS, Kovilpatti, KVK, Tindivanam, KVK, Krishnagiri (private institution located at Elumichangiri), TERI, New Delhi and BCRL, Bangalore (Private lab). A national (India) level network meeting of hub and spoke lab scientists was conducted on July 14, 2010. Spoke labs identified to date in Bangladesh and Nepal are BARI-HRC (Joydephur, Bangladesh) and NARC/IDE (Kathmandu, Nepal). IPDN and the IPM CRSP South Asia Regional Program support a pathologist/diagnostician at IDE.

Expansion of list of subject matter experts

This activity continues slowly in all regions as subject matter experts are identified and recruited to participate in IPDN. In East Africa (Kenya) sample profiles from selected scientists were displayed during the March 2010 planning meeting.

Access to data management materials for countries/labs with limited internet access

As of March 2010, there were 22 labs in the system and 48 registered users. At this point, adoption (sample submission) is not strong; encouraging sample submission will be a priority in Year 2.

The IPDN website (http://www.intpdnddis.org/) continues to be improved; support was provided to users; and additional clinic and lab accounts were set up. Specific activities during Year 1 were as follows: 1) Maintained the website up and running, and provided user support; 2) Attended (J. Xin) IPDN planning meeting in Guatemala to present DDIS/CIMS and answer questions from participants; 3) Modified DDIS Media Library to reflect the need from IPDN users; 4) Created an Excel Spreadsheet for IPDN users with slow Internet connection so that their data can be imported to the system. The form is now available for downloading at IPDN website; 5) Set-up new countries (Nigeria, Bangladesh, India, Nepal) in IPDN system; 6) Modified IPDN homepage to make it faster for initial display; and 7) Updated content and added new features for IPDN website.

A digital media library, GIS capability, and mapping will be incorporated in Phase II. System security, which is described in the "User Confidentiality Policy" within IPDN DDIS is a concern to most members of the IPDN. Samples may be "Private" or "Public"; in the former, only the submitter and the receiver know the origin of the sample. Country information can be blocked on referred samples. It is recognized that sample identification can be a complex issue that may limit adoption of DDIS.

Identification of priority crops, pests and pathogens to provide focus for IPDN efforts

Latin American and the Caribbean: Crop, disease and pest priorities were determined during a joint IPMCRSP LAC Regional Program/IPDN/IPVD meeting at FHIA, Honduras in May 2010. Solanaceous crops tomato, pepper and potato were identified as priorities for the IPDN project. These crops range in production type from low technology field (potato in Guatemalan highlands) to high technology greenhouses (tomato growers export to the USA and other countries). The outbreak of bacterial canker in greenhouse tomato caused significant losses in Guatemala. In peppers, *Phytophthora cinnamomi* (basal rot) is the most important pathogen. In potatoes, the most important disease is bacterial wilt caused by *Ralstonia solanacearum*. *Candidatus* Liberobacter has also become this year an important threat to potato production. Whitefly-transmitted begomoviruses are also a significant problem in vegetables. New races of the Fusarium wilt pathogen in melons are also of concern.

East Africa: The IPM CRSP East Africa Regional Program crop priorities are tomato, passion fruit and onion. During the March 28-30, 2010 priority-setting meeting in KARI, contact persons were identified in each KARI research centre represented in the workshop. This is a primary step towards ensuring that resources are directed to important crop health constraints.

Between July and September 2010, IPDN and the East Africa Regional Program jointly surveyed the three target crops in Kirinyaga and Murang'a in central Kenya. The full report is presented in the EA Regional Program annual report. Tomatoes appeared to have the widest variety of health-related problems, including fungal, bacterial, viral, and nematode infestations. Farmers were usually unable to identify even common diseases in their fields. Therefore, increasing the farmers' capacity to detect/diagnose diseases will be a focus of future work. It will also be important to determine the ease with which people providing services (extension and agro-input sales) are able to identify/diagnose plant disease conditions. Some diseases, in particular those caused by viruses, require the use of definitive analysis such as serology or nucleic acid analysis.

Initial discussions with crop health research scientists in Kenya have shown that prioritization of pathogens and pests require the development of appropriate and agreed criteria for the process. Without this tool, consensus can hardly be reached since there are strong professional/disciplinary biases among the scientists. The task is bound to be even tougher with the inclusion of other categories of stakeholders. As a starting point, the following criteria were suggested and pre-tested in a maize pest prioritization workshop in September 2010:

- the ease of identification of the problem *(very difficult….1; very easy…5)*
- the level of known damage or losses to maize yields *(very high…..1; very low…5)*
- the potential damage when no control measures are taken *(very high…..1; very low…5)*
- the availability of known control measures *(very poor availability…..1; easily available…5)*
- the affordability of known control measures *(highly unaffordable…..1; easily affordable……5)*
- the ease of implementing known control measures *(very difficult to implement…..1; very easy to implement…….5)*

The total score for each pest (insect, pathogen or weeds) was determined on a scale of 1-5 to facilitate ranking (where 1 is most important and 5 is the least important). After robust discussions, the tool was well understood, although it can be revised to make it more effective. It is envisaged that this criterion-based tool will be developed further using particular crop cases for application across all countries where the IPDN and Regional Projects are operative.

West Africa: The target crops of the West Africa Regional Program are tomato, potato and cabbage. Diseases caused by fungi, bacteria, viruses and nematodes are common in tomato and potato, and incidence and severity varies by season. Pests are more important than diseases in cabbage.

South Asia: The South Asia Regional Program has identified tomato, eggplant, cucurbits and cabbage as priority crops. As in other regions, general categories of diseases and pests are known, but specifics as to virus and bacterial causal agents, in particular, are not well known.

Prioritization of diagnostic protocols, assays, etc.

Latin America and the Caribbean: Currently a commercial immunostrip assay is being widely used for bacterial canker diagnosis in LAC, but false positives are common; therefore, developing capacity for conducting confirmatory PCR assays is a priority. PCR assays for *Candidatus* Liberibacter, whitefly-transmitted geminiviruses, and *Phytophthora* spp. are also critical. Protocols for Fusarium detection in melons are also needed.

East Africa: Nucleic acid capture materials (FTA cards, Adsorption strips, RNA stable) were compared for tomato virus diagnostics in collaboration with the AFSI project in Uganda. Results will be available in Year 2. The best product(s) for DNA or RNA extraction from plant pathogens will be used for follow-up identification by PCR in select laboratories in Kenya and Uganda, depending on the pathogen. Permits are not required to move nucleic acids across borders.

West Africa: Nucleic acid sampling materials are also being used to sample tomato and potato for viruses and bacterial pathogens. It will be a priority to develop capacity in the IER lab in Sotuba for PCR diagnostics using nucleic acids collected throughout the region. The Biotech Laboratory at the University of Ghana Legon may also be used for this purpose.

South Asia: Key areas of focus for the South Asia RP include virus-vector interactions (Tospo, Begomo, Poty), fungal-nematode complexes in vegetables, population biology in sucking pests, and fruit flies in vegetable ecosystems. An identified need in South Asia is training in bacteriology. Infrastructure development (for serological and molecular diagnostics) was undertaken in the TNAU diagnostic hub lab during this year.

Prioritization of pathogens or pests to be surveyed/mapped

Latin America and the Caribbean: Priorities for survey are being developed.

East Africa: A tomato virus survey was undertaken in Uganda in conjunction with the AFRI project.

West Africa: IPDN was instrumental in identifying new diseases in West Africa – mango malformation and a new disease of citrus (Ghana).

South Asia: Brinjal gall midge (*Asphondylia* sp) emerged as major pest in Coimbatore Dt; *Liriomyza* sp., *Spodoptera exigua* and Iris yellow spot virus were observed in onion for first time in Tamil Nadu; Little leaf in beetroot (phytoplasma) and Tobacco streak virus in cotton were recorded.

Support for identification/reports of new diseases and pests

Latin America and the Caribbean: Bacterial canker was identified for the first time in greenhouse tomatoes in Guatemala.

West Africa: IPDN was instrumental in identifying new diseases in West Africa – mango malformation and a new disease of citrus (Ghana). In both cases, samples were submitted to DDIS/CIMS and IPDN assisted in identification as well as follow up assistance for laboratory confirmation. Other first identifications were Sweet potato leaf curl virus (SPLCV) (begomovirus) and African cassava mosaic virus (ACMV-Nigerian strain) (begomovirus) Sikasso, Mali, discovered in conjunction with the IPM CRSP West Africa Regional Program (Dr. Robert Gilbertson).

Prioritization for at least five pathogen or pest targets for SOP development

Latin America and the Caribbean: Priorities are *Ralstonia solanacearum*, *Clavibacter michiganensis* subsp. *michiganensis*, *Phytophthora* identification and species differentiation, Whitefly-transmitted geminiviruses, Fusarium wilt in melon.

East Africa: Among the pathogen/pest targets identified during Phase I, the SOP for banana bunchy top disease (BBTD) and banana xanthomonas wilt (BXW) are the most advanced in terms of completion and sharing for potential pre-testing. The BBTD procedure has been availed to Dr. Douglas Miano, a virologist based at KARI's Biotechnology Centre, in order to determine its suitability in surveys, sampling and analysis for the disease in Kenya. The draft SOP is availed separately. The BXW SOP (available separately) has been used to showcase the steps taken in the development of SOPs during pest discussion forums. The latest of such forums was the 6th EAPIC workshop held at Jacaranda Hotel in Nairobi, Kenya from June 9- 11, 2010. The idea of SOPs is highly appreciated in confirmatory processes, particularly those that involve trade in high-value commodities.

South Asia: A mealybug SOP is under development. Other priorities are being developed.

Write up of IPM recommendations

East Africa: A poster on tomato diseases was developed for the East Africa Regional Project. A crop health bulletin is currently in its first draft version in KARI. The bulletin will cover critical pest/pathogen diagnostic and identification aspects for the benefit of farmers, agricultural extension staff and researchers. Publication is expected by the end of 2010.

South Asia: Posters on the pests and diseases of onion, okra, tomato, papaya and brinjal were prepared for training farmers and extension functionaries.

Training pathologists and entomologists in targeted methodologies or pathogen or pest identification

At the request of the IPM CRSP Southeast Asia Regional Program, IPDN assisted in organization and presentation of a 2-day diagnostics training workshop, July 21-23, 2009 at Bogor Agricultural University in Bogor, Indonesia. Dr. Fulya Baysal-Gurel, plant pathologist and postdoctoral associate in Dr. Sally Miller's lab at OSU, conducted training in serology and PCR, bacterial diagnostics, and fungal diagnostics.

Training key host country scientists in classical and modern diagnostics

Latin America and the Caribbean: Ms. Isabel Arias, Agroexpertos, Guatemala, attended in June 2010 a workshop held in Costa Rica for *Phythophthora* diagnostics and identification techniques. The Workshop was part of a USAID Horticulture CRSP project.

East Africa: Ms. Miriam Otipa and Dr. Monica Waiganjo attended the OSU short course, "Pest and Disease Diagnosis for International Trade and Food Security," August 23-September 3, 2010 in Wooster, OH.

- Farmers' seminar organized by Department of Agriculture, Trichy
- Agri-Expo on 21.01.10 – 24.01.10
- Agri-Expo on 24.9.10-26.9.10
- State-level farmers training program organized by NABARD and IFFCO on Feb 15-17, 2010 and 28.9.10
- Mealybug Awareness and management programs on 17.08.10
- Onion IPM Seminar by Private agency M/s. Bayer Crop Science Limited M/s. Indofil Chemicals Limited on 06.11.2009 and 7.3.10

- Twelve monthly zonal workshops organized by Department of Agriculture

Farm Advisory Service

- Diagnostic field visits undertaken by IPM-CRSP scientists: 33
- Plant protection advisory service through telephone: 245
- Farmers visit to Institute for pest management query: 168

Toward the Effective Integrated Pest Management of Plant Disease Caused by Viruses in Developing Countries: Detection and Diagnosis, Capacity Building and Training, and Formulation of IPM Packages

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Summary:

Plant virus diseases transmitted by insect vectors and through seed or germplasm are one of the major contraints to vegetable production in countries of the IPM CRSP. Approaches to management of viral diseasesdesigned from information gained are intended to be applicable throughout the IPM CRSP and incorporated into IPM packages. Within the IPM-CRSP, the program collaborates mainly with the Diagnostics Global Themes and with all Regional Centers. Host country collaborators with scientific expertise in virology have been identified in most countries in all six regions. Efforts in the first year were focused on establishing contacts to enable initiation of work under the objectives. Host countries reporting viruses identified in this IPVDN report include Uzbekistan, Indonesia, Cambodia, India, Bangladesh, Dominican Republic, Guatemala, Honduras, and Mali, representing five of the six regions. Some of the identifications were performed in the host countries by the use of commercial test kits or sample submission for commercial testing, and some by collection of samples by US scientists for testing in their labs by PCR from membranes. The main crops tested were tomato, pepper, potato, cucurbits, bean, okra, and sweetpotato. Viruses from were identified belonging to nine different genera, with whitefly-transmitted begomoviruses and aphid-transmitted potyviruses being the most prevalent. A psyllid-transmitted bacterium, Liberibacter, has been identified in Central America as causing virus-like symptoms in potato and tomato. These findings will be used to prioritize future research on ecology and epidemiological research to study the ecology of virus-vector-host interactions in selected vegetable cropping systems and to recommend management packages. The aim of the second objective is to increase in-country capacity for virus diagnosis and conducting research on management approaches through training. A week-long workshop attended by scientists from the three Asian regions covered principles of virology, diagnosis, epidemiology, and field observation of tomato production practices. Samples collected were used for demonstration of ELISA, TBIA, and PCR diagnostic methods. Appraisals of virus ecology and temporal and spatial dynamics of aphid and whitefly vector species and populations are being conducted in some locations in order to design IPM approaches. Data are presented on efficacy of host-free periods to reduce incidence of whitefly transmitted begomoviruses in parts of the Dominican Republic. Programs are being conducted to produce clean potato and sweetpotato planting material, to reduce seed transmission of virus in okra and yardlong bean, to reduce virus incidence and impact by early roguing of symptomatic tomato, and to select for resistance in pepper, tomato, and other crops.

Important plant virus diseases and their vectors

Southeast Asia: Indonesia

Detection and diagnosis of viruses in vegetable crops in Indonesia

Detection and diagnosis of viruses in Indonesia was initially implemented by collecting field samples from West Java - mainly three vegetable crops, i.e. tomatoes, chilli pepper, and yard long bean. Serological techniques were routinely conducted at Bogor Agricultural University using ELISA as the initial detection method. Further diagnosis using PCR and nucleic acid sequence analysis of the PCR product was undertaken in some cases. Diagnosis of tomato and chilli pepper was usually conducted using 3 antisera, i.e. tobacco mosaic tobamovirus (TMV), cucumber mosaic cucumovirus (CMV), and general potyvirus, and one additional antiserum for chilli pepper, i.e. chilli veinal mottle potyvirus (ChiVMV). Detection of geminivirus of the Begomovirus genus was conducted by PCR methods as a routine activity since geminivirus infection has become epidemic in tomato and chilli pepper in Indonesia for the last few years. In collaboration with the activities of Southeast Asia Regional Project, tomato and chilli pepper samples were collected from fields at Cipanas, Bogor, West Java in 2010. No positives of TMV, CMV, and ChiVMV were detected, but geminivirus was positively detected in 50% of the chilli pepper samples. This result was not surprising since previous surveys, conducted on a yearly basis since 2006, have shown that geminivirus is the predominant virus in tomato and chilli pepper. Survey of viral diseases on chilli pepper was part of the research activities under ACIAR project since 2006 whereas the survey on tomatoes was part of research activities funded by ABSP 2– USAID. Tests have not yet been done to identify the specific geminivirus(es).

Determining a causal agent of the yellow mosaic disease of yard long bean

Specific detection and diagnosis study was conducted to identify a virus associated with the yellow mosaic disease in yard long bean. This research was partially funded by Bogar Agricultural University through an International linkage Research Activity (PUI) to Tri Asmira Damayanti. The serological and transmission tests were conducted in the Laboratory of Plant Virology, Bogor Agricultural University (BAU), and the molecular detection, cloning, and sequencing were done at Washington State University (WSU). Based on serological tests, transmission tests and RT-PCR detection, yellow mosaic disease in Bubulak, Bogor (West Java) was associated with mixed infections of Bean common mosaic potyvirus (BCMV) and CMV. Further field surveys were conducted to collect samples from several districts in West Java, including Jatisari Karawang, Subang (Ciasem, Ciasem Tengah, Pegaden), Indramayu (Jatibarang, Bongas, Cadangpinggan) and Cirebon (Kaliwulu, Dawuan, Babakan, Saraban). Samples were then subjected to serological tests against antiserum (obtained from DSMZ (German Collection of Microorganisms and Cell Cultures), of *Bean common mosaic poytvirus* strain Peanut stripe – BCMV-PSt, *Bean common mosaic necrotic poytvirus* – BCMNV, *Bean yellow mosaic virus* – BYMV, *Bean leaf roll luteovirus* - BLRV, *Bean golden mosaic begomovirus* – BGMV, *Cowpea aphid-borne mosaic potyvirus* – CaBMV, *Cowpea severe mosaic comovirus* – CPSMV, *Cucumber mosaic virus* – CMV and genus specific *Potyvirus*. Samples reacted positively only against antisera to the potyvirus genus and to CMV, revealing both single and double infections. RT-PCR results showed that samples from Karawang (Jatisari), Subang (Ciasem), and Cirebon (Dawuan) were successfully amplified by a universal primer for Potyvirus. Samples from Subang (Ciasem Tengah, Pegaden), Indramayu (Cadang pulang) only showed weak DNA band with the same primer. Samples from Subang (Pegaden), Cirebon (Dawuan) and Indramyu (Cadang Pulang) reacted differently because they were successfully amplified using primer for CMV. Thus it appears that at least two viruses, a potyvirus and CMV, are associated with yard long bean showing yellow mosaic symptoms. Further tests are in progress.

Southeast Asia: Cambodia

Mr. Chou Cheythyrith from the National IPM Program of Cambodia and Ms. Hong Chanvibol, Plant Protection Sanitary and Phytosanitary, attended the Virus Workshop in Coimbatore, India and provided information on crops and viruses in a presentation to the group. Images were shown on tomato and pepper showing severe symptoms and identified simply as Yellow leaf curl virus and Mosaic virus in tomato and pepper. Leaves of Common bean and Yardlong bean had leaves with mosaic and were much smaller in size. Naidu has identified the virus on ribbed gourd and cucumber to be *Luffa yellow mosaic begomovirus* (LoYMV). There seemed to be little known as to exact virus identities, although it was recognized that whitefly and aphids were main vectors.

South Asia and Southeast Asia:

Detection of viruses in several countries from plant tissue imprinted on FTA cards and nitrocellulose membranes (Rayapati, WSU-IAREC)

Plant samples suspected for virus infections, based on visual symptoms, were collected from tomato, chilli peppers, okra, bitter gourd, bottle gourd, cucumber, pumpkin, ridge gourd, sweet potato, okra and tomato in farmers' fields in India, Bangladesh, Nepal, Cambodia, Indonesia and Thailand, and Honduras. Various types of tissue (leaf, stem, petiole and fruit) were directly pressed gently on FTA® cards or nitrocellulose membrane (NCM) in the field, which were allowed to air dry prior to shipment to the Rayapati lab (WSU) for further processing and testing for different viruses. In addition, samples from non-vegetable crops, such as amaranthus, jasmine, papaya, passiflora growing in the vicinity of vegetable fields in the above countries and sweet potato from Honduras, were also imprinted on FTA® cards and sent for virus testing.

A simplified 3-step nucleic acid extraction protocol, initially developed for the detection of grapevine viruses, was used to elute nucleic acids captured on the FTA® cards and NCMs. Four to five discs (~2 mm in diameter) were punched from sap-stained spots on the FTA® cards or NCMs using the Harris Micro Punch (Sigma-Aldrich, St. Louis, MO). These discs were transferred into an eppendorf tube and nucleic acids bound to the discs were eluted using an appropriate buffer. Nucleic acids in the eluent were subjected to polymerase chain reaction (PCR) or reverse transcription (RT)-PCR using species-specific or broad spectrum primers for the detection of viruses infecting vegetable and non-vegetable crops. Degenerate primers specific to a portion of the cylindrical inclusion body of potyviruses, for the common region of geminiviruses or the replicase gene of tospoviruses, or primers specific to the coat protein of Cucumber mosaic cucumovirus (CMV) were used for PCR/RT-PCR detection of viruses in each sample. DNA fragments amplified by RT-PCR or PCR were subsequently cloned and sequenced. The derived nucleotide sequences were compared with corresponding sequences in GenBank. An analysis of the sequence data indicated the presence of potyviruses, geminiviruses and CMV listed in Table 1. None of these samples tested positive for tospoviruses. Further research is being conducted to gain additional molecular data for accurate identification of these viruses. This information will be used subsequently to develop diagnostic assays for virus identification at the field level in varietal evaluations and IPM trials in host countries.

Table 1. Viruses detected in samples from South and Southeast Asia.

Crop	Country	High similarity with:
Bitter gourd	India	*Squash leaf curl Philippines begomovirus* isolate P133; *Tomato leaf curl New Delhi begomovirus* (ToLCNDV)
Bottle gourd	India	ToLCNDV-[Pakistan:Solanum] isolate Rahim Yar Khan 2 clone PT6
Tomato	India	ToLCNDV isolate ToLCNDV-CTM
Amaranthus	India	*Basella rugose mosaic virus isolate BR*
Passiflora	India	*Chili veinal mottle begomovirus* (ChiVMV)
Tomato	Bangladesh	*Tomato leaf curl Patna begomovirus*
Tomato	Bangladesh	*Tomato leaf curl Bangladesh begomovirus*
Tomato	Bangladesh	ToLCNDV
Okra	Bangladesh	*Bhendi yellow vein mosaic begomovirus*
Papaya	Bangladesh	*Papaya ring spot potyvirus*
Tomato	Nepal	ChiVMV
Cucumber	Nepal	ChiVMV
Pumpkin	Nepal	*Zucchini yellow mosaic potyvirus*
Papaya	Nepal	*Papaya ring spot potyvirus*
Chilli pepper	Indonesia	*Cucumber mosaic cucumovirus*
Ridge gourd	Cambodia	*Luffa yellow mosaic begomovirus* (LoYMV)
Cucumber	Cambodia	LoYMV
Jasmine	Thailand	*Plum pox potyvirus isolate 48-922 from Canada*
Sweet potato	Honduras	*Sweet potato feathery mottle potyvirus*
Pepper	Honduras	*Pepper golden mosaic begomovirus*

South Asia: Bangladesh

Survey and diagnosis of virus diseases of vegetable crops using commercial ELISA kits

A survey was conducted on the status of virus diseases of vegetables in five districts (Narsingdi, Bogra, Chittagong, Gazipur and Jessore) of Bangladesh during summer (June-August) 2010. Only farmer's fields were included in the survey. Four to five plots (minimum 0.1 ha) were visited. Disease incidence and severity of virus disease were assessed visually, using a 1-4 rating (Table 2). Samples were collected in poly bags, kept cool over ice during transport, and then refrigerated until laboratory analysis by enzyme-linked immunosorbent assay (ELISA) was conducted, using commercial kits and protocols from ADGEN Phytodiagnostics (NEOGEN Europe Ltd. UK).

Among the cucurbitaceous vegetables, cucumber had the highest incidence of plants showing symptoms of virus disease and severity, followed by sponge gourd, ridge gourd and bottle gourd. Bitter gourd expressed no symptoms except in one area (Jessore). Teasle gourd and pointed gourd were apparently virus free. In other categories of vegetables, okra and yardlong bean had highest incidence of virus symptoms, followed by summer tomato. Country bean was apparently virus free, as no symptoms were observed. Disease incidence was fairly constant across different locations in crops except in okra. In most of the locations incidence of virus in okra was very high (more than 75%) but it was unusually low (around 10%) in Chittagong. In spite of higher incidence of virus disease, the in-field population of potential aphid or whitefly vectors was negligible at the time of observation, which was when the crop was mostly in mid to late fruiting stages and may be one of the reasons for low vector activity.

Table 2. Incidence and severity of virus diseases of some vegetables in several districts of Bangladesh during summer 2010

Crops	**Locations of Surveyed Area**									
	Narsingdi		**Bogra**		**Chittagong**		**Gazipur**		**Jessore**	
	Dis.Inc	**Sev**	**Dis.Inc**	**Sev**	**Dis.Inc**	**Sev**	**Dis.Inc**	**Sev**	**Dis.Inc**	**Sev**
Cucumber	75	3	80	3	70	2	*	*	30	2
Sponge gourd	50	3	*	*	30	2	30	2	*	*
Ridge gourd	30	2	*	*	20	2	*	*	15	2
Bottle gourd	*	*	30	2	20	2	15	2	*	*
Bitter gourd	0	0	*	*	0	0	*	*	50	3
Teasle gourd	0	0	0	0	0	0	*	*	*	*
Pointed gourd	*	*	0	0	*	*	*	*	*	*
Okra	80	3	80	4	10	2	*	*	*	*
Tomato	*	*	*	*	*	*	*	*	20	2
Country Bean	*	*	*	*	*	*	*	*	0	0
Yardlong Bean	*	*	80	3	25	2	*	*	*	*

Dis.Inc: Disease Incidence (%), Sev: Disease Severity (1= Only mild symptom observed on few leaves, 2 = More severe symptom than 1 but no apparent yield loss, 3 = Severe symptom with some degree of yield loss, 4 = Severe stunting and high yield loss). * No fields were observed.

Testing cucurbitaceous crops by ELISA revealed only one virus, Watermelon mosaic potyvirus (WMV), in only one of six sponge gourd and one of three ridge gourd samples. The remaining 23 samples tested negative to CMV and three potyviruses, papaya ringspot, zucchini yellow mosaic, and WMV. This was viewed as very unusual because symptoms in the field were visually very much like those recognized as viral diseases. Failure to identify one of the viruses tested as the cause of symptoms was attributed to the cause being a nutritional disorder or undetectable low titers of the virus in the portions tested because of age of the plants. Alternatively, other viruses might have been present that could not be tested for due to unavailability of appropriate kits. Virus-like symptoms were also observed on Okra and yardlong bean, but identities could not be assessed because of lack of test kits. Further investigations are planned to identify the viruses in these crops.

Latin America and the Caribbean: Dominican Republic

Incidence and distribution of Tomato spotted wilt virus in tomato

Last year, Tomato spotted wilt tospovirus (TSWV) had been detected in protected crops of tomato and pepper at two locations in the northern part of the country, Jarabacoa and Constanza. This year TSWV was documented in tomato growing in open fields in the southern area of Sabana. ELISA kits and immunostrips from Agdia were used for the virus diagnosis. A survey was performed to determine the distribution of TSWV in Nizao, Las Auyamas, Sabana Larga, Rancho arriba, las Caobas, Carretera Ocoa-Azua and Carretera Palenque San Cristobal of Ocoa Valley. Positive samples were found only in Sabana Larga with an incidence of 10%. This thrips-transmitted virus is more prevalent under protected rowing conditions than in open fields.

New virus-like symptoms found on tomato grown under protected conditions

A new symptom typified by apical chlorosis (Fig. 1) was found on tomato grown under protected conditions at San Josè de Ocoa in the localities of Sabana Larga, La cienega, El Pinal and Rancho Arriba. The pathogen has not been characterized, but it is causing around 90% incidence in those facilities. IDIAF ran ELISA tests for PVY, CMV, TEV, and TMV. The results were negative for those viruses. Samples were taken and sent to Dr. Margarita Palmieri at the Universidad del Valle in Guatemala, where she ran the PCR and obtained some bands that need to be sequenced to identify the virus.

Latin America and the Caribbean: Guatemala

Detection of begomoviruses and Candidatus liberobacter in tomatoes and peppers

To gain insight into the nature of the viruses and other pathogens causing disease symptoms in peppers and tomatoes in Guatemala, representative samples were collected from peppers and tomatoes showing symptoms of virus infection in March 2010. Sap was prepared from these samples and applied to AgDia absorption strips, and the strips were sent to UC Davis where DNA extractions and PCR analyses were performed. Vilmori, a French seed company, contributed funds to assist in processing of the samples from Guatemala.

Table 3. Results of virus and Candidatus liberobacter tests conducted on tomato samples collected in Guatemala in March 2010

Sample	Symptoms	General begomovirus	TYLCV	ToMHV	ToSLCV	Liberobacter 1	Liberobacter 2	Phytoplasma
T1	severe distortion, stunting (broccoli) yellowing/purpling	+	--	+	+	+	+	--
T2	Upcurled leaves, purple vein, distorted growth	+	--	+	+	--	--	--
T3	Upcurled leaves, purple vein, crumple, mild distorted growth	+	--	+	+	--	--	--
T4	Strong upcurling, purple vein, new growth stunted	+	--	+	+	--	--	--
T5	Strong upcurling, purple vein (curly top-like) similar to T3	+	--	+	--	--	--	--
T6	Strong interveinal Chlorosis of old lvs, Upcurling, purple vein (=184 sb6)	+	--	+	+	+	+	--
T7	Strong yellow mottle Crumple, light grn Yellow mottle (milder)	+	--	--	+	--	--	--
T8	Older leaves interveinal yellows and brittle/young leaves upcurled w/purple vein	+	--	+	+	--	--	--
T9	General yellowing on older grwth and brittle new growth with yellow And purple veins	+	--	+	+	+	+	--
T10	Strong upcurling, crumple, yellowing TYLCV-like	+	+	+	+	--	--	--
T11	Yellowing of older leaves and brittle stunted growth, purple	+	+	+	+	+	+	--
T12	Strong yellow mottle crumple on old leaves severe distortion/crumple on new growth	+	+	+	+	--	--	--

Results based on PCR analysis with general begomovirus primers, primers specific for TYLCV (2560c/1480c), ToMHV DNA-A (2200v/900c) and ToSLCV DNA-A (520v/1860c). Two primer pairs were used for Liberobacter: 1=OA2/OI2c and 2=CL514F/R and the PI/Tint primers were used to detect phytoplasmas.

The peppers had typical symptoms of begomovirus infection. PCR analyses confirmed all four samples were infected with the begomovirus *Pepper golden mosaic virus* (PGMV). All twelve tomato samples were infected with one or more begomoviruses (Table 3). Four (T1, T6, T9 and T11) were also infected with *Liberobacter* (based on PCR with 2 primer pairs), whereas none were infected with phytoplasma (P1/Tint primers used). Tomatoes infected with *Liberobacter* showed general yellowing, including older leaves, leaf brittleness, stunted growth, and new growth was yellow with purple veins. Most of the tomato samples were infected with *Tomato mosaic Havana virus* (ToMHV) and *Tomato severe leaf curl virus* (ToSLCV), which are commonly found infecting tomatoes in Guatemala and cause severe leaf curl symptoms and purpling and stunting. *Tomato yellow leaf curl virus* (TYLCV) was detected in only three plants (T10, T11 and T12), all of which had a strong degree of yellowing, consistent with infection with this virus, which was introduced into Guatemala two or three years ago. Thus, these tomato samples had varying degrees of mixed infection with begomoviruses and *Liberobacter*. This explains the variety of symptoms observed in the field and why begomovirus-resistant varieties may be showing variable responses as well. This complex of viruses and non-culturable bacteria pose a major threat to the capacity to produce peppers and tomatoes in the field in Guatemala and increase the urgency for the development of IPM packages for insect-transmitted viruses and virus-like agents.

Latin America and the Caribbean: Honduras

Initial testing for viruses in solanecous crops and weeds in potato fields

Ninety-six foliar samples from symptomatic potato plants were collected representing the three main potato cropping regions of the country and the two main cropping seasons. Additionally, 21 samples of tomatoes, 6 of peppers and 6 of weeds, were also collected for analysis to total 129 samples collected of solanaceous crops and associated weeds. In addition to funding from the IPVDN, the costs of these activities were met using leveraged financial support from the local offices of FAO and FINTRAC. The following results have been obtained.

Group A Samples. Between June 2009 and February 2010, a total 98 samples were collected for analyses, of which 89 were of potatoes and 4 and 5 samples, respectively, were of tomatoes and weeds growing in the neighborhood of potato fields. They were analyzed at Agdia Incorporated (Elkhart, IN, USA), subjecting them to a battery of 23 tests that included specific detection of 20 distinct species of viruses or viroids belonging to 13 genera included in at least 6 distinct families of viruses, and also for genus-specific detection of members of the Potyvirus, Begomovirus and Closterovirus genera. The analytical procedure used was ELISA, except for nucleic acid hybridization for viroids and PCR for Begomovirus and Closterovirus genera tests.

The selection of the tests to be performed on each sample (Table 4) was made following a thorough literature review and consultation, and was based at the end on the following selection criteria: a) reported occurrence of the virus in the region or in Honduras; and b) occurrence of the virus in the countries from which Honduras has historically imported potato seed.

Reactions positive to presence of at least one virus occurred in 36% of the samples; 3% were confirmed positives infection with more than one virus. The species detected represented four different genera of viruses as follows.

A. Potyvirus genus. 15% tested positive to this genus, and 13% were positive specifically to PVY; no positives were positive to the other potyviruses tested, namely, PVA, PVV and TEV. This suggests that other unidentified potyvirus species may occur at a lower prevalence.

B. Potexvirus genus. 10% tested positive to PVX, the only species of this genus tested for.

C. Begomovirus genus. 10% samples tested positive, of which 6 were potato and 4 tomato.

D. Closterovirus genus. 4% tested positive, all potato.

Of the insect-transmitted viruses detected, aphid-transmitted potyviruses, mainly PVY, were most prevalent followed by whitefly-transmitted Begomovirus. Neither group appears to be of much importance considering their frequency; nevertheless, they have the potential to cause extensive damage because of the characteristics of their vectors and the concurrent effect of climatic change on their range of activity. PVX, which has no insect vector, was detected at a frequency similar to Begomovirus. This virus can also become a problem as it is transmitted via tubers, which the local growers customarily keep as seed for next cropping season.

Table 4. Viruses selected for testing in solanaceous crops in Honduras

Name of species or virus genus tested for	Initials	Family	Genus
Alfalfa mosaic virus	AMV	Bromoviridae	Alfamovirus
Cucumber mosaic virus	CMV	Bromoviridae	Cucumovirus
Tomato spotted wilt virus	TSWV	Bunyaviridae	Tospovirus
Andean potato mottled virus	APMoV	Comoviridae	Comovirus
Tomato black ring virus	TBRV	Comoviridae	Nepovirus
Potato aucuba mosaic virus	PAMV	Alphaflexiviridae	Potexvirus
Potato latent virus	PotLV	Betaflexiviridae	Carlavirus
Potato virus X	PVX	Alphaflexiviridae	Potexvirus
Potato virus M	PVM	Alphaflexiviridae	Carlavirus
Potato virus S	PVS	Alphaflexiviridae	Carlavirus
Potato leaf roll virus	PLRV	Luteoviridae	Polerovirus
Potato spindle tuber viroid	PSTVd	Pospiviridae	Pospiviroid
Potato virus A	PVA	Potyviridae	Potyvirus
Potato virus V	PVV	Potyviridae	Potyvirus
Potato virus Y	PVY	Potyviridae	Potyvirus
Tobacco etch virus	TEV	Potyviridae	Potyvirus
Andean potato latent virus	APLV	Tymoviridae	Tymovirus
Potato mop top virus	PMTV	Virgaviridae	Pomovirus
Tobacco mosaic virus	TMV	Virgaviridae	Tobamovirus
Tobacco rattle virus	TRV	Virgaviridae	Tobravirus
Potyvirus group	-	Potyviridae	-
Begomovirus group	-	Geminiviridae	Begomovirus
Closterovirus group	-	Closteroviridae	-

Group B Samples. A group of 31 samples (7 potato, 17 tomato, 6 pepper and 1 weed) was collected in July and August 2010, and divided in two sets for analysis. A first set of 4 tomato samples was sent to AGDIA for ELISA testing for TMV and group PCR analysis for begomovirus, closterovirus and potyvirus. These samples (TOM-F-01, TOM-F-02, TOM-F-03, and TOM-F-04) tested negative to TMV, closterovirus and potyvirus These tomato samples were found to be positive in the commercial testing lab (AGDIA) using a set of PCR primers that amplify a non-coding with coding region fragment of begomoviruses. Sequences from this region matched most closely to *Tomato severe leaf curl virus* (~93%) and *Tomato mosaic Havana virus* (~91%). These two begomoviruses have been found to be prevalent in Guatemala as well.

The remaining samples were sent to Dr. J. Brown (U Arizona) for specific PCR analysis of begomovirus and the fastidious bacteria *Candidatus Liberibacter solanacearum*. Laboratory tests were conducted at the Brown lab for begomovirus detection, using a different set of primers that amplify the coat protein (core Cp PCR, updated 2007). Symptomatic tomato and pepper plants mostly positive for whitefly-transmitted geminiviruses. Samples of four tomato and two bell pepper were prepared and from DNA sequencing determined to be *Tomato severe leaf curl virus* (TSLCV). Potato samples gave PCR products, but sequences obtained were not of begomoviruses indicating false positives.

Detection of Sweet Potato Viruses

Between July and August 2010, a group of 20 samples was collected and divided in two sets for analysis. The samples represented different fields and also plants held by Zamorano in greenhouse and tissue culture laboratory as part of an effort to produce virus-free propagative material. One set of 14 samples was sent to AGDIA where they were analyzed for TMV using ELISA and for Begomovirus, Closterovirus and Potyvirus using group PCR analysis.

Tests to be performed were selected using criteria as used for potato. PCR analyses at AGDIA showed that leaf sample CAM-F-01 tested weakly positive for Potyviridae and also for Closteroviridae. Sequences from this sample showed 73% similarity with the Closterviridae species *Sweet potato chlorotic stunt virus* (SCSV), a crinivirus. The samples CAM-F-02 and CAM-Z-4 also tested weakly positive for the presence of Closteroviridae.

Results of commercial lab PCR-testing of some of the sweet potato samples showing virus-like symptoms indicated the presence of a closterovirus giving a weak positive using the 'group test'. One of those two plants (1) also was weakly positive for potyvirus using the 'potyvirus group test'. No significant shared identity was found for the PCR product amplified from sample 4 suggesting that the amplicon was possibly not viral in origin. Sample 1 shared 73% nt identity with *Sweet potato chlorotic stunt virus*, while sample 2 shared 92% identity with *Sweet potato chlorotic stunt virus*. 'Beauregard' (orange) contained both viruses and 'Bushbock' (red) was infected with SCStV only (2 samples each, were tested). The phytosanitary certificate that accompany sweet potato germplasm purchased as seed potatoes for planting in Honduras did not indicate which if any plant viruses were tested for. Ten of the 14 samples sent to AGDIA, including the Closteroviridae-positive CAM-Z-4, came from the Zamorano greenhouse mother plants and tissue culture plantlets. Based on these results, Zamorano proceeded to eliminate the positive mother plant and the plantlets derived from it by tissue culture.

The other 6 samples were sent to Dr. J. Brown of the U. of Arizona for specific PCR analysis of begomovirus. Design of PCR primers for detection of well-studied plant viruses that infect sweet potato, as well as for close relatives of the potyvirus and closterovirus detected in two varieties. Positive controls may be difficult to obtain, but requests are out to several laboratories to obtain known virus cultures or mini-circles (oligos) or cloned amplicons, to use as positive controls to optimize RT-PCR and PCR assays that will be established at the UA-Brown lab and then transferred to Zamorano for local use. In work described above by Rayapati (WSU), *Sweetpotato feathery mottle virus* was detected in a sample from Honduras by PCR from FTA-card eluted RNA.

West Africa: Mali

Detection and identification of viruses infecting pepper, okra and weeds in Mali

During a trip to Mali by Gilbertson (UC-Davis) in May 2010, collected samples of peppers from a variety trial conducted in Baguineda, as well as samples of okra, *Sida* spp. *Physalis* sp. and cucurbits. Sap, was prepared from representative leaves and applied to AgDia absorption strips. These were returned to UC Davis where they were tested for infection by begomoviruses (using DNA extracts from one strip) or RNA viruses (using RNA extracts from another strip). General primer pairs for whitefly-transmitted begomoviruses or for betasatellites were used for DNA viruses. For RNA viruses, general primer pairs for the potyvirus genus and for Cucumber mosaic virus (CMV) were used. Amplified DNA was sequenced to determine and confirm virus identity.

Peppers in the variety trial in Baguineda were collected to represent symptoms ranging from a light green-yellow mosaic/mottle to leaf distortion and up-curling (Table 5). Plants showing mottle/mosaic symptoms were PCR positive only for CMV and generic potyvirus, the sequence of which was 89% similar to Pepper veinal mottle virus (PVMV). Those showing leaf curling, distortion and stunting were infected with a begomovirus that was subsequently determined by PCR-specific primers to be Tomato yellow leaf crumple begomovirus (ToLCrV). Peppers with severe stunting and distortion were found to be infected by all three viruses. These results indicate that a complex of insect-transmitted viruses can infect peppers in Mali, that management strategies will have to take into account both aphid- and whitefly-transmitted viruses, and that viruses cannot be diagnosed by visual symptoms.

Okra plants with severe or mild leaf curl and crumple symptoms were found to be infected with begomoviruses and the associated betasatellite. By sequence analysis, the begomoviruses detected were either Cotton leaf curl Gezira virus (CLCuGV) or Okra yellow crinkle virus (OYCrV), and the associated betasatellite was Cotton leaf curl Gezira betasatellite. Four Okra plant samples from Bamako were all PCR-positive, with CLCuGV-okra and OYCrV co-infecting 3 severe and 1 mild symptom samples. One okra plant with mild symptoms was infected by OYCrV alone. The detection of this complex of begomoviruses and betasatellite is consistent with previous results, showing these agents are responsible for okra leaf curl disease in Mali and other countries in West Africa.

Interestingly, the *Sida* spp. with upcurling and yellowing was found to be infected with a begomoviruses and a betasatellite. The *Sida* spp. from Sotuba was infected with a *Sida* strain of CLCuGV and a betasatellite, whereas the *Sida* from Baguineda was infected with OYCrV and the okra strain of CLCuGV and a betasatellite. A collection of *Physalis* was weakly positive for begomovirus and beta, but a mixed weed sample was negative. These results suggest that the *Sida* spp., a very common perennial weed, is a reservoir for begomoviruses with the potential to infect okra. However, more research needs to be conducted to prove that the viruses in *Sida* can infect okra. Finally, the virus infecting cucurbits was determined to be Zucchini yellow mosaic potyvirus (ZYMV), a virus that we have previously detected infecting cucurbits in Mali.

Table 5. Association of viruses with symptoms in a pepper variety trial in Beguineda, Mali

Symptoms	Begomo	Beta	Poty	CMV	Sequence Similarity
Mottle/mosaic	-	-	+	+	
Mottle/mosaic	-	-	+	+	PVMV-89%; CMV- 97%
Mottle/mosaic	-	-	+	+	PVMV-89%; CMV- 97%
Mottle/mosaic	-	-	+	+	
Severe distortion/stunt 'broccoli;	+	-	+	+	PVMV-89%; CMV- 97%
Severe distortion/stunt	+	-	+	+	PVMV-89%; CMV- 97%
Severe distortion/stunt	+	-	-	-	
Severe distortion/stunt	+	-	-	-	
Upcurling, crumple	+	-	+	-	
Upcurling, crumple	+	-	+	+	
Upcurling, crumple	+	+/-	+	+	PVMV-89%; CMV- 97%
Upcurling, crumple	+	-	-	+	
Mosaic/mottle; Crumple, necrosis	+/-	+/-	+	+	
Mosaic/mottle; Crumple, necrosis	-	-	+	+	PVMV-89%; CMV- 97%
Mosaic/mottle; Crumple, necrosis	+	-	+	+	
Mosaic/mottle	+	-	+	+	PVMV-89%; CMV- 89%

Begomovirus: +=detected with a general primer pair for whitefly-transmitted begomoviruses and subsequently determined to be *Tomato yellow leaf crumple virus* by PCR with specific primers.

Beta: +=detected by PCR with a general primer pair for betasatellites

Poty: +=detected by PCR with a general primer pair for potyviruses

CMV: +=detected by PCR with a primer pair designed for CMV

Central Asia: Uzbekistan

Zarifa Kadirova from the Institute of Genetics and Experimental Biology of Plants of the Academy of Sciences of Uzbekistan, Tashkent, attended the Virus Workshop in Coimbatore, India and provided information on the status of viruses in potato and wheat, major crops in Uzbek. Potato viruses X, Z, M, S, and A as well as Potato leafroll virus have been detected in Tashkent and Samarqand growing regions. Identifications appeared to have been done by biological assays to indicator plants. She had received some training on virus diagnosis in the Rayapati lab (WSU) and reported the discovery of Tomato spotted wilt tospovirus

(TSWV) in market surveys of tomato fruits by the use of Immunostrips (Agdia).

Long-term institutional capacity building

A major, week-long workshop on virus diseases was held in Coimbatore, India at Tamil Nadu Agricultural University, July 12-17, 2010. Lectures were given on the nature of viruses, diagnostics, and management. Host country participants made presentations on their activities and capabilities in virology at their institutions. A field trip was taken to observe tomato infected with peanut bud necrosis, as well as cucurbit and legume crops with virus-like symptoms. Stops included plant nurseries, both contained and open, where tomato seedlings were grown to supply farmers. At vegetable markets, virus symptoms were observed on tomato fruits and okra. Samples were taken at various locations and used for demonstrations of ELISA by Rayapati and of tissue blot immunoassay (TBIA) by Tolin.

Tolin and Gilbertson met with the International Plant Diagnostics Network Global Theme at their planning meeting in Antigua, Guatemala and discussed the interaction between the two projects. Included in these discussions were the activities on increasing virus diagnostic capabilities in host countries. At this time, few locations can reliably conduct PCR and RT-PCR, but are able to conduct immunoassays. Restrictions in obtaining test materials are a major constraint, as well as the cost. Membrane-based methods to collect and store sap from plant samples for transport to a central lab, including those of the US collaborators, has enabled an increase in our knowledge of viruses present, but is not a sustainable model. The description below of the workshop in Indonesia is a good example of the activities and the interest of the countries.

Workshop on Plant Disease and Insect Pathogen Diagnostics was conducted in Bogor, Indonesia in July 22 – 23, 2010 as part of collaborative activities between IPM CRSP Southeast Asia Regional Project and IPDN Global Theme. This workshop was attended by 20 participants (11 males and 9 females) from Indonesia, Phillippines, and Cambodia. The participants have diverse knowledge in regard to plant disease diagnostic due to their different background and professions, i.e. scientists, extension agents, and graduate students from IPB. General plant disease diagnostics was discussed involving serological and polymerase chain reaction techniques for viruses, morphological based identification for fungi, biochemical and physiological based techniques for bacteria, and some basic techniques for insect pathogen diagnostics. Field visit to horticultural growing area in Ciloto was conducted a day prior to workshop to introduce disease type symptoms and also to collect samples for laboratory works during the workshop. Workshop materials (program, power point presentation, and pictures taken during the activities) was documented and saved in two CDs, which were distributed to each of the participants at the end of the workshop.

The diagnostic laboratory at Zamorano in Honduras has made important steps towards validating and adopting appropriate technologies for virus testing. These include ELISA with commercial kits, immunostrips for specific viruses, and PCR to detect DNA viruses such as begomoviruses and phyotoplasmas. In 2009, through funding from the Common Fund for Commodities that supports a research project on the Coconut Lethal Yellowing Diseases, a Real Time PCR thermocycler was acquired and the technology validated and adopted for CLY at the Zamorano lab. The use of FTA cards to by-pass laborious DNA extraction was also validated for CLY. It is expected that the use of RT-PCR and FTA cards will greatly support the diagnostic capabilities of the Zamorano lab for virus testing. The FHIA laboratory is also increasing its capacity to perform testing on site.

The laboratory at University del Valle de Guatemala probably has the most advanced capabilities for virus diagnosis and has reliably conducted PCR and ELISA for several years. The IDIAF lab in Dominican Republic was just constructed in the last phase of the project, but is beginning to conduct tests. Tolin and Deom provided earlier training to this lab, and Martinez received further training in the Tolin lab at Virginia Tech.

India: Ecological Research

Assessment of seed transmission of Tobacco streak virus (TSV) in okra

Based on initial field surveys of okra by Karthikeyan and Rayapati in farmers' fields in Tamil Nadu, dissemination of *Tobacco streak virus* (TSV) via hybrid seed obtained from commercial sources was suspected. Seedlings from virus-infected seed could serve as a source for secondary spread of the virus via pollen carried by thrips. To assess the potential of seed-transmission of TSV, we collected pods from TSV-infected, symptomatic okra plants in farmer's fields and commercial breeding plots in Dharmapuri and Krishnagiri areas of Salem and Coimbatore districts of Tamil Nadu. Seeds from dried pods were harvested from both local varieties as well as hybrids and sown in pots, and seedlings were maintained under greenhouse conditions. Plants were observed for symptoms on leaves and fruits at weekly intervals till harvest. The presence of TSV in symptomatic okra plants was ascertained by RT-PCR using primers specific to the coat protein. Cumulative results from three seasons are shown in Table 5. The data clearly shows high rates of seed transmission of TSV in commercial hybrids produced by self pollination than in local varieties, where seeds are produced by natural, open pollination. The mean rate of seed transmission of 11.4 per cent clearly highlights the risk of TSV spread via distribution of hybrid seed. TSV is known to be transmitted via seed in many crops, and outreach activities should be conducted to bring awareness to farmers and commercial seed companies on the risk of spreading the virus via distribution of commercial hybrid seed and to eradicate sources of infection by rouging symptomatic seedlings for minimizing secondary spread of the virus.

Table 6. Comparison of seed transmission of TSV in different okra seed sources

Sl. No.	Set of experimen t	Seed from	Total no of seed tested	Number of infected plants	Per cent transmission
1	I	Local variety - 1	300	0	0
2	II	Local variety - 2	250	7	2.8
3	III	Commercial hybrid variety - 1	200	58	29.0
4	IV	Commercial hybrid variety - 2	100	19	19.0
5	V	Commercial hybrid variety - 3	300	47	15.7
Mean			**1150**	**131**	**11.4**

Implementation of applied research on specific virus diseases in selected crops

South Asia: India

Evaluation of 'roguing' as a tactic for management of Peanut bud necrosis virus in tomato

Results from previous seasons reported in the Tospovirus global theme have shown that roguing virus-infected tomato seedlings, during and/or soon after, transplanting could reduce the spread of *Peanut bud necrosis virus* (PBNV). To further validate this approach for incorporating into an IPM package for tomato, Karthikeyan and Rayapati conducted a field trial in a farmer's field near Thondamuthur of Coimbatore district using the tomato cultivar Vaishnavi. The field was divided into two equal halves at the time of transplanting, and one half was transplanted with seedlings that appeared healthy and the other half was transplanted with a mixture of seedlings with and without visual symptoms. All seedlings came from a single nursery and were the same age. After transplanting, any seedling that showed symptoms of PBNV was removed in the "with roguing" plot for up to 45 days post-transplanting. These plots were not treated with any pesticides for controlling thrips vectors. Weeds were removed at regular intervals. The number of tomato plants showing symptoms of PBNV was scored at biweekly intervals and are shown in Table 7.

The data indicated that incidence of PBNV was significantly higher in plots with no roguing when compared to plots with roguing in both locations (Table 7). In addition, cumulative yield of tomato harvested from the non-rogued plot was 11.1 t/ha versus 16.45 t/ha from the rogued plot, an increase of 48.2% . An analysis of benefit-cost ratio using tomato sale price at the time of final harvest (a low market price of Rs. 4/kg) concluded that farmers can gain an additional revenue of Rs. 21,400/= per hectare by adopting roguing of infected seedlings during transplanting and within the first 45 days of post-transplanting, without incurring additional costs for spraying pesticides to control thrips vectors.

Table 7. Effect of roguing on the incidence of PBNV in tomato
Location : Thondamuthur / Coimbatore **Tomato Cultivar : Vaishnavi**

Sl. No.	Days after planting	Per cent PBNV incidence*		Per cent PBNV disease increase over plot with roguing	CD (p=0.05)
		Plot with roguing	Plot with no roguing		
1	15	3.90 (11.93)	10.25 (18.65)	163	5.1
2	30	5.65 (13.12)	17.90 (20.04)	217	7.5
3	45	6.80 (15.20)	21.00 (28.10)	209	9.4
4	60	10.40 (18.88)	26.50 (32.22)	155	13.4
5	75	12.20 (20.34)	32.00 (33.24)	162	15.7
6	90	15.00 (22.90)	41.34 (39.80)	176	18.9

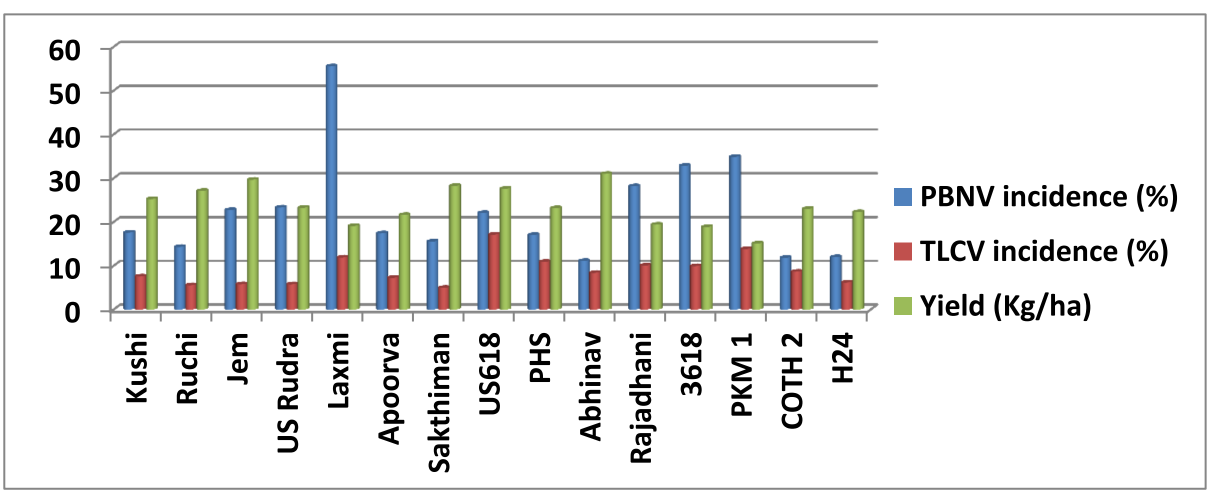
*Values in parentheses are arcsine transformed values

Evaluation of field performance of tomato cultivars and hybrids against Peanut bud necrosis virus and Tomato leaf curl virus

Field trials were conducted to evaluate performance of selected tomato cultivars and hybrids (developed by public institutions and commercial seed companies) commonly grown by farmers of Tamil Nadu. They are Ruchi, Kushi, JEM, US Rudra, Lakshmi, Apoorva, Sakthiman, US 618, PHS, Abinav, Rajadhani, 3618, PKM-1, COTH-2 and H24. The trial was established to evaluate field performance against *Peanut bud necrosis virus* (PBNV) at two different locations of Tamil Nadu endemic for the virus disease (Fig. 4). Healthy seedlings raised under controlled conditions were transplanted in a randomized block design with three replications. The plot size was $5m^2$ with 8 rows of planting. Plants were observed for symptoms caused by PBNV infection at biweekly intervals. In addition, these plots were observed for tomato leaf curl disease caused by *Tomato leaf curl virus* (TLCV) and spread by whiteflies, in order to obtain data on resistance/tolerance to two economically important viral diseases. The populations of thrips and whitefly were also recorded.

The results indicated that the overall incidence of PBNV was greater than of TLCV, and that entries varied in their response (Fig.1). There was no correlation between the number of vectors recorded in each cultivar/hybrid and disease incidence. PBNV incidence at 90 days post-transplanting was lowest in the cultivar Abhinav (11.1%) followed by the hybrid COTH-2 (11.82%) and H 24 (11.97%) . The disease incidence was moderate in hybrids Ruchi (14.31%), Sakthiman (15.54%) and PHS (17.04%), and higher in Jem (22.73%), UD Rudra (23.31), Laxmi (55.55%), PKM-1 (34.87%) and 3618 (32.83%). A low incidence of tomato leaf curl disease was observed in hybrids Sakthiman (4.95%), Ruchi (5.56%), US Rudra (5.78%), Jem (5.79%) and H24 (6.20%) at 90 days post-transplanting**.** The incidence of leaf curl was significantly higher in the hybrids US 618 (17.13%), PKM-1 (13.83%) and Laxmi (11.90%) during the same period (Fig. 1). The data obtained in this trial show that some cultivars and/or hybrids have field tolerance to diseases caused by PBNV and TLCV. Abhinav recorded significantly higher fruit yield of 31 t / ha followed by Jem with 29.65t/ha and Sakthiman with 28.25 t / ha.

Fig. 1. Field performance of different tomato cultivars / hybrids against diseases caused by PBNV and TYLCV; Values are mean of two trials, with incidence at 90 days post-transplant



Latin America and the Caribbean: Dominican Republic

Monitoring the base-line rate of infection of tomato with TYLCV in the Ocoa Valley

IDIAF scientists established an experimental plot designed to observe the behavior of the TYLV epidemic. A local variety, Floradade, was used because it is grown widely in the valley and is very susceptible to TYLCV. Five replicate plots were planted, each with 105 plants. The incidence of TYLV- infected plants was monitored weekly to observe the epidemiology of the disease in order to design an effective intervention. Plants were inspected for symptoms expression, beginning 15 days after transplanting. No application of insecticide against whitefly was done in order to expose the crop to high pressure of inoculum. Traps were placed to collect whiteflies, as reported in the LAC report.

Only 37 plants were infected 15 days after transplanting. After 4 weeks, the infected plants started to increase. By the end of growing season the incidence was 100%. The plants set fruits that were small and showing unripening symptoms, resulting in reduced yield. Of interest from the vector management standpoint, LAC data showed yellow traps were most efficient for trapping whiteflies. According to the numbers of individuals present, colonization of *Bemisia tabaci*, the vector of TYLCV, occurred after the second week. The population increased up to 20 times in the next 3 weeks. The combined results indicate that whitefly populations would need to be controlled by 2nd week to decrease the population explosion and concomitant transmission of TYLCV to all tomato plants.

Monitoring of Tomato yellow leaf curl virus (TYLCV) in whiteflies to assess the continued effectiveness of the 3 month host-free period

The implementation of a 3-month whitefly host-free period in the Dominican Republic (DR) continues to be a key component of a successful IPM program for the management of this damaging virus. As part of the Plant Viruses Global Theme activities, Gilbertson has collaborated with Transagricola to conduct continued monitoring whiteflies for TYLCV to assess the efficacy of the host-free period in the two major tomato-growing areas of the DR, the North (around Santiago) and the South (Azua Valley); as well as in Ocoa, an area where there is no host-free period.

As has been the case in previous years, little or no TYLCV was detected in whiteflies collected early in the tomato growing season (September and October 2009). The virus began to be detected in whiteflies collected in November. By December 2009, many samples from the North and the South were strongly positive for the virus and by January and February 2010, almost all of the whiteflies from both locations were strongly positive for TYLCV; this coincided with the development of TYLCV in tomatoes in the field in the DR. Many of the whiteflies collected in March, April and May 2010 also were positive for TYLCV; however, the viral titers began to decline as the harvest was completed and sanitation efforts were implemented. Following the implementation of the host-free period (June 2010), TYLCV was not detected in whiteflies from the North or the South that were collected in June 2010. TYLCV was not detected in most of the whiteflies collected in July 2010; however, two strong positives were obtained from two locations in the South (Tabara Abajo and Km 15), and these were collected from peppers, a host that should be included in the host-free period. This finding alerted Ministry of Agriculture personnel to visit this area and to make sure all growers were following the host-free period. In addition, it was determined that whitefly populations were relatively high on certain weeds, and sanitation efforts were implemented to decrease the populations of whiteflies. Whiteflies collected in August had very little TYLCV (only a couple samples had very weak positives, and similar results were obtained for whiteflies collected in September. Overall, these results indicated that the host-free period was effective in reducing the amount of TYLCV in whiteflies and that the virus pressure should be low heading into the 2010 growing season. These results also demonstrate how the monitoring of the virus in whiteflies can alert government and industry personnel of possible violations of the host-free period (or other situations) that lead to the build-up of the virus, nd allow for implementation of practices to reduce or eliminate these outbreaks before the start of the growing season. Thus, the monitoring of TYLCV continues to be an important part of the effective IPM program for this virus in the Dominican Republic.

Latin America and the Caribbean: Honduras

Production of virus-free sweet potatoes propagative material through the use of tissue culture

Mother plants were established from material donated by a grower. Preliminary trials to culture sweet potatoes meristems in tissue culture were successful. In July 2010, samples from mother plants and lab microplants were sent to the U.S. for virus diagnostic. One mother plant resulted positive to Closterovirus. At this time, we have under culture 194 plants from the negative virus diagnostic plants. In six months or so, plants will be given to the growers after the acclimation process. The growers will use them to reproduce virus-free vegetative material.

IPM Impact Assessment for the IPM CRSP

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Summary

The Impact Assessment Global Theme interacted with the Regional Programs and Gender Global Theme to initiate impact work in each region with emphasis on South Asia, LAC, and East Africa, and on developing the baseline surveys and data collection formats for the Regional Programs. An MS thesis was completed for West Africa tomato IPM based on survey data collected in the previous year. The projected benefits of the IPM tomato program in Mali and Senegal were $4.8 to $21.6 million. Two MS students (1 male and 1 female) received long-term training (one jointly with the West Africa Regional Program and one with the South Asia regional Program). The first student finished and returned home to West Africa. The second student went to Bangladesh and Nepal to collect her data and develop her model to assess the most cost effective means of reaching a broad audience with IPM packages. Brief planning and training sessions on impact assessment were held in Bangladesh, Nepal, India, Ecuador, Honduras, the Dominican Republic, and Uganda (with 11 males and 9 females), and sample baseline survey and budget template forms were sent to the other regional programs.

Common set of methods for impact assessment

Host country collaborators have been identified for most countries. Each region received guidelines with respect to the farmer baseline survey, and a sample budget form was provided for use in collecting data for each on-farm experiment.

Baseline survey

Statistical frames were set for baseline surveys in Bangladesh, India, Uganda, Ecuador, and the Dominican Republic. Regional programs were helped with baseline survey questionnaires in LAC, South Asia, and East Africa. Sample survey questionnaires were also sent to Central Asia and West Africa. Regional programs in India, Bangladesh, and Ecuador implemented their baseline surveys with others in process in the Dominican Republic and Uganda. The South Asia and Ecuador surveys have been completed, but the reports that summarize the data sets are not yet prepared.

Short-term training on impact assessment

On-site visits were made in East Africa, LAC, and South Asia to discuss impact assessment methods with additional planning on impact assessment completed by the SE Asia program by regional co-PIs.

A multiple day workshop on impact assessment was planned but was not conducted in East Asia. Short-term training plans for impact assessment were developed for LAC, South Asia, and East Africa.

Specialized In-Depth Impact Assessments of Poverty, Environmental, Nutritional, and Other Impacts

In-depth IPM impact studies in West Africa

Graduate student Theodore Nouhoheflin analyzed survey data collected in Mali and Senegal during summer 2009 to assess adoption of host-free period and other pest management practices.

Task 2 Progress: Theodore Nouhoheflin completed an impact assessment of economic impacts of tomato IPM in Mali and Senegal as part of his MS thesis at Virginia Tech. Estimated benefits for the overall program varied from $3.4 million to $14.8 million for the host-free period, $0.5 million to $3 million for the virus-tolerant seeds, and $4.8 million to $21.6 million for the overall IPM program. In projecting environmental impacts of the tomato IPM in Mali, it was found that adoption of the host-free period reduced the amount of insecticide sprays by 71% and the production cost by $200/ha.

In-depth IPM impact studies in the other regional programs

Contact was made with regional program economists in Southeast Asia and Central Asia regional programs, but specific in-depth analyses they will undertake in those regions are not yet defined. Dan Taylor presented the basic concepts of impact assessment to scientists attending the IPM CRSP East Africa Regional Project research reporting and planning workshop in Uganda. He discussed methods and data, and planned for a regional training workshop on impact assessment there in 2011.

An in-depth impact study was identified and initiated in South Asia with graduate student Leah Harris. She is assessing the cost effectiveness of alternative approaches for disseminating IPM in Bangladesh. She has gathered information on the net returns for each IPM CRSP crop and practice in Bangladesh and is combining that information with the cost of per farmer reached and per adopting farmer for each extension approach. She has incorporated that information in a linear programming model to assess the optimal dissemination approaches for the various crops and IPM practices. She traveled to Bangladesh to gather the data and also to Nepal to gather data for a qualitative assessment of the dissemination approach being used on the IPM CRSP there.

Gender Equity, Knowledge, and Capacity Building

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Summary

Research by the IPM CRSP has dispelled the myth that women do not participate in management of pests and diseases in crops. On the contrary, in many IPM sites women have considerable influence over agriculture production returns, sustainability impacts and household food security outcomes. For these reasons, and more, the IPM CRSP is committed to ensuring that priority pest management problems are decided with consideration of gender issues. The GGT incorporated and built gender expertise within the Regional Programs, implemented workshops to raise awareness about gender issues, and identified gender-based constraints and opportunities for IPM. Qualitative and quantitative research was initiated and laid the groundwork for upcoming targeted research that will make significant contributions to the program.

In accordance with the goals of the Gender Global Theme, IPM CRSP has played a role expanding the resources and opportunities for women to be informed and productive farmers through a commitment to gender equity and women's involvement in the program. IPM technologies can also create income-generating opportunities for women to be involved as laborers or in cottage industries implementing new technologies. In order for women to benefit as intended from such technologies, the knowledge generated regarding IPM packages must be transferred to women and the resources required for such packages must be made accessible to women. The goal of achieving gender equity has been addressed through identifying and incorporating gender experts into regional gender teams lead by a gender regional coordinator, creating a gender directory of team members for effective collaboration, conducting trainings with women leaders, and tracking women's participation in IPM programs.

Capacity building includes supporting graduate students, gender awareness workshops, field work with farmers and the production and distribution of Information, Education, and Communication (IEC) materials. In long-term training programs, we have encouraged RPs to select equal numbers of men and women students, increasing the number of women in male-dominated agricultural sciences worldwide. A gender balance was sought in all short-term training activities as well, including technology transfer workshops with women and men farmers and with research and extension personnel. The GGT PI, in coordination with RPs, organized and facilitated a series of gender and participative methodology workshops in each region, with the exception of Central Asia which took a step towards this by participating in a Train-the-Trainers workshop at Virginia Tech. These workshops helped increase RP gender awareness, empower the local gender coordinator and began a process of growing gender capacity in the teams. The attendance at such workshops was very close in numbers of men and women.

While the focus of this first year was objectives one and two, and specifically building teams and capacity, the research objective was launched with the gender and participative methodology workshops. In many cases, the workshop served to initiate a rapid gender assessment using the Gender Dimensions Framework (GDF). The GDF was used to identify gender-based constraints and

document the disadvantages faced by women, while also pointing to the opportunities for increasing gender equity and benefits to women through IPM. The rapid gender assessments lead to the identification of strategies and interventions to ensure that both women and men benefit from the RP activities.

Increase of gender equity and broadening of impacts

Gender experts have been identified in all regions and are working as a part of the overall IPM team.

A Regional Coordinator was appointed in five regions; the West Africa RP is still in the process of selecting a person for this role.

By creating gender teams, we have increased the number of women participating in regional programs as well as increasing the number of social scientists (see table below for full gender teams per region, including country point people, resources and regional coordinators).

The IPM CRSP has significantly increased its gender expertise. Several members of the gender team specialize in gender and have long experience working with agriculture and technology projects. For example, Dr. Alifah Sri Lestari has 19 years of experience in program development, specifically in the areas of participatory monitoring and evaluation for communities and participatory-based training in Indonesia and across Asian countries. Dr. Lestari has worked as the Participatory Monitoring and Evaluation Specialist and Gender Coordinator for the United States Agency for International Development Environmental Services Project (USAID ESP).

Dr. K. Uma is an Associate Professor in the Department of Agricultural and Rural Management at Tamil Nadu Agricultural University (TNAU) in Coimbatore, India. She specializes in gender issues in management and development management, and was named the "Best Researcher for Gender Development" by TNAU in 2004. Dr. Uma has conducted research in areas such as gender and the

Regional Program	Coordinator	Title in HC Institution
Latin America and the Caribbean	Ing. Elena Cruz	Technician, Instituto Nacional Autónomo de Investigaciones Agropecuarias (INIAP); (MSc in Environmental Socioeconomics)
West Africa	To be determined	
East Africa	Dr. Margaret Mangheni	Professor (Agricultural Extension), Makerere University; Associate Dean, College of Agriculture
Central Asia	Dr. Linda Racioppi	Professor (Government and Politics), James Madison College, Michigan State University
Central Asia	Dr. Zahra N. Jamal	Assistant Professor (Anthropology & Middle Eastern Studies) & Program Director, Central Asia and International Development, James Madison College, Michigan State University
South Asia	Dr. K. Uma	Associate Professor (Agriculture & Rural Management), Tamil Nadu Agricultural University
South East Asia	Alifah Sri Lestari	Consultant/Member of Executive Board of Directors, FIELD Indonesia Foundation (Public Administration & Agriculture: Pest and Disease Control, Entomology)

provision of public goods; gender and bio-technology; impacts of agricultural training for women on technology adoption and household livelihood security; rice productivity; and energy use.

As a professor, Dr. Herein Puspitawati has developed many curricular materials for teaching courses on gender theories, gender in the family, and gender equality in education. She has served as a member of the National Experts Team of Gender Mainstreaming in the Department of National Education for the Republic of Indonesia- Jakarta. She has also worked as a Gender and Family Welfare Specialist in The Pro-Poor Planning and Budgeting Project cooperation between Bappenas (National Development Planning Agency) and the Asia Development Bank (ADB). She was also Program Manager of Family Empowerment & Vice Head of the Center for Women Studies, Research Center, Bogor Agricultural University.

Dr. Margaret Mangheni has worked as a team leader of gender mainstreaming for Makerere University's faculty of agriculture as well as the Client Oriented Agricultural Research and Development (COARD) Project of Uganda's National Agricultural Research Organization. She has produced several publications on gender and agriculture, and gender mainstreaming, and she is currently serving as the Principal Investigator of a research project entitled "Understanding the gender dimensions of the impact of climate change on agriculture and adaptation among small scale farmers in Uganda."

Dr. Zahra N. Jamal is a core faculty member of the Center for Gender in Global Context at Michigan State University, and has produced a number of publications and presentations on gender and Islam, and gender and service. Her research and teaching interests include (trans)nationalism and diasporas, citizenship and civic engagement, religion, gender, ethics, and ethnographic methods.

Dr. Linda Racioppi's expertise is in comparative politics (including gender and power) and international relations (including feminist international relations theory). Dr. Racioppi is the co-author with Katherine O'Sullivan of *Women's Activism in Contemporary Russia* (Temple University Press, 1997). She has published articles and book chapters on Soviet arms transfers, women and Russian nationalism, women's organizing in Russia, and gender and ethnic conflict in Northern Ireland.

Elena Cruz has an MSc in Environmental Socioeconomics and has been working with rural development projects in Ecuador for many years. She has carried out gender research for SANREM as well as IPM CRSP.

Dr. Mah Koné Diallo is responsible for gender mainstreaming and training programs with women farmers in OHVN.

A CRSP-wide gender directory including all regional coordinators, country point people, and key contacts has been compiled and is ready for publication on the IPM CRSP website.

Gender workshops held in all of the regions were led by women facilitators. These stressed the need to involve women trainers in future activities. Furthermore, participants were trained to include women-only trainings led by women, and practiced this through the focus group activities carried out in the workshops which included field work. An important impact of the workshops has been to demonstrate the importance of focus groups separated by gender.

Region	Country	Name	Program Title	Title in HC Institution
Latin America and the Caribbean	Ecuador	Ing. Elena Cruz	Regional Gender Coordinator/ Gender Point Person, Ecuador	Technician, Instituto Nacional Autónomo de Investigaciones Agropecuarias (INIAP); (MSc in Environmental Socioeconomics)
Latin America and the Caribbean	Dominican Republic	María de Js. Cuevas Joaquín	Gender Point Person	Enc. de Proyectos, Instituto Dominicano de Investigaciones Agropecuarias y Forestales (IDIAF)
Latin America and the Caribbean	Honduras	Yordana Valenzuela	Gender Point Person	Coordinadora Programa de Agricultura sostenible en Laderas (PASOLAC), responsable género y monitoreo y evaluación PROMIPAC. Escuela Agrícola Panamericana, Zamorano
West Africa	Mali	Ms. Aminata Doucouré	Gender Point Person	
West Africa	Mali	Mah Koné Diallo	Key Contact	Responsible for Gender Programming, Office de la Haute Vallee du Niger (OHVN)
East Africa		Dr. Margaret Mangheni	Regional Gender Coordinator	Professor (Agricultural Extension), Makerere University; Associate Dean, College of Agriculture
Central Asia		Dr. Linda Racioppi	Co-Gender Coordinator	Professor (Government and Politics), James Madison College, Michigan State University
Central Asia		Dr. Zahra N. Jamal	Co-Gender Coordinator	Assistant Professor (Anthropology & Middle Eastern Studies) & Program Director, Central Asia and International Development, James Madison College, Michigan State University
South Asia		Dr. K. Uma	Regional Gender Coordinator/ Gender Point Person, India	Associate Professor (Agriculture & Rural Management), Tamil Nadu Agricultural University
South Asia	India	Dr. S. Thiyageshwari	Key Contact	Associate Professor (Soil Science and Agricultural Chemistry), Tamil Nadu Agricultural University
South Asia	India	Dr. M. Anjugam	Key Contact	Associate Professor (Agricultural Economics), Tamil Nadu Agricultural University
South Asia	Nepal	Ms. Ambika Kumari Rai	Gender Point Person	Gender consultant, International Development Enterprises (IDE) Nepal
South Asia	Bangladesh	Mr. M. Sadique Rahman	Gender Point Person	Bangladesh Agricultural Research Institute (BARI)
South Asia	Bangladesh	Dr. Shahnaz Huq-Hussain	Key Contact and student advisor	Professor (Geography) & Chairman, University Chairperson, Dept. of Geography and Environment Dean, Faculty of Earth and Environmental Sciences University of Dhaka
South East Asia	Indonesia	Alifah Sri Lestari	Regional Gender Coordinator/ Gender Point Person, Indonesia	Consultant/Member of Executive Board of Directors, FIELD Indonesia Foundation (Public Administration & Agriculture: Pest and Disease Control, Entomology)
South East Asia	Indonesia	Dr. Herien Puspitawati	Key Contact	Gender and Family Sociologist, Bogor Agricultural University
South East Asia	Cambodia	Ms. Mam Sitha	Gender Point Person	Technical Support Officer, Ministry of Agriculture Forestry and Fisheries
South East Asia	Philippines	Dr. Maria Helen F. Dayo	Gender Point Person	Director, Gender Center, University of the Philippines Los Baños (UPLB) (Anthropologist)

The work plan for year 2 was developed in coordination with each regional program. As found in East Africa, integration of gender and impact assessment into IPM research projects is most feasible when they are on farm interfacing with male and female farmers. Therefore, the work plans of projects in all countries were reviewed so as to determine the time when gender and impact assessment integration would be done in the future, once projects are on farm.

A discussion of participation indicators was included in the gender workshop trainings. The PI is waiting for regional program gender reports which include an indicator chart. We will be developing further qualitative indicators during FY 2; this will be part of the monitoring process.

Capacity Building: Empowering teams to integrate gender

A Gender and Participatory Methodology workshop has been conducted for each regional program. The GGT PI led all of these, except for the South Asia workshop which was led by the Regional Coordinator from India. (The West Africa workshop was carried out at the conclusion of the previous phase and served as a model for future workshops. For this reason, we did not carry out a new workshop in West Africa. Due to conditions in the region, the Central Asia program sent their two co-coordinators to Virginia Tech for a "Train the Trainers" workshop. They will use this training to implement a workshop in Tajikistan in the future.) In three of the regions (LAC, S. Asia, W. Africa), the workshops included collection of field data in a 3 - 4 day workshop. Workshops in the other regions were one day only. These longer workshops have gathered initial qualitative data on gender relations and have served to teach the regional coordinators how to run these workshops in other areas. In the case of LAC, the representative from the Dominican Republic will reproduce the workshop on a smaller scale in that country in FY 2. This was made possible in part because in all workshops, a full copy of workshop materials were left on CDs.

Workshops

The numbers below do not reflect the number of farmers involved in Focus Group activities that were carried out as part of the workshop but rather the participants who attended the full workshop. The disproportionate number of women to men (90 to 63) reflects a bias in partner institutions which tends to associate gender with women and send women to "gender events" - as well as the greater interest exhibited by some women in such aspects.

Networking with US and HC institutions was encouraged during workshops and kick-off meetings. Gender specialists from IPM CRSP or neighbor institutions participated in the gender workshops. Due to limited funding, RPs expressed resistance to working outside of their institutions and devoting 20% of the limited gender funds in the future to this. In cases where gender expertise has been identified within the partner institutions, this seems acceptable. However, in the case of RPs needing to look outside for gender expertise, as may be the case in Central Asia and West Africa, this is still encouraged.

Online teaching modules have been created for the use of IPM team members regarding gendered space, gendered knowledge, and postcolonial feminist theory, and are available on the Virginia Tech scholar website. They are not on the IPM CRSP website for copyright reasons, but can be made accessible to any of our partners upon request.

Research: Producing and disseminating knowledge of gender issues

Students have been identified for gender research in the United States and Bangladesh.

Gender questions for impact assessment surveys were developed in conjunction with the impact assessment global theme, and included in South Asia, Latin America and the Caribbean's surveys. In East Africa, questions

Date	Regional Program	Host Country/ Sponsor	Participating Countries	Title	Facilitators	Participants	
						Male	Female
June 15-18, 2009*	West Africa	Mali/ OHVN	Mali, Senegal, Burkina Faso, U.S.	Atelier régional sur le genre et méthodologies participatives dans la recherche agricole	Maria Elisa Christie; Marie Cécile Sidibé; Mah Koné Diallo	16	17
April 7-10, 2010	Latin America & the Caribbean	Ecuador/ INIAP	Ecuador, Dominican Republic, Honduras, U.S.	Género y metodologías participativas en investigacón agrícola	Maria Elisa Christie; Elena Cruz	13	12
14-May-10	Central Asia	Virginia/ OIRED VT	U.S.	Train the Trainers: Workshop on Gender and Participatory Methodologies in Agricultural Research for the IPM CRSP Central Asia Regional Program	Maria Elisa Christie	5	3
19-Jun-10 (Full day with gender team and PI)	East Africa	Uganda/ Makerere University	Kenya, Uganda, U.S.	Gender and Participatory Methodologies in Agricultural Research and IPM Global Theme	Maria Elisa Christie; Margaret Mangheni	1	5
22-Jun-10 (half-day with EA team at annual meeting)	East Africa	Uganda/ Makerere University	Uganda, Kenya, Tanzania, U.S.	Gender and Participatory Methodologies in Agricultural Research and IPM Global Theme; ME & USAID Gender Requirements	Maria Elisa Christie	6	8
22-Jul-10	South East Asia	Indonesia/Bogor Agricultural University	Cambodia, Indonesia, U.S.	IPM CRSP Southeast Asia Regional Program Gender and Participatory Methodologies Workshop	Maria Elisa Christie; Alifah Lestari	2	13
15-18 - Sept-2010	South Asia	India/ Tamil Nadu Agricultural University	India	Gender Equity, Capacity building and Research in IPM		20	32
					Total:	63	90

were developed together with co-PI Dan Taylor and gender regional coordinator Margaret Mangheni. The Dominican Republic's survey is currently being carried out now. In Ecuador, the GGT worked with the PI to include significantly greater numbers of women in their baseline survey so that both men and women would be interviewed in households.

Rapid gender assessments (RGAs) have been conducted in the following regions during the gender workshop: Southeast Asia, South Asia, East Africa, Latin America and the Caribbean. As a follow-up to the workshops, researchers carried out rapid gender assessments in Ecuador, India, Indonesia and Uganda. These set the groundwork for identifying case studies for future research.

Where full RGAs have not been carried out in all regions, some gender-based constraints and opportunities were identified. The reporting format for case studies based on the RGA includes a place for these under each of the four dimensions listed above in the Gender Dimensions Framework. Thus far, for example, the India workshop clearly identified an opportunity for transmitting information to women in India using the radio and television media, because women noted that radios were the most commonly available and most common source of information for them. This is important because women are not getting their information primarily from traditional farmer field schools, but rather alternative technologies. Additionally, in West Africa, adult literacy classes were identified as a key location for potential education on IPM, and were one of only two sites in the community which women reported that they controlled. Having women present IPM information in these settings would serve to empower women trainers, reach more women farmers, and potentially increase their knowledge and odds ratio to adopt IPM technology. This is important because worldwide, as also noted in Ecuador and in Indonesia, women are less comfortable with technology changes simply because they are not trained.

In Indonesia, the purpose of the activity for year 1 was to examine the gender roles in kitchen space and home yards which include access, control, and participation over the resources. The team conducted 2 separate Focus Group Discussions with women and men groups to identify the gender issues related to IPM in kitchen and garden spaces. The objective of having 2 separate discussions was because the team wants to compare the different perspective among men and women on the issues above. The activities were conducted at Sindangjaya Village, Cipanas Sub-District, Bogor District, in West Java Province-Indonesia in September and October 2010. The participants of the study were 10 females and 11 males of farmers. It was found that the activities in the kitchen space were mostly dominated by women whether in access, control or participation. While activities in home yards related to cultivating vegetables, taking care of animals and trees are dominated by men. The interesting result was that female's group responded in questions more details and neat in drawing pictures of kitchen space and home yards than male's group. The main problems of the women's group compared to men's were the lack of education, the lower skill of cultivating vegetables, and the lack of information on marketing and trainings. Finally, the issue of safety from insecticides is a problem for households where the insecticides are stored in the kitchen space, usually under the table and close to foods and children.

During the workshop in Tamil Nadu, India, a Rapid Gender Assessment was conducted to identify a strategy to better include women in sustainable technology adoption. Still many farmers are not adopting IPM technology because the technology is not available to them or not reaching all the farmers. Farmers are cultivating vegetables throughout the year, but at a small scale in order to supply vegetables throughout the year, to get better prices and to avoid losses. Still farmers are facing constraints in acquiring knowledge. For women, time availability and mobility is the problem. Hence the strategy would be hands-on training at the village level for women, research demonstration with women, resource based IPM technology (what is available at farm), agri-based SHGs, conducting training on different IPM components, field diagnostic guide prepared and distributed, and gender awareness on pesticide residue and on safe use of agro chemicals that will be implemented in the second year. The resources and actors in the agricultural production were listed, and they will be involved in the survey for the second year. There is also possibility of using the existing form of institutions like IAMWARM and Precision farming, which are involved at field level training and monitoring for better technology adoption.

Strides were also made in Nepal where a one-day training was held with 93 participants, 66.6% women and 33.3% male. A gender survey was also conducted with 74% of respondents being female and 26% male. The GDF was used to assess gender perspectives on practices and participation, access to assets, beliefs and perceptions and laws and policies regarding IPM. In terms of practices, it was found that 89% of women use their IPM training in the field, compared to 60% of men. Furthermore, women were found to be highly involved in nursery management and weeding among the IPM package activities. According to socio-cultural factors, however, women expressed that their domestic work posed problems to women's productivity because they are in charge of these extra labors and do not have as much time to work in the field as men do (ex: men can stay outside overnight where women cannot). This extra labor also hinders women's ability to learn new information from trainings or meetings. It was found under the access dimension that men control decision making, and women do not have a lot of decision making power in the family but do have power over smaller things which they create. For example, 96% of female respondents decide the price at which to sell their vegetables without asking their husband. Under Hindu socialization, men are valued higher than women, and society believes that men and women play different roles in society. Women are thus not perceived to be as important to agricultural development is because of patriarchal discrimination holding that daughters are born for another home and that it is only the son who continues the paternal line and cares for his house and family. Policies and official institutions are doing little to bridge this gap, when only 5.3% of women own land and an estimated 64% of women use and contribute to production on bits of land. Thus, some key findings include that both males and females have equal opportunities to earn money and access information regarding agriculture, particularly vegetable, production, but more focus needs to be placed on the actual benefits gained by males and females from these programs. Furthermore, Terai women need to be exposed to outside influences to break the obstacles caused by their culture and language. Finally, women participate in great numbers in vegetable production and rearing cattle, from which they make a high income in these sectors. However, women have fewer opportunities to give input and gain the output from marketing, so more emphasis needs to be placed on women regarding marketing practices.

In Ecuador, it was found that in general men decide where to store chemicals, how to apply them, what to apply to combat pest problems, what to purchase, and how to mix the chemicals. Thus, women are constrained because they are not as familiar with the toxicity of pesticides, the proper warnings, or the side-effects because they do not have as much direct contact with the decision-making about pesticides. In terms of trainings, fewer women attend trainings (10 women to 24 men during INIAP training on June 23, 2010 and 46.2% of the population responding that men attend community meetings), so they are not aware of proper protection methods taught about working with chemicals. When asked about this disparity, the leader of the community responded, “Someone has to take care of the children”. Thus, women are often left out of trainings because of their reproductive roles such as child care. Furthermore, their reproductive roles can be double when working in the field, as it was observed that when two parents are working in the field, the mother is in charge of working and simultaneously taking care of the children, who accompany the parents and play alongside the field, with 53.8% of participants responding that child care was a woman’s job, and 0% of the population responding that child care is a man’s job. Additionally, there was great variance between the upper and lower watershed regions, and women of the indigenous region are constrained from participation because they speak Quechua and translators were not always readily available.

Women have opportunities, though, in that they may not have the final say in the decision-making process, but they do seem to have a considerable amount of weight in their suggestions to men about where to store pesticides, because the arranging and cleaning of the house is overwhelmingly considered to be a female job (80.8% of respondents answering as such). Women are caretakers of children (80.8%) and the elderly (53.8%), and thus could identify more illnesses because of this role. Only one person in the community was of the opinion that pesticides were good for a person’s health; so it is clear that men and women both identify pesticides are harmful to health. However, since women are the predominant care takers, if they are better informed about the health effects tied to pesticides, they can better track the frequency of illnesses and have a higher awareness about what types of chemical interactions make their family sick. Women also are primarily in charge of cooking, at 80.8% of those surveyed, which allows them to identify different tastes and consistency of the food as it is affected by pesticides. Both of these reproductive roles can allow for dialogue between husband and wife about the best methods to use for pest management.

The Gender Regional Coordinator from East Africa, Dr. Margaret Mangheni, participated in designing and conducting a baseline survey for scotch bonnet in Mubuku irrigation scheme, Uganda. Hot Pepper (Scotch bonnet) production in Mubuku Irrigation scheme is constrained by the root rot and wilt disease. IPM is therefore implementing 3 studies aimed at testing various tactics for managing these diseases, namely, resistant varieties, optimum irrigation frequency and ridge size. A survey was conducted to collect gender disaggregated baseline information on the socio economic characteristics, production, and prevalence of insect pests and diseases affecting pepper, current pest and disease control measures, enterprise characteristics, operational constraints, and the current application level of the code of practices. The baseline survey questionnaire was developed in June 2010 with input from a multidisciplinary team of social scientists including the Gender Regional Coordinator. It was pre-tested in the field in the first week of July 2010. Data was collected in July by five enumerators assisted by the District Agricultural Officer, the Sub-county Extension officer attached to Mubuku Irrigation Scheme, and the Scheme’s records officer. The data was entered and preliminary analysis done using the SPSS computer program. More in-depth analysis of the baseline data will be carried out and papers for publication written in year 2.

The GGT worked in collaboration with impact assessment and other regional programs to incorporate gender into socio-economic surveys. Sex-disaggregated data has been collected through a baseline survey in Uganda, Bangladesh and Ecuador.

A concept note of proposed HC research was not developed yet this year, except for the case of Ecuador with graduate student Megan Byrne. Nonetheless, workshops did point to opportunities and concept notes will be developed in FY 2.

The grafting studies approach has been dropped in favor of individual research based on the rapid gender assessments of each region.

IPMnet News

Principle Investigator

Allan Deutsch, IPMnet NEWS Editor / Coordinator, Integrated Plant Protection Center, Oregon State University (ipmnet@science.oregonstate.edu)

Summary

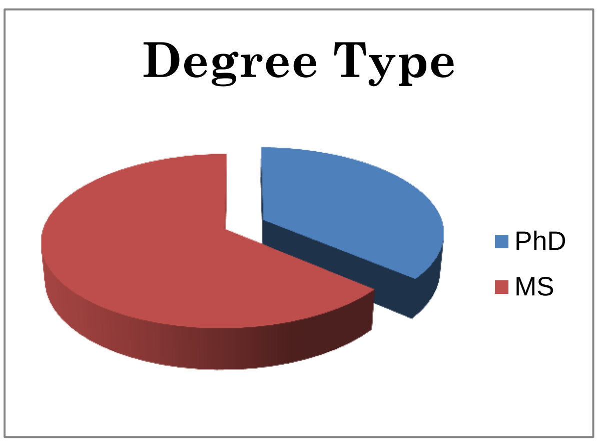
IPMnet NEWS, the free global email newsletter supported in part by the IPM CRSP, marked its 17th year of providing IPM and crop protection information during fiscal 2010, with publication of issue #183. The NEWS is published eight times per year and currently serves 7,338 subscribers in more than 150 countries. In some cases, subscribers pass on NEWS files to their own sub-networks, thereby expanding coverage. The NEWS alerts its subscribers about IPM technologies, developments, relevant papers and publications, services, equipment, and professional opportunities. Each issue is emailed to a wide cross-section of recipients including extensionists, research specialists, growers, governmental policy officials, USAID missions, international and national agricultural research centers, experiment stations, and private sector personnel. It is freely sent to anyone who requests it. Each issue of the NEWS updates a rolling global calendar of relevant events (meetings, symposia, workshops, and short courses). The format is highly condensed with most items including either, or both, an email address or a website so that readers with a specific interest can follow up and obtain more detailed information. IPMnet NEWS is the only known periodic, free, global reach, English language publication currently being published solely focused on IPM and related crop protection material.

Training and Institutional Capacity Development

Long-Term Training

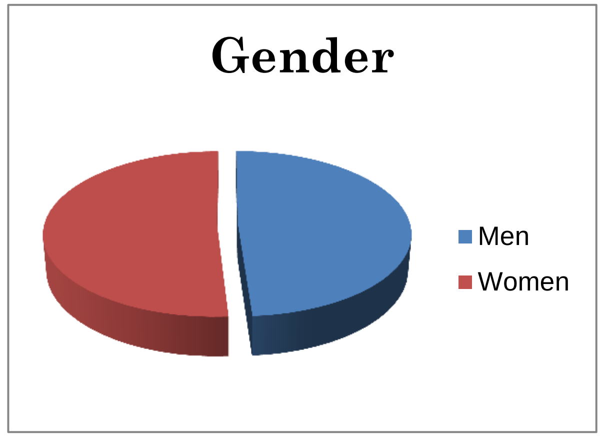
IPM CRSP provides long-term training to build the capacity of the host country scientists who will have major responsibilities for crop protection in their home countries. It is also made available to young U.S. scientists who plan for careers in international crop protection and development work. While addressing a global knowledge base in the U.S. Universities, it addresses specific host country IPM questions, opportunities, and constraints. These programs are designed to meet the needs of host country scientists by integrating with IPM CRSP research carried out by the researchers based at the U.S. universities.

- 6 U.S. Universities and 11 host country universities provided long-term training.
- 47 graduate students (Tables 1 and 2)
- 17 PhD and 30 MS

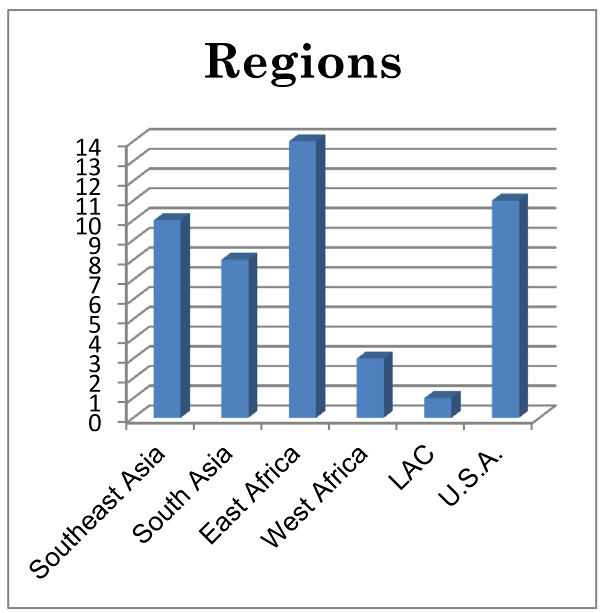


- PhD: 11 men and 6 women
- MS: 12 men and 18 women
- Bachelors: 10 (3 men and 7 women)
- Post Doctoral Research Associate: 1

- Gender ratio of graduate students: men 23, women 24



- Graduate students by region
  - Southeast Asia 10
  - South Asia........................... 8
  - East Africa 14
  - West Africa.......................... 3
  - LAC..................................... 1
  - U.S.A 11



- Graduate student major subject areas:
    - Agricultural Economics 11
    - Entomology........................14
    - Crop Protection....................5
    - Crop Science 6
    - Geography............................3
    - Plant Pathology 6
    - Others 2

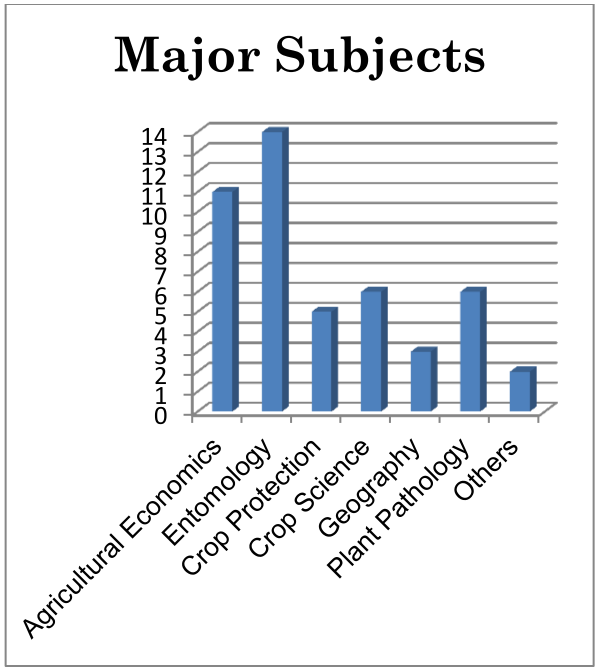


Table 1: Long-Term Training Participants by Country, FY 2010

Program	Doctorate		Masters		Bachelors		Post Docs	Total
	Men	Women	Men	Women	Men	Women		
Bangladesh	1			2				3
Benin			1					1
Honduras					1			1
India	1	1	2					4
Indonesia	1	2	2	5		2		12
Kenya		1		2	1			4
Nepal	1							1
Nigeria							1(M)	1
Peru	1							1
Senegal	2							2
Tanzania	3							3
Uganda			5	3		5		13
U.S.A.	1	2	2	6	1			12
Total	11	6	12	18	3	7	1	58

Table 2: Long-Term Training and Institutional Capacity Development, FY 2010

Student Name	Sex (M/F)	Nationality	Discipline	University	PhD/MS	Start Date	End Date	IPM Program	Guide/Advisor
Umme Habiba	F	Bangladesh	Geography	University of Dhaka	MS	Aug. 2010	May 2012	Gender/ South Asia	Shahnaz Huq – Hussein
M.A.T. Masud	M	Bangladesh	Plant Pathology	Bangabandhu Sheikh Mujibur Rahman Agricultural University	PhD		Sept. 2010	South Asia	David Francis & Sally Miller
Tahera Sultana	F	Bangladesh	Geography	University of Dhaka	MS	Aug. 2010	May 2012	Gender/South Asia	Shahnaz Huq - Hussein
Theodore Nouhoheflin	M	Benin	Agricultural Economics	Virginia Tech	MS	Aug. 2008	Aug. 2010	Impact Assessment	George Norton
Randolfo Mejia	M	Honduras	Plant Pathology	Universidad Nacional de Agricultura (Olancho)	BS	July 2010	Sept. 2010	LAC	Jose C. Melgar
N. Kirithika	F	India	Agricultural Economics	TNAU	PhD	June 2009	April 2012	Impact Assessment	K. Chandran & K.N. Selvaraj
Sudarsan Poojari	M	India	Virology	Washington State Univ.	PhD	Jan. 2009	June 2013	IPVDN (Virus Global Theme)	N. Rayapati
J. Rajesh	M	India	Entomology	TNAU	MS	June 2009	April 2010	South Asia	C. Durairaj
G. Selva Muthu Kumar	M	India	Entomology	TNAU	MS	June 2009	April 2010	South Asia	G. Gajendran
Eva Baideng	F	Indonesia	Entomology	Sam Ratulangi University	PhD	Jan. 2010	Oct. 2012	Southeast Asia	D.T. Sembel
Lydia Ivakdalam	F	Indonesia	IPM	Bogor Agricultural University	MS	2008	2010	Southeast Asia	Aunu Rauf
Yani Maharani	F	Indonesia	Entomology	Bogor Agricultural University	MS	2009	2011	Southeast Asia	Aunu Rauf
Titov Manoi	M	Indonesia	Entomology	Sam Ratulangi University	MS	Feb. 2009	Aug. 2010	Southeast Asia	Dan Sembel
Johanna Mariana	F	Indonesia	Entomology	Sam Ratulangi University	MS	Feb. 2009	Aug. 2010	Southeast Asia	J. Pongoh and D.T. Sembel
Agustriana N. Modjanggo.	F	Indonesia	Agricultural Economics	Sam Ratulangi University	BS	April 2009	Aug. 2010	Southeast Asia	J. Tatuh
Betsy Pinaria	F	Indonesia	Entomology	Sam Ratulangi University	PhD	Jan.2008	Aug. 2011	Southeast Asia	Saartje Rondonuwu - Lumanau
Nur Pramayudi	F	Indonesia	Entomology	Bogor Agricultural University	MS	2008	2010	Southeast Asia	Aunu Rauf
Yohanes Umbu Rebu	M	Indonesia	Entomology	Bogor Agricultural University	MS	2009	2011	Southeast Asia	Aunu Rauf
Samsudin	M	Indonesia	Entomology	Bogor Agricultural University	PhD	2008	2011	Southeast Asia	Teguh Santoso
Oral Sembeka	F	Indonesia	Agricultural Economics	Sam Ratulangi University	BS	2009	2010	Southeast Asia	J. Tatuh
Deiby Tumilaar	F	Indonesia	Agronomy	Sam Ratulangi University	MS	2008	2010	Southeast Asia	Jantje Pongoh
Joe Ng'ang'a Kahinga	M	Kenya	Horticulture	Jomo Kenyatta University of Agriculture and Technology	BS	June 2010	June 2013	East Africa	Wesonga and M. Waiganjo

Sylvia Nyambura Kuria	F	Kenya	Plant Pathology	Makerere University	MS	Sept. 2010	Sept. 2012	East Africa	G. Tusiime and M. Waiganjo
Pauline Mbinya Mueke	F	Kenya	Entomology	Kenyatta University	MS	June 2010	June 2011	East Africa	J.P. Mbugi and M. Waiganjo
Miriam Otipa	F	Kenya	Plant Pathology	Jomo Kenyaatta University of Agriculture and Technology	PhD	Sept. 2008	Sept. 2011	East Africa	Elija Ateka, Edward Mamati, Douglas Miano
Naworaj Acharya	M	Nepal	Entomology	Penn State University	PhD	2010	2014	South Asia	Ed Rajotte
Olufemi J. Alabi	M	Nigeria	Virology	Washington State Univ.	Post Doc.	---	---	IPVDN (Virus Global Theme)	N. Rayapati
Tomas Melgarejo	M	Peru	Virology	University of California – Davis	PhD	Sept. 2009	Aug. 2013	IPVDN (Virus Global Theme)	R. Gilbertson
Djbril Badiane	M	Senegal	Entomology	University of Bamako	PhD	2010	2013	West Africa	Doug Pfeiffer
Kemo Badji	M	Senegal	Entomology	University of Dakar	PhD	2010	2013	West Africa	C.C. Brewster
M. Kilambo	M	Tanzania	Crop Science	Sokoine University of Agriculture	PhD	Nov. 2010	July 2014	East Africa	Maerere and Teri
Godsteven Maro	M	Tanzania	Crop Science	Sokoine University of Agriculture	PhD	Nov. 2010	Sept. 2014	East Africa	A.P. Maerere
Hosea Dustan Mtui	M	Tanzania	Horticulture	Sokoine University of Agriculture	PhD	Oct. 2008	Sept. 2012	East Africa	A.P. Maerere and M. Bennett
Didas Asimwe	M	Uganda	Plant Science	Makerere University	MS	August 2009	Aug. 2011	East Africa	Patrick Rubaihayo & Geoffrey Tusiime
Rosemary Isoto	F	Uganda	Agricultural Economics	Ohio State University	MS	Aug. 2010	Aug. 2011	Impact Assessment	David Krayabill
David Kirunda	M	Uganda	Crop Protection	Makerere University	MS	Aug. 2009	Aug. 2011	East Africa	M.Ochwo-Ssemakula & P. Sseruwagi
Jennifer Lhughabwe	F	Uganda	Crop Protection	Makerere University	BS	Aug. 2010	Aug. 2011	East Africa	G. Tusiime
D. Munyazikwiye	M	Uganda	Crop Protection	Makerere University	MS	Aug. 2010	Aug. 2012	East Africa	Geoffrey Tusiime
Zachary Muwnaga	M	Uganda	Crop Protection	Makerere University	MS	Aug. 2009	Aug. 2011	East Africa	Michael Otim & S. Kymanywa
Judith Namara	F	Uganda	Crop Science	Makerere University	BS	July 2010	Aug. 2011	East Africa	Jeninah Karungi
Rosemary Namusisi	F	Uganda	Agricultural Economics	Makerere University	BS	Aug. 2010	Aug.2011	East Africa	J. Bonabana
P. Nansamba	F	Uganda	Crop Science	Makerere University	BS	Aug. 2010	Aug. 2011	East Africa	G. Tusiime
Robinah Natukunda	F	Uganda	Crop Science	Makerere University	MS	Aug. 2010	Aug. 2013	East Africa	Mildred Ochwo-Ssemakula
Malson Natuhwera	F	Uganda	Agricultural Economics	Makerere University	BS	Aug. 2010	Dec. 2010	East Africa	J. Bonabana
Charles Ssemwogerere	M	Uganda	Crop Protection	Makerere University	MS	Aug. 2010	Aug. 2012	East Africa	S. Kyamanywa
Amy Buckmaster	F	USA	Agricultural Economics	Virginia Tech	MS	Aug. 2010	Aug. 2012	LAC	Jeffrey Alwang
Megan Byrne	F	USA	Public and International Affairs	Virginia Tech	MS	Aug. 2009	May 2011	Gender/ LAC	Maria Elisa Christie

Hillary Kessler Cheeseman	F	USA	Plant Pathology	Penn State University	PhD	Aug. 2010	Dec. 2015	LAC	Paul Backman & Beth Gugino
Cody Dunn	M	USA	Mechanical Engineering	Virginia Tech	BS	Aug. 2007	May 2012	LAC/Gender	Jeff Alwang
Leah Harris	F	USA	Agricultural Economics	Virginia Tech	MS	Aug. 1009	July 2011	Impact Assessment	George Norton
Kellyn Montgomery	F	USA	Geography	Virginia Tech	MS	Aug. 2007	Dec. 2010	Gender/ East Africa	Maria Elisa Christie
Emily E. Pfeufer	F	USA	Plant Pathology	Penn State University	PhD	Aug. 2010	Dec. 2015	LAC	Beth K. Gugino
Devon Prater	F	USA	Urban Affairs and Planning	Virginia Tech	MS	Aug. 2009	May 2011	Gender/Southeast Asia	Maria Elisa Christie
William Secor	M	USA	Agricultural Economics	Virginia Tech	MS	June 2010	Aug. 2011	Gender/LAC	Jeffrey Alwang
Andrew Sowell	M	USA	Agricultural Economics	Purdue University	MS	Aug. 2009	Aug. 2011	LAC	Shively/Alwang/ Weller
Adam Sparger	M	USA	Agricultural Economics	Virginia Tech	PhD	Aug. 2009	Aug. 2012	LAC	Jeffrey Alwang
Anna Testen	F	USA	Plant Pathology	Penn State University	MS	Aug. 2010	Dec. 2012	LAC	Paul Backman & Beth Gugino

Short-Term Training

During the FY 2010, IPM CRSP conducted over 154 short-term training events serving more than 45,566 persons. In addition through mass media it communicated to over 80,000 persons. IPM CRSP activities were held in 20 different developing countries with host country collaborators active participation. Thirty six workshops, 53 training sessions, 44 meetings, 9 surveys, 25 field days, and 7 seminars were held to impart various technologies to stakeholders. Sex disaggregated data was collected in most of the training events.

IPM CRSP Non-Degree Training (Activity Summary), FY 2010

Individual Participation to Each Type of Event	Workshop	Training	Meeting	Survey	Field Day/ Demonstration	Seminar/ conference	Total
Regional Programs							
Latin America and the Caribbean	17	2	21		1	1	42
East Africa	3	1	6	3	4		17
West Africa		2	2	6			10
South Asia	2	12	4		10	3	31
Southeast Asia	4	32			7	2	45
Central Asia		3			1		4
Global Programs							
Parthenium		1					1
IPDN			3		2	1	6
IPVDN	3		1				4
Impact Assessment			7				7
Gender	7						7
Total	**36**	**53**	**44**	**9**	**25**	**7**	**174**

IPM CRSP Non-Degree Training (Participants Summary), FY 2010

Individual Participation to Each Type of Event	Workshop	Training	Meeting	Survey	Field Day/ Demonstration	Seminar/ conference	Total
Regional Programs							
Latin America and the Caribbean	534	2	962		115	30	1,643
East Africa	104	41	84	252	276	99	856
West Africa		4	230	639			873
South Asia	83	33,657	661		3,146	423	37,970
Southeast Asia	115	2,073			921	49	3,158

Central Asia		17			43		60
Global Programs							
Parthenium		38					38
IPDN			212		60	300	572
IPVDN	123		100				223
Impact Assessment			20				20
Gender	153						153
Total	1,112	35,832	2,269	891	4,561	901	45,566

Latin America and the Caribbean – Regional Project

Honduras

Program Type	**Date**	**Training Type**	**Number of participants**	**Men**	**Women**	**Audience**
Workshop	Oct. 22023, 2009	Field sampling and recognition of pests/disorders	8	8	0	Extension staff and farmers
Workshop	Nov. 12-13, 2009	IPM for warm climate vegetables (twice)	35	33	2	Extension staff and farmers
Workshop	June 10-11, 2010	Safe/efficacious use of agricultural pesticides	9	8	1	Extension staff and farmers
Workshop	Aug. 2-3, 2010	Zebra chip-potato psyllid complex	78	73	5	Extension staff and farmers
Short talk	Oct. 1, 2009	Posharvest diseases	27	20	7	Extension staff and farmers
Short talk	Oct. 6,7,8, 2009	Plantain and cassava diseases (thrice)	84	79	5	Extension staff and farmers
Short talk	Oct. 26, 27, 28,2009	Vegetable crops (thrice)	105	95	10	Extension staff and farmers
Short talk	Nov. 14, 24, 24, 2009	Vegetable crops (thrice)	55	44	11	Extension staff and farmers
Short talk	Nov. 26, 2009	Tomatoes	53	52	1	Extension staff and farmers
Short talk	Jan. 13, 2010	IPM locally important vegetable crops	53	47	6	Extension staff and farmers
Short talk	Jan. 26-27, 2010	Cool climate vegetables (twice)	70	61	9	Extension staff and farmers
Short talk	Feb. 10, 2010	Diseases ofVegetable crops (twice)	45	44	1	Extension staff and farmers
Short talk	Feb. 17, 2010	Vegetable crops	36	34	2	Extension staff and farmers
Short talk	March 3 and 4, 2010	Vegetable crops (twice)	52	46	6	Extension staff and farmers
Short talk	March 9,2010	Vegetable crops	47	40	7	Extension staff and farmers
Short talk	March 16,17,18, 2010	Vegetable crops (thrice)	118	106	12	Extension staff and farmers
Short talk	April 12, 2010	IPM plant diseases	34	30	4	Extension staff and farmers

Short talk	April 15, 16, 2010	Onion pests	18	16	2	Extension staff and farmers
Short talk	April 20, 2010	Vegetable crops	30	28	2	Extension staff and farmers
Short talk	April 20-21, 2010	Avocado diseases	15	15	0	Extension staff and farmers
Short talk	April 22-23, 2010	Pests of solanaceous crops	34	32	2	Extension staff and farmers
Short talk	April 27, 2010	Vegetable diseases	12	11	1	Extension staff and farmers
Short talk	May 11, 2010	Avocado diseases	54	49	5	Extension staff and farmers
Short talk	Aug. 16, 2010	Ornamental diseases	18	7	11	Extension staff and farmers
Field day	March 10, 2010	General field pest management practices	115	109	6	Extension staff and farmers
Seminar	April 28, 2010	Potato Zebra chip-Psyllid complex IPM	30	27	3	Extension staff and farmers
Total participants in Honduras			**1235**	**1114**	**121**	

Ecuador

Program Type	**Date**	**Training Type**	**Number of participants**	**Men**	**Women**	**Audience**
Workshop	Aug.27, 2010	IPM CRSP – Ecuador, 1998-2014	25	16	9	Partners USAID
Annual Meeting	May17, 2010	IPM – CRSP LAC meeting at Honduras	2	1	1	Professionals INIAP
Workshop	April 7, 2010	Genero y methodologias participativas en la investigacion agaricola	25	13	12	
Workshop	April 23, 2010	Manejo Integrado de Plagas en frutales Andinos	30	19	11	Farmers
Workshop	Oct. 22, 2009	Manejo integrado del barrenador del fruto de naranjilla *Neoleucinodes eleganteles*	27	17	10	Farmers
Workshop	Oct. 21, 2009	Manejo Integrado de Plagas en frutales Andinos	32	24	8	Farmers
Training		Cody Dunn, Trining at INIAP	1	1	0	student
Training		Clara Osborne, Training at INIAP	1	0	1	student
Workshop	Aug. 12, 2010	Naranjilla pest and disease management	7	6	1	Technician
Workshop	May 14, 2010	Identification and control of *Fusarium oxysporum* in naranjilla	20	15	5	Technicians
Workshop	May 23, 2010	Naranjilla pest and disease management, locality of Pampas de Aguillas, Cotopaxi.	28	25	3	Farmers
Workshop	March 7-10, 2010	Training for IPM CRSP personnel on gender and participatory methodologies, Guaranda, Bolívar Province.	25	13	12	Professionals and partners
Workshop	April 8, 2010	Gender sensitization Illangama sub-watershed, Bolívar.	44	19	25	Professionals and partners
Workshop	April 9, 2010	Gender sensitization Alumbre sub-watershed, Bolívar.	38	18	20	Professionals and partners
Workshop	Oct. 22, 2009	Late blight and fruit worm management in naranjilla cultivation in 10 de Agosto, Pastaza Province.	80	60	20	Technicians and Farmers

Workshop	Oct, 21, 2009	Training on strategies for disease management in naranjilla, las Pampas Argentinas, Santo Domingo de los Tsachilas.	23	17	6	Farmers
Total participants in Ecuador			**408**	**264**	**144**	
Total Participants for Latin America and the Caribbean			**1643**	**1378**	**265**	

East Africa – Regional Project

Program Type	Date	Training Type	Number of participants	Men	Women	Audience
Field visit	May 2010	Review Demonstaration plot Mbale, Uganda	17	7	10	Scientists
Field visit	May 2010	Review Demonstaration plot Mbale, Uganda	14	4	10	Scientists
Workshop	April 12-13, 2010	Grafting and hijo tunnel tomato production, Thika and Mwea, Kenya	44	26	18	Farmers
Workshop	July 2, 2010	Grafting and hijo tunnel tomato demonstration, Mwea, Kenya	56	41	15	Farmers
Meeting		Evaluation of passion fruit lines, Juja, Kenya	15	7	8	Farmers
Farmers training		Tomato IPM, Mlali, Tanzania	40	22	18	Farmers
Interview	Aug. 2010	Survey on onion production, Morogoro, Tanzania	100	54	46	Farmers
Survey	July 2010	Baseline survey for pepper production	112	73	39	Farmers
Meeting	June 2010	Progress of the Impact Assessment, Mbale, Uganda	16	7	9	Scientists
Presentation in ABM 1205 course		Presentation on Impact Assessment to students at Makerere University	59	39	20	Students
Farm tour	May 2010	Alternate methods for controlling potato pests, Uganda	245	151	94	Farmers
Focus group discussion		Focus group discussion on pepper production, Uganda	40	28	12	Farmers
Workshop	June 19, 2010	Gender participatory methodologies	4	0	4	Country coordinators
Meeting	Dec. 1, 2009	USAID Mission, Nairobi	7			Scientists and officials
Meeting	Dec. 2, 2009	Integration of Regional and Global theme projects, Uganda	10			Scientists
Meeting	Dec. 8-12, 2009	Technical Committee meeting, Uganda	20	8	12	Scientists
Assessment	May 16-20, 2010	Research site assessment at Kubuku irrigation scheme, Uganda	40	28	12	Farmers
Meeting	June 21-22, 2010	Technical Committee meeting	16	7	9	Scientists
Training	Aug. 20 to Sep 10, 2010	Waiganjo visit to Ohio State University	1	0	1	Scientist
Total participants for East Africa project			**856**	**502**	**337**	

West Africa – Regional Project

Program Type	Date	Training Type	Number of Participants	Men	Women	Audience
Meeting	May 26-27,2010	Planning meeting	30	22	8	Scientists
Meeting		Discussion on tomato pests in Mali	200			Farmers
Survey		Tomato production practices in Ghana	20			Farmers
Survey		Tomato production practices in Mali	150			Farmers
Training		Tomato cultivation	3			Farmers
Training		Language training	1	1		Scientist
Survey		Survey of potato production farmers in Mali	150			Farmers
Survey		Potato production practices in Mali	100			Farmers
Survey		Pest of cabbage in Mali	150			Farmers
Survey		Cabbage production practices in Mali	69			Farmers
Total participants for West Africa project			**873**			

Southeast Asia – Regional Project

Indonesia						
Program Type	**Date**	**Training Type**	**Number of participants**	**Men**	**Women**	**Audience**
Seminar	April 2010	IPM for vegetable crops, North Sulawesi	18	11	7	Farmers
Workshop	June 7-8, 2010	IPM for vegetable crops, North Sulawesi	22	22	0	Farmers
Seminar	July 13, 2010	IPM in Indonesia	31	18	13	Faculty and students
Field trip	July 14, 2010		45	18	27	Farmers
Workshop	July 22-23, 2010	Plant disease diagnostic network, Bogor, Indonesia	20	11	9	Scientists
Workshop	July 22, 2010	Gender workshop, Bogor	23	4	19	Farmers and house wives
Workshop	July 20-21, 2010	Southeast Asia program planning, Bogor	50	32	18	Scientists, Extension agents and students
Training	June 8, 2010	Trichoderma production, Bogor	27	20	7	Farmers
Total participants in Indonesia			**236**	**136**	**100**	
Philippines						
Training	July 14, 2010	IPM and biological control, Bogor	47	29	18	High school students
Field school	May-Aug. 2010	IPM, agroecosystem analysis, Bogor	25	18	7	Farmers
Farmers field school	2009-2010	Technology transfer, North Sumatera	725	458	267	Farmers
Farmers field school	2009-2010	Technology transfer, West Sumatera	21	12	9	Farmers

Farmers field school	Nov. '09-Jan. '10	Onion IPM at Sinait Ilocos Sur, Philippines	28	27	1	Farmers
Farmers field school	Dec. '09 – Feb. '10	Onion IPM at Ilocos Sur, Philippines	33	18	15	Farmers
Farmers field school	Oct. '09 – Feb. '10	Tomato IPM at Urdaneta City, Philippines	58	53	5	Farmers
Farmers field school	Nov. '09 – Feb. '10	Onion IPM atPangasinan, Philippines	43	41	2	Farmers
Farmers field school	Dec. '09 – Mar. '10	Eggplant IPM at Ilocos Norte, Philippines	31	24	7	Farmers
Farmers field school	Nov. '09 – Mar. '10	Garlic IPM at Ilocos Sur, Philippines	22	18	4	Farmers
Farmers field school	Nov. '09 – Mar. '10	Eggplant IPM at Ilocos Norte	49	27	22	Farmers
Farmers field school	Nov. '09 – Mar. '10	Tomato IPM at Ilocos Norte	20	18	2	Farmers
Farmers field school	Nov. '09 – Mar. '10	Eggplant IPM at Ilocos Norte	29	27	2	Farmers
Farmers field school	Dec. '09 – Apr. '10	Onion IPM at Pangasinan	37	22	15	Farmers
Farmers field school	Dec. '09 – Apr. '10	Onion IPM at Pangasinan	33	26	7	Farmers
Farmers field school	Nov. '09 – Mar '10	Eggplant and String bean IPM at La Union	51	23	28	Farmers
Farmers field school	May – Oct. 2010	Eggplant IPM at Ilocos Notre	27	13	14	Farmers
Farmers field school	May – Oct. 2010	Eggplant,okra, and tomato IPM at Pangasinan	36	28	8	Farmers
Farmers field school	Jun-Oct. 2010	Eggplant IPM at Ilocos Sur	37	33	4	Farmers
Farmers field school	Jun-Oct. 2010	Eggplant IPM at Ilocos Sur	30	26	4	Farmers
Farmers field school	Jun-Oct. 2010	Bitter gourd IPM at Pangasinan	60	49	11	Farmers
Farmer trainings	2009 – 2010	Nine Farmer trainings, Philippines	302	219	83	Farmers
Training	Oct. 2009	Vegetable IPM at Pmpanga	15	12	3	Pampanga school teachers
Training	Nov. 2009	Onion IPM at Nueva Ecija	42	27	15	Farmers
Training	May 2010	Vegetables and onion IPM at Nueva Vicaya	31	17	14	Farmers

Training	June 2010	Vegetable IPM at Pacis, Ilocos Sur	37	33	4	Farmers
Training	June 2010	Vegetable IPM at Parparia, Ilocos Sur	23	18	5	Farmers
Training	June 2010	Vegetable IPM at Urdaneta, Pangasinan	60	49	11	Farmers
Training	May 2010	Vegetable IPM at Bayambang, Pangasinan	33	28	5	Farmers
Training	June 2010	VAM and Trichoderma production	22	3	19	Extension workers
Training	Sept. 2100	Eggplant and vegetable IPM at Tamayo, Pangasinan	39	32	7	Farmers
Farmers field days		Tomato IPM at Catablan, Pangasinan	109	46	63	Farmers
Farmers field days		Tomato IPM at Sucsuquen, Ilocos Norte	73	51	22	Farmers
Farmers field days		Eggplant IPM at Nalvo, Ilocos Norte	46	34	12	Farmers
Farmers field days		Eggplant IPM at Mumulaan, Ilocos Norte	174	74	100	Farmers
Farmers field days		Onion IPM at Caranglaan, Pangasinan	73	42	31	Farmers
Information campaign		Pest and disease managment in onion, Bayambang, Pangasinan	401	312	89	Farmers and extension staff
Total participants in the Philippines			**2922**	**1987**	**935**	
Total participants for Southeast Asia project			**3158**	**2123**	**1035**	

South Asia – Regional Project

India

Program Type	Date	Training Type	Number of participants	Men	Women	Audience
Seminar	Nov. 6, 2009	Onion IPM	154	128	26	Farmers
Agri-Expo	Jan. 21-24, 2010	Trichy	148	95	52	Farmers
Field day	Feb. 2, 2010	Onion IPM , Perambalur	150	120	30	Farmers
Farmers training	Feb. 15-17, 2010	Trichy	98	75	23	Farmers
Seminar	Mar. 23, 2010	Onion IPM Perambalur	175	155	20	Farmers
Seminar	Mar. 7, 2010	Pulse IPM	94	90	4	Farmers
Meeting	Aug. 28, 2010	Farmers meeting, Coimbatore,	102	82	20	Farmers
Field day	Sept. 8, 2010	Onion IPM , Dindigul	90	67	23	Farmers
Meeting	May 11-12, Sept. 15,17, 22, 25, 2010	Papaya mealybug awareness at various locations in Tamil Nadu, India	335	225	110	Extension staff
Farmers meeting	Sept. 16-17, 2010	IPM in vegetable crops, Coimbatore	85	84	1	Farmers
Agri-Expo	Sept. 24-26, 2010	Trichy	139	105	34	Farmers
Farmers meetings- 22		Upeda, Bagadpur, and Taraput	139	101	38	Farmers
Field days		Villages in Karnataka and Andhra Pradesh	291	202	89	Farmers

Total participants in India			2000	1530	470	

Bangladesh

Program Type	Date	Training Type	Number of participants	Men	Women	Audience
Field days		IPM technologies	1,575			Farmers
Training		Training the trainers	41	30	11	Field staff
Training		IPM practices	10,500			Farmers
Training		GKSS training on Tricho compost	1,673			Farmers
Field days		Tricho compost demonstration	250			Farmers
Cuelue use		Use of cuelure of melonfly control	15,000			Farmers
Parasitoid use		Use of parasitoids of control of vegetable insects	6,000			Farmers
Total participants in Bangladesh			**35,039**	**30**	**11**	

Nepal

Program Type	Date	Training Type	Number of participants	Men	Women	Audience
Training	July 23, 2010	IPM for vegetable crops	37	5	32	Farmers
Training	Aug. 30, 2010	IPM for vegetable crops	35	8	27	Farmers
Training		IPM for vegetable crops	93	31	62	Farmers
Workshop		Experience sharing	72	53	19	Scientists and Extension agents
Workshop	July 1, 2010	Gender workshop	11	8	3	Farmers
Field days – 15		IPM for vegetable crops, Lalitpur district	214	53	161	Farmers
Field days - 12		IPM for vegetable crops,Rupandehi district	174	78	96	Farmers
Fields days – 15		IPM for vegetable crops,Kashi district	205	127	78	Farmers
Trainig	April 7-8, 2010	Grafting of tomato and eggplant	90	74	16	Farmers
Total participants in Nepal			**931**	**437**	**494**	
Total participants for South Asia			**37,970**	**1,997**	**975**	

Central Asia – Regional Project

Program Type	Date	Training Type	Number of participants	Men	Women	Audience
Short course	June 13-16, 2010	IPM short course at MSU	3	2	1	Scientists
Training	July 12-16, 2010	Plant virus diseases training in India	1		1	Scientist
Field days	August 2010	Potato Pest Management	43	29	14	Farmers
Training the trainers	Feb. and April, 2010	Mountain Society Devleopment Program	13			Farmers
Total for Central Asia program			**60**	**31**	**16**	

International Plant Diagnostic Network – Global Theme

Program Type	Date	Training Type	Number of participants	Men	Women	Audience
Seminar	Nov. 2009	Pathogens of Potato, Guatemala	300	240	60	Farmers and Extension staff
Meeting	Aug. 17, 2010	Mealybug awareness and management	104	85	19	farmers
Meeting	Sept. 15, 2010	Mealybug awareness , Trichy, India	98	86	12	Extension staff
Meeting	March 16-21, 2010	IPDN planning meeting, Guatemala	10	6	4	Scientists
Field day	May, 2010	Diseases of solanaceous crops, Guatemala	30	25	5	Growers
Field day	June, 2010	Diseases of solanaceous crops, Guatemala	30	25	5	Growers
Total Participants for IPDN			**572**	**467**	**105**	

International Plant Virus Disease Network – Global Theme

Program Type	Date	Training Type	Number of participants	Men	Women	Audience
Workshop	July 12-16, 2010	IPVDN planning meeting, Coimbatore, Inida	25	14	11	Scientists
Workshop	July 22-23, 2010	Plant Disease and Insect Pathogen diagnostics, Bogor, Indonesia	20	11	9	Scientists
Workshop	Aug. 2-4, 2010	Zebra Chip-Potato Psyllid complex	78	73	5	Scientists and Plant Proteciton Specilists
Farmers meeting	Aug. 28, 2010	Integrated management of virus diseases,India	100	80	20	Farmers
Total Participants for IPVDN			**223**	**178**	**45**	

Parthenium – Global Theme

Program Type	Date	Training Type	Number of participants	Men	Women	Audience
Training	Dec. 18 – 23, 2009	Planning meeting	38	33	5	Scientists
Total for Parthenium project			**38**	**33**	**5**	

Impact Assessment – Global Theme

Program Type	Date	Training Type	Number of participants	Men	Women	Audience
Meeting	Feb. 8, 2010	Planning meeting in Bangladesh	3	2	1	Scientists
Meeting	Feb. 2010	Planning meeting in Nepal	2	1	1	Scientists
Meeting	Feb., 2010	Planning meeting in India	4	2	2	Scientists
Meeting	July 2010	Planning meeting in Dominican Republic	2	1	1	Scientists
Meeting	June 2010	Planning meeting in Uganda	3	2	1	Scientists
Meeting	April 2010	Planning meeting in Ecuador	4	2	2	Scientists

Meeting	May 2010	Planning meeting in Honduras	2	1	1	Scientists
Total participants for Impact Assessment Project			**20**	**11**	**9**	

Gender – Global Theme

Program Type	Date	Training Type	Number of participants	Men	Women	Audience
Workshop	June 15-18, 2010	Focus group activity in Mali	33	16	17	Scientists and Farmers
Workshop	April 7-8, 2010	Focus group activity in Ecuador	25	13	12	Scientists and Farmers
Workshop	May 14, 2010	Training the trainers	8	5	3	Scientists
Workshop	June 19, 2010	Participatory methodologies, Uganda	6	1	5	Scientists
Workshop	June 22, 2010	Participatory methodologies, Uganda	14	6	8	Scientists
Workshop	July 22, 2010	Participatory methodologies, Indonesia	15	2	13	Scientists and farmers
Workshop	Sept. 15-18, 2010	Gender workshop	52	20	32	Scientists and farmers
Total for Gender Global Theme Project			**153**	**63**	**90**	

Publications

IPM CRSP publications, Presentations, Posters and Abstracts (Summary)

	Books/Book Chapters	Publications	Presentations	Bulletins/ Posters	Theses	Others	Total
Regional Programs							
Latin America and the Caribbean	4	2	28	12	11	0	57
East Africa	0	5	33	5	0	6	49
West Africa	0	0	0	0	0	0	0
South Asia	1	4	2	69	0	39	115
Southeast Asia	3	13	9	5	3	24	57
Central Asia	0	2	0	8	0	0	10
Global Programs							
Parthenium project	0	4	2	0	0	2	8
IPDN	0	3	9	0	0	2	14
IPVDN	0	4	5	0	0	5	14
Impact Assessment	1	1	0	0	0	0	2
Gender	0	0	1	0	0	7	8
ME	1	3	1	2	0	0	7
TOTAL	**10**	**41**	**90**	**101**	**14**	**85**	**341**

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DVDs, CDs and other electronic media productions:

Zebra chip-potato psyllid complex. A CD was prepared with the lectures presented on August 02-04, 2010 in the regional workshop titled Potato Psyllid/*Ca*. Liberibacter Solanacearum: A New Bacterial-insect Vector Complex Causing Diseases of Potato and Tomato in the Americas held at Siguatepeque (Honduras).

CDs with gender in agriculture resources were distributed at 5 workshops to all participants (1 Spanish, 1 French, 3 English).

CD **-** FFS Modules on Onion Production and Other Vegetables, Philippines.

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Sinaga, M. S. 2010. Diagnosis of fungal plant diseases. Bogor, Indonesia.

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Zebra Chip Disease of Potato in Honduras-PDF. Jose Mauricio Rivera, Jose C. Melgar, and Hernan Espinosa (FHIA, Honduras)**,** and Judith K. Brown (The University of Arizona). Posted at the IPM CRSP website September 2010.

Radio programs

March 2010, an oral presentation entitled, 'Gardening in the Era of Alien Plant Invasions in Kenya' was made to a group of succulent plants specialists and gardeners with the appeal to guard against spreading potential invasive species. The idea is to reach as many people as possible with information on dangers of invasive species so that they can help in educating the rest of the public and in finding local solutions to the IAS problem. Members of the group committed themselves to notify others of occurrence of Parthenium and other invasive species to enhance their management in the country.

The National Agricultural Research Organization (NARO) of Uganda launched a national campaign on TV stations and local news media to inform the public about the effects of Parthenium.

The gender workshop in India was covered by The Hindu and the New Indian Express ("Women still have no access to knowhow, says Agri VC" on 9/19/10), and was also published online.

The Mali Gender workshop was covered by French cable news and broadcast throughout West Africa.

IPM messages for various crops numbering 37 have been flashed through All India Radio, Trichy and Coimbatore for the benefit of farmers of this region.

Theses

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Exhibits

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Adaptation of FTA card aids world food crops (http://www.wsutoday.wsu.edu/Pages/Publications.asp?Action=Detail&PublicationID=21721).

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Media Release

Title	Date	Media
Biofertilizer use in vegetables saves on production cost	18 February 2010	PhilRice online
Ilocos Sur vegetable farmers advocate IPM	15 February 2010	PhilRice online
Save on input costs of veggies with biofungicide	April 14, 2010	SeedQuest online
Save on fertilization Cost of Veggies with Biofertilizer	March issue	Agriculture Magazine
Save on Input Costs with Biofungicide	April issue	Agriculture Magazine
Microorganism to the rescue	March	PhilRice Newsletter
Engineering a profitable farm		PhilRice online
This farmer is making Eco-friendly cash		PhilRice online
Ilocos Sur vegetable farmers found biofertilizer effective		PhilRice online
Ilocos vegetable farmers laud *Trichoderma* sp. as biofungicide		PhilRice online

Appendices

Appendix A – List of Acronyms

AMF........................Arbuscular Mycorrhiza Fungi
ANCAR...................Agence Nationale de Conseil Agricole et Rurale, Sénégal
APEP......................Agricultural Production Enhancement Project
AVRDC ....Asian Vegetable Research and Development Center/World Vegetable Center
ATC-RAS ....Advisory Training Center of the Rural Advisory Services, Kyrgyzstan
BARI.......................Bangladesh Agricultural Research Institute
BPI ....Bureau of Plant Industry
CABI.......................Commonwealth Agricultural Bureau International
CEDEH ....Experimental and Demonstration Center for Horticulture
CGIAR....................Consultative Group on International Agricultural Research
CILSS.....................Comite Inter-Estate pour la Lutte contre la Sécheresse au Sahel
CIMMYT................International Maize and Wheat Improvement Center
CIP ....International Potato Center
CIRAD....................French research center working with developing countries
CMV ....Cucumber Mosaic Virus
CORI ....Coffee Research Institute, Uganda
CRI ....Crops Research Institute
CSIR.......................Council for Scientific and Institutional Research
CSNV ....Chrysanthemum Stem Necrosis Virus
CSB ....Community Seed Bank
CU ....Coordinating Unit
DA...........................Department of Agriculture
DPV ....Direction de la Protection des Vegetau, Sénégal
EA...........................East Africa
EIAR.......................Ethiopian Institute for Agricultural Research
ELISA.....................Enzyme-Linked Immunosorbent Assays
ETQCL ....Environmental Toxicology and Quality Control Laboratory, Mali
FFS.........................Farmers Field Schools
FGD........................Focus Group Discussion
FHIA ....Honduran Foundation for Agricultural Research
FIELD ....Farmers Initiatives for Ecological Literacy and Democracy
FPA.........................Fertilizer and Pesticide Authority
GIS ....Geographical Information System
GPS ....Global Positioning System
IARCs.....................International Agricultural Research Centers
ICARDA.................International Center for Agricultural Research in the Dry Areas
ICIPE ....International Center for Insect Physiology and Ecology
ICRISAT ....International Crops Research Institute for Semi-Arid Tropics
ICTA.......................Institute of Agriculture Science and Technology
IDIAF ....Instituto Dominicano de Investigaciones Agropecuarias y Forestales
IER ....Institut D'Economie Rurale, Mali

IITA .... International Institute of Tropical Agriculture
INSAH .... Institut du Sahel
INTECAP .... Instituto Técnico de Capacitación
IPB.......................... Institut Pertanian Bogor (Bogor Agricultural University)
IPDN...................... International Plant Diagnostic Network
IPM CRSP .... Integrated Pest Management Collaborative Research Support Program
IRRI .... International Rice Research Institute
ISA.......................... Instituto Superior de Agricultura, Ecuador
ISRA .... Senegalese Institute for National Agricultural Research
KARI...................... Kenya Agricultural Research Institute
LAC........................ Latin America and Caribbean
MOA .... Memorandum of Agreement
MOFA.................... Ministry of Food and Agriculture
MU/FA .... Makerere University Faculty of Agriculture
NGOs..................... Non-Governmental Organizations
OHVN.................... L'Office de alla Haute Vallée du Niger, Mali
OMAG.................... Office of the Municipal Agriculturist
OPAG..................... Office of the Provincial Agriculturist
PBNV..................... Peanut Bud Necrosis Virus
PCR........................ Polymerase Chain Reaction
PPP .... Participatory Planning Process
PSE .... Pesticide Safety Education
PTM .... Potato Tuber Moth
RADHORT .... Réseau Africain de Development de l'Horticulture, Sénégal
RC .... Regional Coordinator
RCBD..................... Randomized Complete Block Design
SeNPV .... Spodoptera exigua Nuclear Polyhedrosis Virus
SUA .... Sokoine University of Agriculture, Tanzania
TACRI .... Tanzania Coffee Research Institute
TNAU .... Tamil Nadu Agricultural University
TSWV .... Tomato Spotted Wilt Virus
TYLCV................... Tomato Yellow Leaf Curl Virus
TYLCMV .... Tomato Yellow Leaf Curl Mali Virus
UC-D...................... University of California, Davis
UPLB..................... University of the Philippines at Los Banos
USDA/APHIS........ US Department of Agriculture/ Animal and Plant Health Inspection Service
USDA/ARS .... US Department of Agriculture/ Agricultural Research Service
WSU .... Washington State University

Appendix B - Collaborating Institutions

U. S. Universities and NGOs

Clemson University
Florida A&M University
Fort Valley State University
Kansas State University
Michigan State University
Montana State University
North Carolina A&M University
North Carolina State University
Ohio State University
Oregon State University
Pennsylvania State University
Purdue University
University of California-Davis
University of Florida
University of Georgia
University of Hawaii
US Department of Agriculture/ NIPA
US Department of Agriculture/ ARS/Horticultural Research Laboratory
US Department of Agriculture/ APHIS USDA/ARS Vegetable Crops Laboratory
US Department of Agriculture/ ARS Sustainable Perennial Crops Laboratory
Virginia Polytechnic Institute and State University
Virginia State University
Washington State University

Non-U.S. Universities, Government Organizations and NGOs

Agence Nationale de Conseil Agricole et Rural, Sénégal
Agroexpertos, Guatemala
Bangladesh Agricultural Research Institute,
Center of Research and Ecotoxicology of the Sahel (CERES/Locustox Foundation, Senegal
Centro para el Desarrollo Agropecuario y Forestal, Dominican Republic
Coffee Research Institute, Uganda
Direction de la Protection des Vegetau, Sénégal
Environmental Toxicology and Quality Control laboratory, Mali
FIELD Indonesia
Haramaya University, Ethiopia
Honduran Foundation for Agricultural Research, Honduras
Human Resources Development Center, Tashkent, Uzbekistan
Institute D'Economie Rurale, Mali
Instituto Centroamericano de Desarrollo Agropeuario
Instituto Dominicano de Investigaciones Agropecuario y Forestales, Dominican Republic
Instituto Nacional Autonomo de Investigaciones Agropecuarias, Ecuador
Institut Pertanian Bogor (Bogar Agricultural University), Indonesia
Institut Sénégalais de Recherches Agricoles, Sénégal

Kenyan Agricultural Research Institute, Kenya
L'Office de la Haute Vallee du Niger, Mali
Makerere University, Uganda
National Agricultural Research Institute, Senegal
PhilRice, Philippines
Plant Protection Research Institute, South Africa
Programme de Developpement de la Production Agricole au Mali, Mali
Reseau African de Developpment de l'Horticulture, Senegal
Samarkand Agricultural Institute, Uzbekistan
Sam Ratulangi University in North Sulawesi, Indonesia
Sokoine University of Agriculture, Tanzania
Tamil Nadu Agricultural University, India
Tanzania Coffee Research Institute, Tanzania
University of the Philippines at Los Banos, Philippines
University of Queensland, Australia
World Cocoa Foundation
World Conservation Union, Kenya
Zamorano School of Tropical Agriculture

IARCs

The World Vegetable Center (AVRDC)
International Crops Research Institute for the Semi-Arid Tropics (ICRISAT)
The International Institute of Tropical Agriculture (IITA)
International Rice Research Institute (IRRI)
International Food Policy Research Institute (IFPRI)
International Center for Agricultural Research in the Dry Areas (ICARDA)
International Center for Insect Physiology and Ecology (ICIPE)
International Potato Center (CIP)
The International Maize and Wheat Improvement Center (CIMMYT)

Private Sector

World Cocoa Foundation
The Energy and Resources Institute
AGROEXPERTOS, Guatemala